Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments

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HAZARDOUS MATERIALS COOPERATIVE RESEARCH PROGRAM

HMCRP REPORT 8

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HAZARDOUS MATERIALS COOPERATIVE RESEARCH PROGRAM

The safety, security, and environmental concerns associated with transportation of hazardous materials are growing in number and complexity. Hazardous materials are substances that are flammable, explosive, or toxic or that, if released, produce effects that would threaten human safety, health, the environment, or property. Hazardous materials are moved throughout the country by all modes of freight transportation, including ships, trucks, trains, airplanes, and pipelines.

The private sector and a diverse mix of government agencies at all levels are responsible for controlling the transport of hazardous materials and for ensuring that hazardous cargoes move without incident. This shared goal has spurred the creation of several venues for organizations with related interests to work together in preventing and responding to hazardous materials incidents. The freight transportation and chemical industries; government regulatory and enforcement agencies at the federal and state levels; and local emergency planners and responders routinely share information, resources, and expertise. Nevertheless, there has been a long-standing gap in the system for conducting hazardous materials safety and security research. Industry organizations and government agencies have their own research programs to support their mission needs. Collaborative research to address shared problems takes place occasionally, but mostly occurs on an ad hoc basis.

Acknowledging this gap in 2004, the U.S. DOT Office of Hazardous Materials Safety, the Federal Motor Carrier Safety Administration, the Federal Railroad Administration, and the U.S. Coast Guard pooled their resources for a study. Under the auspices of the Transportation Research Board (TRB), the National Research Council of the National Academies appointed a committee to examine the feasibility of creating a cooperative research program for hazardous materials transportation, similar in concept to the National Cooperative Highway Research Program (NCHRP) and the Transit Cooperative Research Program (TCRP). The committee concluded, in *TRB Special Report 283: Cooperative Research for Hazardous Materials Transportation: Defining the Need, Converging on Solutions,* that the need for cooperative research in this field is significant and growing, and the committee recommended establishing an ongoing program of cooperative research. In 2005, based in part on the findings of that report, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) authorized the Pipeline and Hazardous Materials Safety Administration (PHMSA) to contract with the National Academy of Sciences to conduct the Hazardous Materials Cooperative Research Program (HMCRP). The HMCRP is intended to complement other U.S. DOT research programs as a stakeholder-driven, problem-solving program, researching real-world, day-to-day operational issues with near- to mid-term time frames.

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FOREWORD

By William C. Rogers
Staff Officer
Transportation Research Board

HMCRP Report 8: Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments examines the challenges of advancing the use of electronic shipping papers as an alternative to the current paper-based hazardous materials communication system. Paper copy hazardous materials shipping papers have several drawbacks: they are labor intensive and subject to human error; they are perishable and may not be available to emergency responders in the event of an incident; and they are difficult to exchange between modes or different vehicles within a mode. The use of internationally compatible electronic data-sharing technologies could significantly improve the exchange of hazardous materials shipping information among shippers, carriers, regulatory agencies, and emergency responders. Timely access to accurate hazardous materials shipping information will likely reduce errors in information exchange, improve efficiency, enhance security, and improve the response efforts in the event of a hazardous materials incident.

Organizations representing shippers and carriers have expressed the need to improve the hazardous materials documentation process by allowing the option of electronic shipping papers, thereby enhancing transportation productivity and efficiency. Although there are no legal or regulatory prohibitions regarding the use of electronic shipping papers, cost, privacy, and lack of uniformity are factors that could restrict their adoption.

Under HMCRP Project 05, Battelle was asked to develop a road map for the use of electronic shipping papers as an alternative to the current paper-based hazardous material communication system. To do so, the researchers examined the needs of key stakeholder groups including (1) motor carriers, railroads, ocean shippers, and cargo-carrying airlines; (2) emergency responders; (3) regulatory agencies; and (4) associations, organizations, and agencies affiliated with the preceding groups. The research examined current practices involving electronic transactions, including those applicable to hazardous materials transportation, and impediments to more widespread use of electronic shipping papers. The research resulted in a critical examination of how a unified electronic shipping paper system could emerge. This is expressed in a road map that demonstrates how affected stakeholders can implement an electronic hazardous materials documentation and data transfer system. It also identifies a methodology for proof-of-concept exercises designed to test the implementation strategies and functionality of an electronic hazardous materials documentation and data transfer system identified by the road map.

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Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

SUMMARY

Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments

Introduction

Project Objective

The objective of this project was to develop a road map for the use of electronic shipping papers as an alternative to the current paper-based hazardous material communication system. The road map addresses the electronic transfer of safety, operational, regulatory compliance, and emergency response data and documentation, for and among all carrier transport modes including highway, rail, marine, and air.

Problem Statement/Discussion

A hazardous material shipping paper is a shipping order, bill of lading, manifest, or other shipping document serving a similar purpose and containing the information required by Part 172, Section C of the Hazardous Materials Regulations (HMR). The HMR are issued by the U.S. Department of Transportation's (U.S. DOT's) Pipeline and Hazardous Materials Safety Administration (PHMSA). The HMR do not require that shippers use a special form, but require that descriptive information be provided in a specific sequence. A proper hazardous materials shipping description includes a basic description (identification number, proper shipping name, hazard class, and packing group if applicable), additional information that depends on the materials and mode of transport, quantity of hazardous material(s), and type of packing used.

The U.S. DOT requires that carriers have a shipping paper with the hazardous materials shipment in a specified location in the transporting vehicle for the duration of the trip, and both the shipper and carrier must retain a copy of this shipping paper for a period of time after the shipment has reached its final destination. Hard copy hazardous materials shipping papers have some drawbacks. A hazardous materials shipment may be exchanged between different modes and different vehicles within a mode, which is more easily handled electronically since the current paper documents may not be easily interchangeable. A hard copy system is labor-intensive and subject to human error. Hard copy documents are perishable to the extent that in some hazardous materials incidents the shipping papers may be destroyed, removing vital emergency response information.

While there is a substantial amount of e-commerce conducted within transportation, especially if faxes are included, in other aspects of our lives electronic transactions have long since superseded the exchange of paper as a requirement. For example, e-commerce is routinely used by banks, investment firms, and healthcare providers to transmit large amounts of sensitive information quickly and securely. It is very common for an individual to pay bills

and file income taxes online and withdraw money from an ATM in cases where paper may serve as a record of receipt but is not required for the transaction.

Why then are electronic transactions not in greater use in commerce related to transportation in general, and more particularly to types of commerce in which hazardous materials electronic shipping papers could be used? How can the e-commerce systems that have the potential to enable more widespread use of electronic shipping papers better meet the diverse needs of the hazardous materials stakeholder groups? The research from HMCRP Project 05 explored these and other questions in considering issues and strategies for advancing the use of electronic shipping papers.

It should be emphasized that this research evaluated the use of electronic shipping papers for hazardous materials transportation as an alternative to hard copy shipping documents rather than a replacement for them. "Alternative" was interpreted to mean that electronic shipping papers are a voluntary replacement for hard copy shipping papers under circumstances where hard copies are not required, and work in conjunction with hard copies where those are required, rather than as a mandatory replacement of hard copies by electronic shipping papers. This research recognizes the benefits of unifying the growing advantages of an electronic shipping paper system in a way that it becomes increasingly desirable and attainable, so that the hazardous materials transportation community is not bound by the limitations of hard copy shipping papers. While certain segments of the hazardous materials transportation community are currently using electronic shipping papers consistently and successfully, it must be recognized that a process of standardization and adoption is needed for the larger community to attain the potential benefits of a unified electronic shipping paper system.

Nomenclature. The term "hazardous materials" is most commonly used in the United States; the more universal term worldwide is "dangerous goods." Both terms are used in this document and are interchangeable. Hazardous materials are often referred to in this document by the commonly accepted, abbreviated form of "hazmat." Similarly, electronic shipping papers are hereafter referred to as "ESP," an abbreviation that also applies to the association of hazmat ESP with their corresponding, required emergency response information. In this document, both of these terms—hazmat and ESP—refer to both singular and plural usage for convenience, although verb agreement depends on the context. The Hazardous Material Regulations are referred to as the "HMR." The terms "marine mode" and "ocean mode" (also referred to by some sources as "maritime mode" or "water mode") are essentially interchangeable, although inland barge transport is not included in ocean mode. The terms "paper" and "hard copy" referring to shipping papers or bills of lading are used interchangeably. Where there is mention of hazmat classes and divisions, they are per U.S. DOT designations. While international standards and commerce are discussed, this document references stakeholder organizations that are primarily North American. Nevertheless, the research recognizes that the needs, challenges, and solutions are truly international.

Definitions of terms and acronyms and abbreviations are found in Appendix A.

Project Approach and Findings

Focus

The heart of HMCRP Project 05 was the creation of a road map that describes the benefits of, and the path toward, creating a unified ESP system that supports interoperability and exchange of standardized electronic commerce for hazmat transportation. The road map demonstrates how affected stakeholder organizations can implement an electronic hazmat documentation and data transfer system. The research also identifies a methodology for proof-of-concept exercises designed to test the implementation strategies and

functionality of an electronic hazmat documentation and data transfer system identified by the road map.

The research initially examined the needs of those organizations involved with shipments of placarded hazmat including hazardous waste, although the research also considered ESP in the benefits of transportation-related electronic document transactions in general. It examined the needs of key stakeholder groups, including motor carriers, railroads, ocean shippers, and cargo-carrying airlines; emergency responders; regulatory agencies; and associations, organizations, and agencies affiliated with the preceding groups. The research examined current practices involving electronic transactions, including those applicable to hazmat transportation, and impediments to more widespread use of ESP. It resulted in a critical examination of how a unified ESP system could emerge.

Organization

HMCRP Report 8 is organized as follows:

- Summary
- Chapter 1: Background
- Chapter 2: Research Approach [including project objectives, problem statement, and preliminary findings (Tasks 1 through 3)]
- Chapter 3: Findings and Applications (Tasks 4 through 7)
- Chapter 4: Conclusions
- References
- Appendix A: Acronyms, Abbreviations, and Terms
- Appendix B: Initial Research Interview Summary and Guideline
- Appendix C: Results of Initial Research Interviews
- Appendix D: Technology That Can Benefit Stand-Off Detection of ESP by Emergency Response and Regulatory Compliance Personnel

Chapter 2: Research Approach

Chapter 2 describes the major tasks followed to conduct the project's research as well as the major results and insights garnered from the tasks:

- Task 1: Gather information,
- Task 2: Develop sample process maps of common and complex hazmat shipments,
- Task 3: Submit an interim report based on the findings of Tasks 1 and 2,
- Task 4: Submit a draft road map for the implementation of a cost-effective electronic hazmat documentation and data transfer system,
- Task 5: Propose a methodology for proof-of-concept exercises,
- Task 6: Submit the road map and a draft final report that documents the entire research effort, and
- Task 7: Respond to project panel comments and submit the final report.

The methods followed for the project's tasks and their findings are summarized in the following.

Task 1: Gather Information. The research conducted under this task identified relevant information concerning the use of ESP, electronic freight management (EFM) systems, and enforcement and emergency response issues surrounding access to and use of hazmat

shipment information. The task included a literature search and interviews with selected stakeholders. Literature sources reviewed were general publications, professional journals, websites, media reports, and other materials.

In total, there were approximately 50 direct interviews conducted, in addition to surveys of specific carrier groups by their respective associations. The interviews were conducted by telephone or in person. Some individuals were provided copies of the questions in advance and were contacted to gather additional information about their responses.

The interviews involved (1) 22 organizations, including government agencies, carrier and trade associations of various modes, and a council; (2) 23 carriers of all modes, and (3) four national emergency response organizations. Some additional interviews were also conducted, such as with a wireless technology provider.

The discussion under Task 1 was organized as follows:

1. Current use of ESP and EFM systems in general,
2. Enforcement and emergency response issues related to hazmat shipping information, and
3. Issues involving the implementation of electronic data interchange (EDI) systems

The research described three systems implementing EDI applications that could serve to contribute valuable insights into what works. The Bolero system is based on an initial entry, created by a transaction, followed by messages related to the transportation and shipment. By documenting specific messages along the entire shipping process, the Bolero system is able to track where a bill of lading and shipment are at all times. TradeNet, another EDI application, is an electronic network that facilitates international trade by integrating all the processing procedures for import, export, and trans-shipment documents and licenses. It uses a single document to fulfill all the trade documentation requirements, and that document is routed electronically to all the parties associated with trading. U.S. Customs and Border Protection (CBP) implemented the Automated Commercial Environment (ACE) (*1*), the commercial trade processing/truck manifest system, to facilitate legitimate trade and strengthen border security. With ACE, motor carriers and other eligible parties are required to transmit advance electronic truck cargo information to CBP through a CBP-approved EDI. [It should be noted that Canada has its counterpart to ACE, the Advance Commercial Information (ACI) system (*2*).] For all of the systems investigated, maintaining a high level of security was a key requirement, and all of the systems included mechanisms to accomplish this.

The literature review and interviews also identified enforcement and emergency response issues. In general, emergency responders and enforcement personnel favor any mechanisms that enhance their ability to accomplish their jobs more effectively. Emergency responders believe that the presence of ESP in addition to paper provides an added option in an emergency. For example, the emergency responders indicated that in a situation where a hazmat vehicle is burning and the hard copy hazmat papers may be unavailable, obtaining the shipping papers electronically could be another way of identifying the nature of the hazmat cargo, thus enabling more rapid deployment of the most suitable response measures. Similarly, regulatory compliance enforcement personnel indicated that the presence of electronic emergency response papers could provide quicker access to information about the type and quantity of hazmat in cargo and enable their personnel to improve inspection efficiency.

Important issues revolve around the specific method employed to make ESP available to emergency response and enforcement personnel. Impediments relate to such issues as how ESP data will be collected and stored and how emergency responders and enforcement

personnel will access these electronic papers. As expected, the potential costs of the program for a centralized system as well as costs of equipment and training for field personnel are seen to present a formidable obstacle to adoption. (It should be noted that a centralized system was not suggested as the goal or expected outcome of the research; however, some interviewees chose to offer their thoughts on a potential centralized system.)

Task 2. Develop Sample Process Maps of Common and Complex Hazmat Shipments. The research conducted under this task described the transportation of hazmat across various modes. It examined process activities and relationships, which were shown at a relatively high level. Process activities and relationships are generic in nature since individual industries, carriers, shippers, or transportation intermediaries may have unique processes for their handling of hazmat shipments.

Carriers across various modes treat hazmat shipments with care, starting with shipment booking. Carrier databases are used to varying degrees in managing this process. In many cases, all documentation required for hazmat transportation is generated from the carrier system based on the booking information. Documentation and electronic notification for forwarders and interlining carriers are often generated from the carrier's system. (Interlining is a voluntary commercial agreement between individual carriers to handle cargo that requires multiple carriers.)

Special equipment or loading requirements are involved in hazmat shipments. Stowage and loading plans for less-than-truckload (LTL), ocean, and air carriers are critical since these conveyances combine a multitude of shipments and commodities. Proximity and handling of hazmat commodities in mixed conveyances are of critical importance. Carriers prepare stowage plans or hazmat manifests to enable emergency responders to quickly identify commodity locations.

Through the information obtained by reviewing the literature and interviewing stakeholders, an initial sample process map was developed that incorporated the specific elements that are present in most shipment types. This initial process map was ultimately used as a basis for developing distinct process maps for a number of unique shipment profiles.

Process maps were developed for each mode [two for highway mode: truckload (TL) and LTL]. The TL process flow shown in Figure S-1 is straightforward and serves as a useful model for understanding the basic interrelationships between shipper (consignor), carrier, and receiver (consignee). There are only one carrier, one vehicle (typically), and three parties involved. The represented business processes between consignor and consignee are generalized. In TL shipments, the documents, including shipper's hazmat certification, move with the shipment.

Task 3. Submit an Interim Report Based on the Findings of Tasks 1 and 2. The literature search and interviews and resulting process maps show that electronic communication offers many advantages over paper-based communication. For the shipper, all information pertaining to the shipment can be instantly delivered to anyone designated to receive it. For the freight forwarder or carrier, data are more reliable because they reflect the content of the shipper's computer. In addition, ESP are more likely to be presented in a standardized format, and electronic communication is a less time-consuming method for companies to process documentation. The primary benefits to carriers are through the reduction of operational costs, primarily in back-office clerical activities. The quantification of such savings depends greatly on the level of process automation for the implementing carriers and their partners and the types of solution implemented. Finally, ESP offer the potential for emergency responders to remotely learn about the details of the cargo that are critical to protecting the health and safety of the responders and the public.

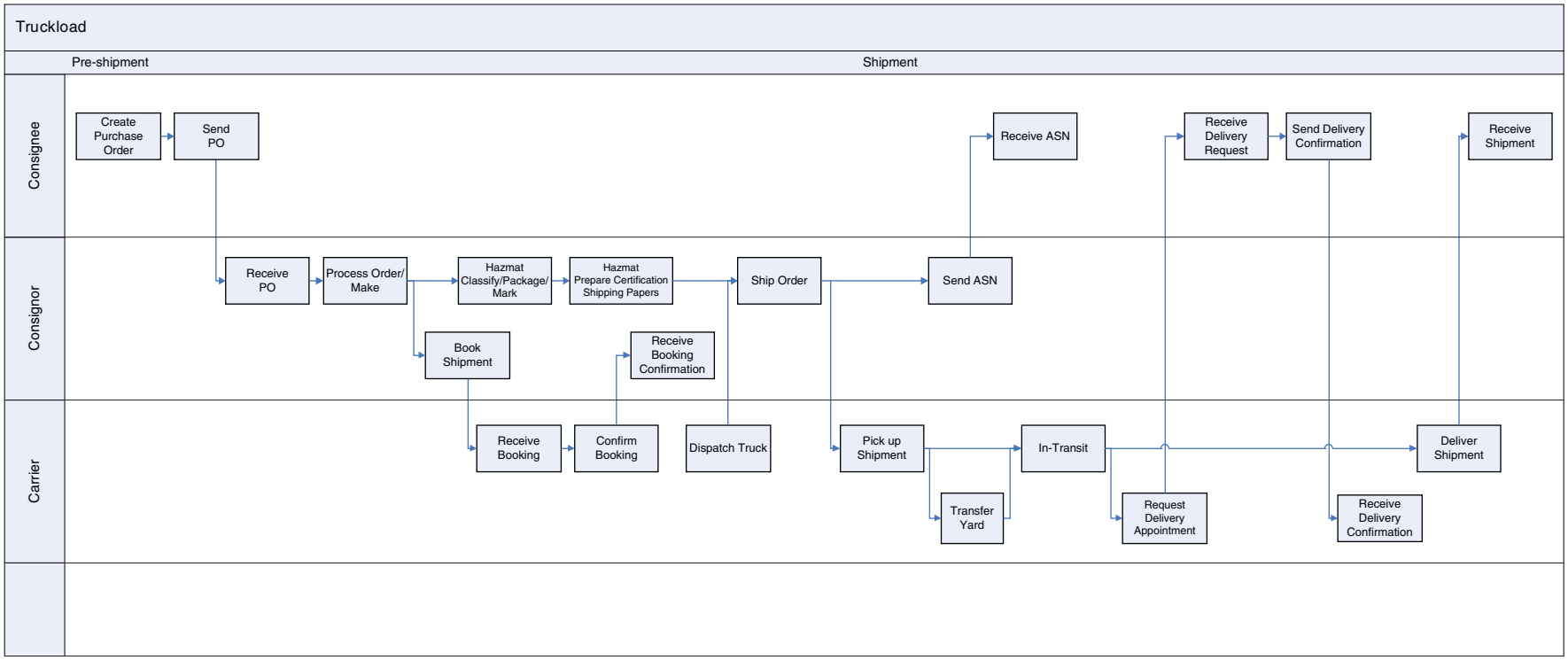

Figure S-1. Truckload process map.

The report emphasized that for users to realize the widespread benefits from ESP, there must be both effective standardization and implementation. Implementation of a standardized shipping paper format will require an institution to assume a leadership role in the process (i.e., a muscular champion is needed). The research showed that government is the most likely institution to take the lead in standardizing shipping paper format.

Chapter 3: Findings and Applications

Chapter 3 includes the process followed and results of Task 4: Submit a Draft Road Map and Task 5: Propose a Methodology for Proof-of-Concept Exercises, as well as the overall findings and a discussion of the applications of ESP. Chapter 3 describes both the benefits identified from successful implementation of ESP and the issues that are likely to create problems for augmenting or replacing the existing hazmat communication system.

The project identified four major stakeholder groups, with differences in the findings related to each group. For example, some regulatory compliance personnel may be primarily involved with safety and others with security.

Survey interviews asked participating carriers to estimate the total processing time or cost associated with their processing of hard copy shipping papers. Responses varied. Table S-1 provides a sample of responses that illustrate the range of impacts, depending on the level of automation and mode-specific processes and practices. It is unclear why the range of estimated impacts varies so greatly, particularly with the ocean carrier. Respondents felt that time would be saved by entering data once and then using it multiple times. Although hard copy shipping papers and emergency information for hazmat are required to be on the vehicles transporting them, having the data in the form of ESP allows the hard copies to be printed.

The primary benefits to government will be through the streamlining of document (shipping paper) acquisition and review, as well as a reduction in data entry errors if ESP information can be integrated with roadside inspection software and other relevant reports to be completed such as crash and incident reports. After initial investments, there likely will be a reduction of operational costs through efficiency gains, particularly with the ability to move ESP data electronically to stakeholders on a need-to-know basis more quickly and accurately than is done today so that it may be acted upon more quickly. The quantification of such savings will depend greatly upon the level of process automation for the particular government entities and the type of solution(s) implemented. Regulatory benefits will depend on the modifications made or parameters established by oversight agencies to accept ESP as an alternative to hard copy papers.

Impediments to the adoption of ESP relate predominantly to three areas. The first is cost. Carriers and shippers are concerned that the costs of instituting ESP will outweigh the benefits. The second is a concern that regulatory agencies will use ESP as a means to expand compliance. This could make transporting hazmat more expensive and difficult, and there is also concern that greater access to shipment information through a mandated, nationwide ESP system would risk exposing business-sensitive data to inadvertent disclosure. Third, both

Table S-1. Impact of processing time avoided by ESP over hard copy shipping papers.

Respondent	Estimate of Impact
Air carrier	1 hour
Air carrier	40 min – 1 hour, 40 min
Integrator	5 min
Ocean carrier	minutes – hours

carriers and shippers express the fear that unless implementation is universal, some companies will be bearing additional costs that would be avoided by their competitors. There are also concerns that any mandated system may not be affordable to small operations, including those that service specialized needs or remote locations. Effective functioning of the system would be very difficult unless ESP is adopted universally.

Stakeholders and User Needs Summary. Chapter 3 identifies the major stakeholders and user needs for the four primary stakeholder groups involved with ESP: shippers, carriers, regulatory agencies, and emergency responders. A single hazmat shipment from its origin to destination may involve intermodal transportation and international border crossing(s), and otherwise may involve a number of the stakeholder groups. Shippers and carriers are more concerned with the commercial, logistical, freight management back-office nature of ESP benefits. Shippers (who may also be product manufacturers) offer hazmat for delivery to a consignee. They verify that the shipment complies not only with Title 49 of the Code of Federal Regulations (49 CFR) but also with other mode-specific regulations. Business operations need additional information such as on nonhazardous materials, other parties in the supply chain, billing and financial data, and expected delivery time. Carriers accept shipments and execute the contracted needs of the shipper, transporting the goods to the consignee or to an interline carrier (i.e., transfer to a different transportation carrier).

Regulatory enforcement personnel need information with which to determine whether the hazmat shipment is compliant with safety requirements. Emergency responders primarily need specific information on the materials present, types of containers, and quantities of materials. Potential interaction of hazmat with other materials in the shipment is a concern to emergency responders. While it is not feasible to have information about chemical interactions in either electronic or hard copy shipping papers, ESP can otherwise help emergency responders by being available more quickly and to more organizations than hard copies when accessed remotely.

Table S-2 characterizes the basic user needs for each primary stakeholder group.

Table S-2. User needs characterization.

Stakeholder Group	User Needs
Shippers	• In-transit visibility • Data sharing with supply chain partners • Regulatory compliance • Paperwork reduction/reduced administrative expense • Hazmat/dangerous goods shipping paper creation • Commercial information security
Carriers	• In-transit visibility • In-transit records compliance • Paperwork reduction/reduced administrative expense • Data sharing with authorized interlines • Record retention compliance • Bill of lading, manifest, and freight bill creation • Commercial information security • Anti-theft/-sabotage/-terrorism security
Regulatory compliance	• In-transit records compliance • Record retention compliance • Shipment, vehicle, and driver documentation
Emergency responders	• Specific information on materials present, types of containers, material quantities, and how to get timely expert information on potential interactions with other materials in the shipment • Awareness of product name • Emergency contact information • Receipt of information quickly and ideally at safe stand-off distance

Existing Electronic Interchange Systems. One important contribution of the research was to identify and categorize types of electronic interchange systems. As part of the effort to identify best practices in place for ESP, many existing solutions were identified. These solutions were grouped into categories. The descriptions of the existing systems and examples follow. None of the specific commercial solutions are cited, but their functionality is described in general terms. These categories are:

Direct partner-to-partner exchanges, in which trading partners agree on the format and method of information exchange and implement the exchange directly between the partners' respective systems. The format and method of the information exchanged can take any form agreed to between the partners, but it is suggested that industry standards [e.g., EDI; extensible markup language (XML)] be adhered to in these implementations.

Value-added networks (VANs), in which trading partners use a third-party forwarding or translation service to facilitate the exchange of information between parties, such that each party can maintain its existing document format. The VAN serves to receive a document or file from one trading partner in that partner's preferred electronic format, translate the data as necessary into a format that the receiving partner can read, and forward the document to the receiving party or parties.

Hosted systems, in which all data intake takes place under a single, often centralized system that allows for trading partners with little information technology infrastructure to participate in e-commerce-type activities. A trading partner will typically log onto a service provider's website to generate shipping documents, check status of shipments, and perform other functions.

Variations, which include systems that are a combination of the previous approaches. For instance, a large retailer may conduct direct data exchanges with its top Tier 1 suppliers (i.e., suppliers that sell products directly to a company and thus are very high on that company's chain of suppliers) but use a VAN to communicate with Tier 2 suppliers (i.e., suppliers that sell products to Tier 1 suppliers rather than directly to the company).

Chapter 3 recognizes a number of current efforts that have relevance to ESP (see Section 3.2), such as:

- PHMSA's Hazardous Materials – Automated Cargo Communications for Efficient and Safe Shipments (HM-ACCESS) program, which is conceptually related to HMCRP Project 05, and
- U.S. DOT's Dynamic Mobility Applications (DMA) program, which seeks to identify, develop, and deploy applications that leverage the full potential of connected vehicles, travelers, and infrastructure. Within DMA, automated vehicle-to-infrastructure (V2I), vehicle-to-vehicle (V2V), and infrastructure-to-vehicle (I2V) communications could play a significant role in the future of ESP.

Chapter 4: Conclusions

Chapter 4 suggests a path forward for the use of ESP for hazmat shipments. The analysis concludes that much of what needs to be in place to realize a standards-based ESP solution already exists. Table S-3 summarizes, in stoplight format, the state of readiness of eight key elements. While most components are displayed as yellow (Y), only one component, displayed as red (R), signifies a major hurdle.

Chapter 4 suggests that efforts such as the International Vessel Operators Dangerous Goods Association's (IVODGA's) Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping program (see Subsection 3.3.2) and the International Air Transport Association's (IATA's) e-freight initiative (see Subsection 3.3.1) be referred to for valuable

Table S-3. ESP implementation state of readiness.

Readiness Element	Readiness	G/Y/R*
Stakeholder buy-in	Shippers and carriers must see a positive net cost–benefit ratio before adoption is likely. Challenges to data privacy and sensitivity must be overcome before regulators and emergency responders can expect to benefit.	Y
Data entry requirements	A data dictionary must be selected and subsequently extended to handle hazmat information.	Y
Information flow parameters/limits	Interfaces that enable the integration of ESP with existing business-to-business (B2B) applications and open standards must be developed/adopted.	Y
Support of multimodal shipments	Marine and air have begun moving down the path of multimodal standards. Rail's use of Standard Transportation Commodity Code (STCC) is a critical barrier.	Y
Degree of in-transit visibility	This visibility is dependent on the willingness of partners to share information as well as the timeliness and availability of the data.	Y
Adequacy of standards	Standards exist to support nearly all aspects of an ESP solution, and it is simply a matter of choosing which best serves the user needs.	G
Interoperability with other electronic commerce systems	A multitude of current, disparate systems and no specific mandate to change preclude this from being readily implementable.	R
Data/communications security	Current security standards and best practices implemented in other industries are adequate to support e-commerce and ESP needs.	G

*G = Green, Y = Yellow, R = Red

lessons. Both efforts took a multimodal approach and gleaned useful information regarding the use of data elements in place across multiple modes. IVODGA prepared a detailed multimodal mapping of these elements in its 3.12 Shipping Paper worksheet of all modes. Both efforts have faced challenges in realizing broad acceptance and adoption, yet how and why these challenges arose and what these organizations have done to address them yielded lessons for hazmat ESP. Among these lessons is that of developing an approach and performance metrics that account for the business processes and improve efficiency of participants along the transportation information chain. Also, stakeholder education leading to broad acceptance and adoption is critical to move from research to practical application.

The road map (i.e., path forward) will entail a multiphase, multiyear effort requiring sponsors and champions from the public sector and associations representing key modes. The key elements of this effort involve:

- Development of standards for e-commerce and data elements;
- Proof-of-concept tests, field tests, and pilots; and
- Cost–benefit analyses.

Approaches for ESP compliance may be developed that offer alternatives to electronic data exchange. Broad adoption that meshes with business processes and improves efficiency will need to incorporate electronic data exchange. Standards for e-commerce, including data elements, must be established in the path forward. As shown in Table S-3, interoperability with other e-commerce systems remains a key hurdle, while the standards needed to support ESP solutions have already been covered by IVODGA and IATA.

A series of proof-of-concept exercises, field testing, and operational pilots should be conducted to assess the feasibility and functionality of alternative approaches. This report

Table S-4. Timeline (outline for a path forward).

	Near-Term		Mid-Term		Long-Term
Action/ milestone	Identify champion for ESP effort Review and consolidate products of prior related efforts (e.g., IATA e-freight, IVODGA's Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping, HM-ACCESS) Facilitate meetings of ESP stakeholder organizations	Discuss e-commerce standard(s) and data elements applicable to ESP Conduct initial cost–benefit analyses on elements of ESP implementation Conduct sponsored proof-of-concept test(s) Identify conceptual ESP system Conduct cost–benefit analyses on conceptual ESP system	Reach agreement on required ESP data elements Define e-commerce standard(s) applicable to ESP Accept e-commerce standard applicable to ESP	Conduct field tests of prototype ESP system Conduct limited and wider field tests of ESP standard and system Enact guidance	Conduct pilot implementations involving all transportation modes (i.e., highway, rail, marine, and air)

provides a detailed methodology for the proof-of-concept exercises designed to test implementation strategies and functionality. The proof-of-concept exercises will be the first phase, and subsequent tests will narrow feasible options to those most likely to meet the goals and performance objectives of the ESP.

Cost–benefit analyses should attend each test phase to ensure that practical and implementable solutions that meet business-level returns on investment (ROIs) are being sought. Industry will not accept unfunded mandates or approaches that provide benefits to one segment of participants while driving up the cost of another segment.

In terms of the road map, Table S-4 shows key milestones that need to be achieved for implementation of ESP. These are essentially sequential, although some overlap should be possible. With an aggressive approach, it may be possible for pilot ESP implementations to be underway within a decade.

Summary and Conclusions

The key to implementing hazmat ESP for the benefit of all of its major stakeholder groups and for multimodal shipments is solving the larger challenges of e-commerce. E-commerce is currently being used successfully by groups using electronic document submission. However, for hazmat stakeholders these successful examples have developed largely in isolation from other modes and stakeholders, and there is no common standard with adequate guidance to allow them to have the desired compatibility across multimodal domains.

For ESP to be successful as an alternative to hard copy shipping papers, data need to be entered once and reused to the greatest extent. To achieve that, entry of electronic data into ESP needs to start with the shipper to provide sufficient continuity throughout the shipment's life cycle and meet the potential of ESP. Origination with the shipper is not currently occurring to a significant extent, which is a large obstacle that must be resolved to achieve success.

When identified issues and impediments have been addressed, the following benefits can be expected to accrue from the adoption of ESP:

- *Improved accuracy and advanced notification of shipping paper information.* This could also improve safety by helping ensure that a particular facility is adequately equipped to receive a certain hazmat.
- *Improved safety by being able to obtain access to ESP when the paper copies are unavailable.* A costly delay could occur when shipping papers are destroyed or inaccessible due to the aftermath of a serious hazmat spill resulting from a tank truck crash or rail tank car derailment.
- *Protection of security-sensitive and business-sensitive information through advanced processing techniques and commercial encryption practices*. Potential users will be more accepting of ESP's efficiencies and communications advantages when they are sure that sensitive data will be protected.
- *Cost savings.* When total costs are aligned, savings should be achievable. For example, paper copies can be printed from highly accurate ESP as opposed to ESP resulting from laborious electronic keying of information from the paper copies by a stakeholder that does not realize a benefit.
- *Access to ESP by emergency responders and roadside inspection personnel through pre-arranged permissions appropriate to their need.* This will allow quicker access to the information on the shipping paper, including emergency-response-related information that can supplement services already available to help emergency responders.
- *Improved transferability of hazmat shipping information to other modes, facilitating interlining.* When shipments are split up en route, electronic signatures and approvals can help reduce confusion and provide greater visibility into timing and composition of the material to be delivered to the consignee.

Despite the identified challenges of implementing ESP, there are no substantive logical or legal impediments involved. However, the research shows that a single solution that will meet the needs of all stakeholder groups to an appreciable degree would be very difficult and costly to achieve, and for it to even be possible a number of trade-offs must be considered. Thus, the research implies the need for a unified ESP system view that supports interoperability and exchange of standardized electronic commerce for hazmat transportation of all carrier modes, carrier types, and hazmat classes without duplicate data entry.

The aforementioned benefits can be achieved through voluntary action. This will require cooperation and commitment among the stakeholders. The private sector is most concerned with business efficiency and cost savings. Industry knows the most appropriate technology solutions and standards that should be applied to the challenge and can effectively implement them.

While voluntary efforts are preferred, if regulation involving ESP is pursued, ESP adopters should not be penalized.

Trade associations and other stakeholder organizations can help define ESP implementation goals to benefit the hazmat transportation community and advance the interests of their members. Key stakeholder groups could be aligned to sponsor and conduct the proof-of-concept exercises, participate in collaboration to help promote achievable goals along the path to ESP implementation, and encourage participation in a global ESP implementation process.

CHAPTER 1

Background

1.1 Project Objectives

The HMCRP Project 05 statement of work (SOW) noted that:

> When offering hazardous material for transportation, a shipper is required to create a shipping paper that is intended to inform the carrier of the inherent risks involved in the handling and transport of the material. Shipping papers also contain specific hazard information, standardized so that emergency responders may identify appropriate measures to be taken in the event of a hazardous material incident. The U.S. Department of Transportation (U.S. DOT) requires carriers to have a shipping paper with the hazardous material shipment at all times, and both the shipper and carrier must retain a copy of this shipping paper for a period of time after the shipment has reached its final destination. Hazardous material shipping papers have some drawbacks: the current paper documents may not be interchangeable between modes; a paper system is labor intensive; and paper is perishable to the extent that in some hazardous material incidents, the shipping papers may be destroyed, removing vital emergency response information.
>
> Organizations representing shippers and carriers have expressed the need to improve the process by allowing the option of ESP [electronic shipping papers] as an important tool for enhancing productivity and efficiency in hazardous material transport. The International Maritime Dangerous Goods Code and the International Civil Aviation (Organization) Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Technical Instructions) permit the use of electronic data processing (EDP) and electronic data interchange (EDI) transmission techniques. Nevertheless, carriers still usually require hazardous material shippers to generate hazardous material shipping papers prior to accepting cargo, partly because no shipment can move only by aircraft or vessel, and regulations governing other modes may not facilitate the use of EDI for hazardous materials.
>
> The use of internationally compatible electronic data sharing technologies could significantly improve the exchange of hazard information among shippers, carriers, regulatory agencies, and emergency responders, especially for time-sensitive cargo and containerized cargo. Timely access to accurate hazardous materials information will likely reduce errors in information exchange, improve efficiency, enhance security, and improve the response efforts in the event of a hazardous material incident. Research is needed to identify the capability within the transport sector to use an electronic means of documentation as a complementary alternative to a paper-based system.

Per the U.S. DOT requirement, the carrier transporting the hazmat must keep a hard copy shipping paper for the hazmat cargo in a specified location in the vehicle for the duration of the trip (see Subsection 1.2.4.3).

The objective of this project was to develop a road map for the use of ESP as an alternative to the current paper-based hazmat communication system. It should be emphasized that this research evaluated the use of electronic shipping papers for hazardous materials transportation as an alternative to hard copy shipping documents rather than a replacement for them. "Alternative" was interpreted to mean that ESP are a voluntary replacement for hard copy shipping papers under circumstances where hard copies are not required, and working in conjunction with hard copies where those are required, rather than as a mandatory replacement of hard copy shipping papers by ESP. The research recognizes the benefits of unifying the growing advantages of an electronic shipping paper system in a way that it becomes increasingly desirable and attainable, so that the hazardous materials transportation community is not bound by the limitations of hard copy shipping papers. While certain segments of the hazardous materials transportation community are currently using electronic shipping papers consistently and successfully, it must be recognized that a process of standardization and adoption is needed for the larger community to attain the potential benefits of a unified electronic shipping paper system.

The road map addresses the electronic transfer of safety, operational, regulatory compliance, and emergency response data and documentation, for and among all (carrier) transport modes. A methodology for proof-of-concept exercises designed to test the implementation strategies and functionality of an electronic hazmat documentation and data transfer system was developed in conjunction with the road map.

The remaining organization of this report is as follows:

- Chapter 2: Research Approach [including project objectives, problem statement, and preliminary findings (Tasks 1 through 3)]
- Chapter 3: Findings and Applications (Tasks 4 through 7)
- Chapter 4: Conclusions
- References
- Appendix A: Acronyms, Abbreviations, and Terms
- Appendix B: Initial Research Interview Summary and Guideline
- Appendix C: Results of Initial Research Interviews
- Appendix D: Technology That Can Benefit Stand-Off Detection of ESP by Emergency Response and Regulatory Compliance Personnel

The project's preliminary findings that were based on Tasks 1 through 3 are provided in Chapter 2. These findings include:

- Information gathered on relevant topics and organizations (Task 1);
- Development of sample process maps of common and complex hazmat shipments, including intermodal shipments, from origin to destination (Task 2); and
- An interim report (Task 3) that was based on the findings of Tasks 1 and 2.

The project's findings and applications that were based on Tasks 4 through 7 are provided in Chapter 3. These findings and applications include:

- A road map for the implementation of a cost-effective electronic hazmat documentation and data transfer system (Task 4);
- A methodology for proof-of-concept exercises (Task 5) designed to test the implementation strategies and functionality of an electronic hazmat documentation and data transfer system identified in Task 4;
- A draft final report that documents the entire research effort, explains and justifies recommendations, provides background information used in the development of recommendations that address deficiencies, and recommends further research, including the proof-of-concept exercises (Task 6); and
- This final report (Task 7).

Chapter 4 provides the project's conclusions.

1.1.1 Nomenclature

The term "hazardous materials" is most commonly used in the United States; the more universal term worldwide is "dangerous goods." Both terms are used in this document and are interchangeable. Hazardous materials are hereafter referred to in this document by the commonly accepted abbreviated form of "hazmat." Similarly, electronic shipping papers are hereafter referred to as "ESP," an abbreviation that also applies to the association of hazmat ESP with their corresponding, required emergency response information. In this document, both of these terms—hazmat and ESP—refer to both singular and plural usage for convenience, although verb agreement depends on the context. The Hazardous Material Regulations are referred to as the "HMR." The terms "marine mode" and "ocean mode" (also referred to by some sources as "maritime mode" or "water mode") are essentially interchangeable, although inland barge transport is not included in ocean mode. The terms "paper" and "hard copy" referring to shipping papers or bills of lading are used interchangeably. Where there is mention of hazmat classes and divisions, they are per U.S. DOT designations. While international standards and commerce are discussed, this document references stakeholder organizations that are primarily North American. Nevertheless, the research recognizes that the needs, challenges, and solutions are truly international.

Definitions of terms and abbreviations are found in Appendix A.

1.2 Problem Statement/Discussion

1.2.1 Background

Code of Federal Regulations (CFR), Title 49—Transportation, Chapter 1—Pipeline and Hazardous Materials Safety Administration (PHMSA)—Hazardous Materials Regulations are issued by the U.S. DOT and govern the transportation of hazmat in interstate, intrastate, and foreign commerce. The primary goal of the HMR is the safety of the public and those whose occupations involve preparing hazmat for transportation or transporting them. The general area of the HMR that covers shipping papers is *hazard communication,* and it is HMR Part 172 Subpart C—Shipping Papers that gives the specific requirements for shipping papers, whether in electronic or hard copy form.

While there is a substantial amount of e-commerce in transportation, especially if faxes are included, in other aspects of our lives electronic transactions have long since superseded exchange of paper as a requirement. For example, e-commerce is routinely used by banks, investment firms, and healthcare providers to transmit large amounts of sensitive information easily and securely. It is very common for an individual to pay bills and file income taxes online and withdraw money from an ATM in cases where paper may serve as a record of receipt but is not required for the transaction.

Why then are electronic transactions not in greater use in commerce related to transportation in general, and more

particularly to types of commerce in which hazmat ESP could be used? How can the e-commerce systems that have the potential to enable more widespread use of ESP better meet the diverse needs of the hazmat stakeholder groups? This project's research explored these and other questions in considering the path that can be taken to advance the use of ESP (i.e., the road map).

The road map describes the benefits of, and the path toward, a unified ESP system view that supports interoperability and exchange of standardized electronic commerce for hazmat transportation of all carrier modes, carrier types, and hazmat classes without duplicate data entry. The road map illustrates the way ahead for affected stakeholder organizations to achieve implementation of an electronic hazmat documentation and data transfer system.

When offering hazmat for transportation, a shipper is required to provide shipping documents containing the HMR-mandated information that is intended to inform the carrier of the inherent risks involved in the handling and transport of the material. Shipping documents also contain specific hazard information, standardized so that emergency responders can identify appropriate measures to be taken in the event of a hazmat incident. U.S. DOT's HMR do not restrict this information to being paper, except that carriers of hazmat must maintain paper shipping papers for the duration of the trip as part of the current regulatory framework stated in 49 CFR 172. These shipping papers must be carried with the shipment in a specified location in the vehicle for on-scene use by enforcement officials conducting inspections and by emergency response personnel at the scene of an accident or incident. Subsection 1.2.4.3 elaborates on the details of carrying and presenting those hard copy shipping papers under that requirement.

The text of 49 CFR 172.600 (c) General Requirements states that:

> No person to whom this subpart applies may offer for transportation, accept for transportation, transfer, store or otherwise handle during transportation a hazardous material unless:
>
> 1. Emergency response information conforming to this subpart is immediately available for use at all times the hazardous material is present; and
> 2. Emergency response information, including the emergency response telephone number, required by this subpart is immediately available to any person who, as a representative of a Federal, State or local government agency, responds to an incident involving a hazardous material, or is conducting an investigation which involves a hazardous material.

Hard copies of shipping papers are an original and authorized method of documentation in the United States; however, the use of ESP is also currently authorized as a method of documentation. For example, 49 CFR 174.24 (Carriage by Rail) states that "(b) Each person receiving a shipping paper required by this section must retain a copy or an *electronic image* thereof, that is accessible at or through its principal place of business and must make the shipping paper available, upon request, to an authorized official of a Federal, State, or local government agency at reasonable times and locations" (italics added for emphasis). Indeed, ESP are in use for hazmat transportation of all modes and are used almost exclusively for North American Class 1 railroads.

The Canadian Transportation Commission has mandated the use of the Emergency Response Form (ERF) for rail shipments of dangerous goods as classified by Transport Canada with regulated form and printing styles. Every full load of most dangerous goods shipped by rail must have an ERF, which provides emergency responders with basic information about the properties of the most dangerous goods. The ERF includes the shipper's name and phone number, destination, and location of the product (shipping or routing information). Similar to the U.S. DOT requirement, ERFs must be physically attached to dangerous goods shipping documents, which currently precludes their replacement by an EDI system.

Hard copy hazmat shipping papers have some drawbacks. A hazmat shipment may be exchanged between different modes and different vehicles within a mode, which is more easily handled electronically since the current paper documents may not be easily interchangeable between modes. A hard copy system is labor intensive and subject to human error, and there are several disadvantages to using physical forms, including lack of availability, potential destruction in an accident, time wasted looking for the form if it is not stored where intended, and misinterpretation of the information.

Organizations representing shippers and carriers have expressed the need to improve the process by allowing the option of ESP as an important tool for enhancing productivity and efficiency in hazmat transport. The International Maritime Dangerous Goods (IMDG) code and the International Civil Aviation (Organization) Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO Technical Instructions) permit the use of e-commerce transmission techniques. Nevertheless, carriers still usually require hazmat shippers to generate hard copy hazmat shipping papers prior to accepting cargo, partly because no shipment can move only by aircraft or vessel, and regulations governing other modes may not facilitate the use of e-commerce for hazmat. The use of internationally compatible e-commerce technologies could significantly improve the exchange of hazmat information among shippers, carriers, regulatory agencies, and emergency responders, especially for time-sensitive cargo and containerized cargo.

It should be noted that numerous other federal and state agencies regulate materials not covered under the HMR (e.g., industrial waste) that can pose some degree of risk if mishandled; thus, many of the advantages that ESP bring

to hazmat shipments also apply to non-hazmat shipments. Timely access to accurate hazmat information will likely reduce errors in information exchange, improve efficiency, enhance security, and improve the response efforts in the event of a hazmat incident. Research was needed to understand the issues and capabilities associated with the transport sector using an electronic means of documentation as an alternative to a paper-based system.

A highly capable ESP system can only be as versatile as the e-commerce system that it depends upon. U.S. DOT's Electronic Freight Management (EFM) program (*3*) demonstrated the capability of an e-commerce system to maintain a high degree of visibility over in-transit shipments as they pass mode to mode and country to country. North American Class 1 railroads use e-commerce almost exclusively for their shipment transactions. U.S. Customs and Border Protection's (CBP's) Automated Commercial Environment (ACE) program (*4*) and Canada's Advance Commercial Information (ACI) program (*5*) require that an electronic manifest be transmitted in advance of a shipment crossing the border. The largest freight forwarders have invested in proprietary systems and developed IT systems that communicate on behalf of shippers and customers within discrete supply chains. Thus, there are examples of both demonstrated potential and everyday use of e-commerce in supply chains. For the future, certain U.S. DOT initiatives are looking to move the highway transportation community toward vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and infrastructure-to-vehicle (I2V) communications, potentially including the retrieval of electronic manifest information as part of that concept.

1.2.2 Research Objective

The objective of this research was to develop a road map for the use of ESP as an alternative to the current paper-based hazmat communication system. The road map addresses the electronic transfer of safety, operational, regulatory compliance, and emergency response data and documentation for and among all transport modes (*6*). The modes that require shipping papers per the HMR are those that involve carriers but not pipeline. Modal provisions involving shipping papers are:

- 49 CFR 172.606, carrier information contact/parked trailers;
- 49 CFR 174.24 and 174.26, shipping papers for rail transport;
- 49 CFR 175.33, shipping paper and notification of pilot in command for air transport;
- 49 CFR 176.24, 27, and 30, shipping papers, certificates, and dangerous cargo manifests (DCMs) for vessel transport (which in some areas outside the United States is called the dangerous goods manifest, or DGM); and
- 49 CFR 177.817, shipping papers for motor vehicle transport.

1.2.3 Definition of the Road Map and Methodology for Proof-of-Concept Exercises

The road map describes:

> the implementation of an electronic hazmat documentation and data transfer system including, but not limited to:
>
> 1. Safety and operational implications of mixed paper and electronic operations;
> 2. Solutions to maximize benefits and minimize impediments to the use of electronic hazardous materials documentation, such as how the implementation of an electronic communication system will impact
>   a. Safety and security,
>   b. Incident mitigation,
>   c. Total transportation costs,
>   d. Movement of hazmat, and,
>   e. Preparedness of emergency responders for incidents;
> 3. Methods to transfer and receive safety, operational, regulatory compliance, and emergency response data;
> 4. Regulatory changes;
> 5. Standard electronic hazmat communication practices to exchange data across international borders and amongst intermodal carriers; and
> 6. Secure transfer and receipt of electronic data communications (7) [which should be only to authorized users].

Per the definition used by U.S. DOT's relevant Dynamic Mobility Applications (DMA) program that is referenced in the Summary and Subsection 3.2.2.2, "Proof-of-Concept testing . . . include(s) testing of standards, procedures, tools, and institutional arrangements. Test results will be used to refine existing standards, procedures, and tools. Promising data environments (and associated applications) identified . . . will be considered for pilot deployment (*8*) . . ." Per the HMCRP Project 05 SOW, the proof-of-concept describes "exercises designed to test the implementation strategies and functionality of an electronic hazmat documentation and data transfer system identified in the road map. The proof-of-concept is not expected to detail specific scenarios, but is intended to provide a framework, a guideline, and/or a series of questions through which future researchers may propose validation exercises."

The proof-of-concept process described in Subsection 4.2.1 includes:

1. Performance objectives,
2. Identification of potential electronic data exchange systems for ESP,
3. Determination of major characteristics and strengths and weaknesses of each system,
4. Identification of the system for testing the systems' applicability to hazmat shipments in the United States,
5. Selection of a scenario for a test that meets certain criteria,

6. Development of a table-top exercise in a workshop prior to the field exercise,
7. Conduct of a limited field test of the selected system following selected scenarios,
8. Evaluation of the field test and recommendations for the next steps, and
9. Conduct of a wider field test of the selected system.

1.2.4 Definition and Requirements of Shipping Paper/Emergency Response Information

This subsection describes U.S. DOT requirements for shipping papers and associated emergency response information.

1.2.4.1 Hazmat Shipping Paper

A hazmat shipping paper is a shipping order, bill of lading (BOL), manifest, or other shipping document serving a similar purpose and containing the information required by Part 172, Section C of the HMR. The HMR do not require that the shipper use a special form but instead require that descriptive information be provided in a specific sequence. A proper hazmat shipping description includes a basic description (identification number, proper shipping name, hazard class, and packing group if applicable), additional information that depends on the materials and mode of transport, quantity of hazmat, and type of packing used (*9*). Some in the hazmat transportation industry use the term "bill of lading" interchangeably with "shipping paper." PHMSA has made available a guide to preparing hazmat shipping papers including a checklist, hazmat table excerpts and shipping descriptions, hazmat table description, and a sample shipping paper.

The description of hazmat on shipping papers includes (*10*):

- Basic description: identification number
  - Proper shipping name (PSN)
  - Hazard class or division (plus subsidiary risks)
  - Packing group
- Technical names [required for "not otherwise specified" (NOS) entries] (may be entered after PSN)
- Total quantity: mass or volume, except:
  - Net explosive mass for Class 1 (explosives)
  - Activity for Class 7 (radioactive materials)
- Number and type of packages

Requirements for additional description found in 49 CFR 172.203 include:

- Special permits (exemptions)
  - DOT-SP12345
- Limited quantity (Ltd Qty)
- Hazardous substance – reportable quantity (RQ)
- Radioactive material
- Empty packages
- Transportation by modes
- Technical names
- Marine pollutants
- Poison inhalation hazard or toxic inhalation hazard (PIH/TIH)
- Elevated temperature materials
- Organic peroxides

1.2.4.2 Emergency Response Information

Per 49 CFR 172.600, emergency response information must be provided during transportation and at facilities where hazmat is loaded, handled, or stored incidental to transportation. This applies to persons who offer or accept for transportation, transfer, or otherwise handle hazmat during transportation. The emergency response information must be available at all times hazmat is present and be immediately available during an incident.

Per CFR 172.202, emergency response information includes:

- Minimum content information used in mitigation of an incident:
  - Basic description and technical name;
  - Immediate hazards to health;
  - Risks of fire or explosion;
  - Immediate precautions to be taken in the event of an accident or incident;
  - Immediate method for handling fires;
  - Initial methods for handling spills or leaks in the absence of fire; and
  - Preliminary first aid measures.
- Format:
  - Printed legibly in English; available away from hazmat package; maintained like shipping paper;
  - Presented on shipping paper, in a document that includes basic description and technical name (e.g., Material Safety Data Sheets, or MSDSs); or related to info on shipping paper, Notification to Captain (NOTOC)/ Notification to Pilot in Command (NOPIC), or DCM in a separate document (e.g., the *Emergency Response Guidebook*, or ERG). (It should be noted that the NOTOC or NOPIC is the written information that must be provided to the aircraft commander when dangerous goods are carried as cargo on an aircraft. The electronic data are verified during hazmat acceptance or, if not present, converted from paper to electronic form at the dangerous goods acceptance location.)
- Emergency response telephone numbers:
  - Person who offers hazmat shipping papers must provide an emergency response telephone number monitored at all times the hazmat is in transportation;

- Number of offeror or agency capable of, and accepting responsibility for, providing detailed information;
- Provider must have comprehensive emergency response and incident mitigation information for that material, or immediate access to a person who possesses such knowledge; and
- Number entered on shipping paper in clearly visible location or following hazmat descriptions.

As mentioned, U.S. DOT requires all hazmat shippers to provide constant monitoring of an emergency response telephone number while the hazmat is being transported. In the event of a hazmat accident or incident, to ensure that they are acting on correct information, it is important for the emergency responder and the carrier/transporter to call that number found in the emergency response information before taking any action.

U.S. DOT rulemaking HM-206F regarding new requirements for emergency response telephone numbers on shipping papers became effective October 1, 2010. The website for the Council on Safe Transportation of Hazardous Articles (COSTHA) notes that "with few exceptions, hazardous materials shipping papers are required to include a telephone number where emergency responders can obtain product-specific information in the event of an incident during transportation. This number may connect directly to either the initial shipper/offeror of the material or to a contract emergency response information (ERI) provider" (*11*).

Although the chemical name and United Nations (UN) number are required for shipping papers, inclusion of the hazmat chemical's trade name has been shown to have advantages over use of its U.S. DOT proper shipping name in the emergency response scenario (*12*).

1.2.4.3 Presentation and Retention of ESP

According to 49 CFR 5110, Shipping Papers and Disclosure, responsibility for retaining and providing hazmat shipping papers *or their electronic format* is as follows for these key groups ("Secretary" refers to the U.S. Secretary of Transportation):

(a) Providing Shipping Papers. Each person offering for transportation in commerce hazardous material to which the shipping paper requirements of the Secretary apply shall provide to the carrier providing the transportation a shipping paper that makes the disclosures the Secretary prescribes in regulations.

(b) Keeping Shipping Papers on the Vehicle.
  (1) A motor carrier, and the person offering the hazardous material for transportation if a private motor carrier, shall keep the shipping paper on the vehicle transporting the material.
  (2) Except as provided in paragraph (1) of this section, the shipping paper shall be kept in a location the Secretary specifies in a motor vehicle, train, vessel, aircraft, or facility until
    (A) The hazardous material no longer is in transportation; or
    (B) The documents are made available to a representative of a department, agency, or instrumentality of the United States Government or a State or local authority responding to an accident or incident involving the motor vehicle, train, vessel, aircraft, or facility.

(c) Disclosure to Emergency Response Authorities. When an incident involving hazardous material being transported in commerce occurs, the person transporting the material, immediately on request of appropriate emergency response authorities, shall disclose to the authorities information about the material.

(d) Retention of Papers:
  (1) Offerors. The person who provides the shipping paper under this section shall retain the paper, or an electronic format of it, for a period of 2 years after the date that the shipping paper is provided to the carrier, with the paper or electronic format to be accessible through the offeror's principal place of business.
  (2) Carriers. The carrier required to keep the shipping paper under this section, shall retain the paper, or an electronic format of it, for a period of 1 year after the date that the shipping paper is provided to the carrier, with the paper or electronic format to be accessible through the carrier's principal place of business.
  (3) Availability to government agencies. Any person required to keep a shipping paper under this section shall, upon request, make it available to a Federal, State, or local government agency at reasonable times and locations.

CHAPTER 2

Research Approach

The project consisted of performing the following tasks:

Task 1. Gather information focused on topics and organizations such as but not limited to:
1. Previous research in the documentation of hazmat shipments, including findings from HMCRP Project 04, "Emerging Technologies Applicable to Hazardous Materials Transportation Safety and Security," and the PHMSA regulatory docket;
2. Current international efforts;
3. Hazmat data needs assessment in industry and the emergency response community;
4. Current electronic hazmat data-sharing processes between parties in the distribution chain (e.g., shippers, carriers, freight forwarders);
5. Commercial applications and safety benefits;
6. Impediments to electronic hazmat data systems in technology and regulations; and
7. Interviews (in-person, electronic, or telephonic) with officials and stakeholders in federal, safety, and industry organizations.

Task 2. Develop sample process maps of common and complex hazmat shipments, including intermodal shipments, from origin to destination.

Task 3. Submit an interim report based on the findings of Tasks 1 and 2. The interim report should include:
1. The results of work to date;
2. A summary of the interviews conducted;
3. Effective practices identified;
4. Benefits and impediments as described in terms of the objective; and
5. A differentiation of the information required for emergency response and business operations. Upon panel approval, proceed with Task 4.

Task 4. Submit, for panel review and approval, a draft road map for the implementation of a cost-effective electronic hazmat documentation and data transfer system, including but not limited to:
1. Safety and operational implications of mixed paper and electronic operations;
2. Solutions to maximize benefits and minimize impediments to the use of electronic hazardous materials documentation, such as how the implementation of an electronic communication system will affect:
   a. Safety and security,
   b. Incident mitigation,
   c. Total transportation costs,
   d. Movement of hazardous materials, and,
   e. Preparedness of emergency responders for incidents;
3. Methods to transfer and receive safety, operational, regulatory compliance, and emergency response data;
4. Regulatory changes;
5. Standard electronic hazardous materials communication practices to exchange data across international borders and amongst intermodal carriers; and
6. Secure transfer and receipt of electronic data communications.

Task 5. Propose a methodology for proof-of-concept exercises designed to test the implementation strategies and functionality of an electronic hazmat documentation and data transfer system identified in Task 4 (i.e., the road map). The deliverable is not expected to detail specific scenarios but is intended to provide a framework, a guideline, and/or a series of questions through which future researchers may propose validation exercises.

Task 6. Submit the road map and a draft final report that documents the entire research effort, explains and justifies recommendations, provides background information used in the development of recommendations that address deficiencies, and recommends further research, including the proof-of-concept exercises.

Task 7. Consider and respond to panel review comments and submit the final report.

The following sections describe the approach followed through the project's task progression. The background research and information gathering described in detail in this chapter make up the first three tasks: gather background information, develop process maps, and submit interim report.

2.1 Detail of Task 1 (Gather Information on Topics and Organizations)

A thorough literature review was conducted to identify relevant information. The search included periodicals, journal articles, media reports, Internet resources, and other reports. In addition, interviews were conducted with various stakeholders and experts in the field to determine the range of practices related to the electronic sharing of information, to identify any issues or concerns, to obtain their thoughts on best implementation strategies as well as potential impediments to widespread adoption, and to solicit suggestions for additional organizations, companies, or individuals to contact for additional input. A summary of the literature review is presented in Subsection 2.1.1. A summary of the interview results is presented in Subsection 2.1.2; a more detailed discussion of the interviews conducted appears in Appendix C.

The literature search for this project focused on gathering published information, data, and sources related to the identification of relevant information concerning the use of ESP and electronic freight management (EFM) systems as well as enforcement and emergency response issues surrounding access to and use of hazmat shipment information. While shippers and carriers are required to have hard copy shipping papers that accompany hazmat shipments throughout the trip, there are various advantages and disadvantages to the current system of using hard copy shipping papers that are discussed. For example, in a hazmat incident response scenario, electronic systems could be either beneficial or detrimental depending on the circumstances. The research explored whether a transition to the use of ESP could be advantageous overall.

There are already several industries and international groups that have integrated ESP or EDI systems into their shipping routines. In addition to looking at these established systems, the literature search reviewed how the use of EFM systems can be beneficial to hazmat incident response. The project was informed by *HMCRP Report 4: Emerging Technologies Applicable to Hazardous Materials Transportation Safety and Security.*

2.1.1 Synopses of Relevant Information

The discussion that follows contains synopses of relevant literature organized into three overarching themes: (1) current use of ESP and EFM systems in general, (2) enforcement and emergency response issues related to hazmat shipping information, and (3) issues involving the implementation of EDI systems. Other than data obtained through the stakeholder interviews and summarized in Subsection 2.1.2, there were limited reference materials that focused on ESP or transportation-related EDI in general.

2.1.1.1 Use of ESP and EFM Systems

Electronic communication offers several advantages over paper communication. For the shipper, all information pertaining to the shipment can be delivered to any party immediately. This information can be transmitted without the need to re-enter the information and allows for a quicker method for readying goods for shipment. For the freight forwarder or carrier, data are more reliable because they reflect what is in the shipper's computer. In addition, ESP are more likely to be presented in a standardized format, and electronic communication is a less time-consuming way for companies to process documentation. Finally, ESP offer the potential for emergency responders to be able to stand off from a hazmat transportation accident or incident scene and remotely learn about the details of the released hazmat that are critical to protecting the health and safety of the responders and the public.

However, it must be emphasized that for ESP to realize the widespread benefits that can accrue from their use, there must be both effective standardization and implementation. A standardized shipping paper format will not happen by itself. Software is dependent on standardization and may need to reformat shipping papers differently for various entities throughout the supply chain. Government needs to take the lead in standardizing shipping paper format.

While it is certainly the case that ESP are intended to meet the needs of e-commerce business information exchanges, have a low error rate, and operate within effective standardization, it is recognized that there are currently factors that preclude all of these benefits from being realized by all who are involved in transportation. Exchanges of electronic shipping information currently are working quite well for some in the transportation community. But there are some areas where, despite standardization, the manner in which data are retrieved and/or standards are applied is inconsistent, which can lead to confusion. For emergency circumstances in which the electronic shipping paper data need to be available very quickly and with unquestioned accuracy, confusion must be eliminated.

This report gives examples in which EDI, a type of electronic exchange of data, is already providing benefits for its users. However, it is not suggested that these examples necessarily represent the realities of EDI for additional users, nor is it intended to convey that any of the examples are a

recommendation or preference for the road map that was developed in this project. EDI is an electronic transmission of data that replaces a physical transfer of paper. It was designed to eliminate the need for paper, reduce errors, improve accuracy, and allow more productivity. However, there are several legal obstacles that prevent the implementation of EDI for shipments. An electronic bill of lading (e-BOL) must legally be authenticated so that ownership can be easily determined. In addition to proving a shipment's existence and contents, an e-BOL—similar to a hard copy BOL—confirms the condition of the shipment at the point of origin and specifies to whom the shipment should be delivered at the final destination. In most circumstances, the carrier is legally required to deliver a BOL/e-BOL to the person who receives the shipment.

Note: In addition to EDI, other modes of electronic data exchange mentioned in Subsections 2.1.1 and 2.1.2 include extensible markup language (XML) and electronic data interchange for administration, commerce, and transport (EDIFACT). XML is a set of rules for encoding, transferring, and storing data electronically. XML has an increasingly important role in the exchange of a wide variety of data on the Internet, World Wide Web, and elsewhere. The EDIFACT coordinates international standardization by working through the United Nations/Economic Commission for Europe (UN/ECE). Among other attributes, EDIFACT provides an international EDI standard.

There are two methods for legally authenticating an e-BOL. The first is to use an intermediate third party that will receive documents from the shipper and receiver. In the event of a dispute, the records held by the third party would be considered valid. The other possibility is the use of a digital signature. This digital signature can only be created by the person generating it. A document needs to be encrypted by the sender and then decrypted by the receiver, but the receiver would not have the capability to encrypt the document again.

The Bolero Project, funded 50% by the European Commission, was created in 1998 to develop an e-BOL. Bolero is a company headquartered in London with worldwide regional offices that operates to develop, implement, and enforce standards that facilitate electronic (paperless) commerce. Bolero supports a combining of the physical and financial supply chains for solutions. It has the role of a neutral entity, a third part that supplies an open platform. This platform makes possible paperless trading applications for many multinational businesses, and it provides the attendant advantages of electronic commerce such as speed and visibility. Its established role in electronic commerce and support by large multinational businesses makes it worthy of study.

The Bolero system is based on an initial entry, created by a transaction, followed by messages related to the transportation and shipment. By documenting specific messages along the entire shipping process, the Bolero system is able to track where an e-BOL and shipment are at all times. Security is a fundamental concern of any EDI system. Digital signatures and smart keys are used in the Bolero system to verify all signatures, messages, and goods transfers. Thus, Bolero uses both the e-BOL and the digital signature methods mentioned. The Bolero system is able to maintain its neutrality by not being managed by a purchasing, shipping, or receiving group.

TradeNet, another EDI application, is an electronic network that facilitates international trade by integrating all the processing procedures for import, export, and transshipment documents and licenses. It uses a single document to fulfill all the trade documentation requirements, and that document is routed electronically to all the parties associated with trading. All the trading partners are linked to each other electronically. The software also ensures the confidentiality and integrity of all communication and permits electronic payments for government duties and fees, customs, and other controlling agencies. It also offers an online inquiry system that gives the status of any trade declaration at any time.

ACE is the commercial trade processing/truck manifest system developed by CBP to facilitate legitimate trade and strengthen border security. With ACE, truck carriers and other eligible parties are required to transmit advance electronic truck cargo information to CBP through a CBP-approved EDI. All contract carriers hauling general freight that enters the United States through any border crossing must (with some exceptions) submit an electronic manifest (e-manifest) to CBP prior to arriving at the border crossing. Before reaching the border, all Canadian, Mexican, and American truck carriers will ultimately be required to submit an e-manifest to CBP by using the ACE secure data portal or a CBP-approved EDI. Receiving the manifest information early allows CBP and other border security agencies to prescreen the manifest through multiple checks for items of interest before the truck arrives at the port. As mentioned, Canada has a comparable system, the ACI.

2.1.1.2 Enforcement and Emergency Response Issues Concerning Hazmat Shipping Information

The regulations promulgated under 49 CFR state that for hazmat shipments, emergency response information must remain with the shipment. U.S. regulations are not limited to full-load shipments, and all shipments of hazmat entering the United States must comply with 49 CFR. However, 49 CFR does not specify how or in what format this information should be presented. When considering different alternatives to physical forms, a number of separate objectives should be considered. These include identifying the products involved in the shipment and delivering the proper response information

for emergency responder, compliance, enforcement, and commercial purposes.

Enforcement/roadside inspection personnel currently depend on the availability of hard copy shipping papers to enforce provisions of the HMR. The main benefits for them should ESP be allowed are that the accessibility aspect of the regulations will virtually disappear, and they will not have to rely on the driver providing paperwork that is already available online. The enforcement/roadside inspection personnel contacted do not have a formal policy concerning ESP at this time and do not oppose the use of ESP as a method of supplying shipment information. They noted the importance of standardizing information and communication protocols, having a process to identify those carriers that are using ESP rather than paper copies, and accessing shipment information in areas of diminished or no connectivity. They wondered whether implementation and widespread use of shipping papers would be hampered by costs associated with computer system and programming requirements and by carriers' concerns that proprietary information could be lost to competitors or to the criminal element.

One of the national emergency response organizations contacted had no problem with a carrier having both paper and ESP but nevertheless indicated that they have serious concerns that confusion will result should there be variances in the information contained on the shipping paper and the electronic information. This organization was also concerned that not all jurisdictions have access to electronic technology.

Other national emergency response organizations were very much in favor of ESP for a number of reasons, including ease of obtaining information, accuracy, the ability to expedite mitigation of an incident, and resolution of disputes and claims. They felt that lives and property could be saved due to the increased speed by which electronic data could be provided. They also felt that there will practically always be some access to electronic technology through cell phones and computers, although computers can be more limited than cell phones due to constraints that may be imposed by a jurisdiction or agency.

The Transportation Security Administration (TSA) initiated research, reported in 2005, to evaluate the potential for alternative technologies applicable to replace the current hazmat placarding system (*13*). The TSA research is mentioned to illustrate that the idea of technology alternatives to placards is somewhat analogous to the idea of technology alternatives to hard copy shipping papers for emergency responders. In the TSA research, the technologies examined as alternatives to placarding fell into three categories:

- Cloaking devices – Individual systems located on the tank car that provide equivalent placard information when queried or when triggered by an incident,
- Decentralized systems – Component systems that rely on a distributed database to supply information on tank car contents through some means or method of communication other than the tank car, and
- Centralized systems – Systems that use a centralized database to maintain all tank car information for authorized user access.

The TSA research summary noted the potential trade-offs between safety and security that could result from technology systems that are alternatives to the current placards. This report assumes that some of these same trade-offs could apply to technologies that are alternative systems to the current hard copy shipping papers.

From an emergency response standpoint, one of the main problems with transitioning to an ESP approach is that most emergency responder groups are unlikely to have either the necessary equipment to take full advantage of ESP or the funds for the equipment. Thus, in many cases emergency responders can only benefit if they invest money in the equipment.

It would be more efficient to establish a link between carriers and emergency responders by using a centralized system rather than establishing a link between each potential emergency responder and each carrier. It is easier to train one group rather than many, and the central group is able to pass the information on to emergency responders who have varying degrees of technological capabilities. However, there would be costs with a potential centralized system.

Rail carriers are exploring the use of local databases to access EDI information rather than transmitting it, and these databases could also be used for emergency response information. Paper documentation can only provide limited support when an accident occurs. In the United States, there is a partnership between CHEMTREC and CSX railroad and another partnership between the FRA, the American Short Line and Regional Railroad Association, RailInc [a wholly owned subsidiary of the Association of American Railroads (AAR)], and CHEMTREC.

The Canadian Transport Emergency Center (CANUTEC) is a centralized call center available to Canadian emergency responders that tells them what is on a particular train and what actions to take. CANUTEC is similar to the U.S.-based CHEMTREC. CANUTEC contacts the appropriate carrier to find out what is on a train and perform other research as needed. This could be taken a step further if CANUTEC were equipped with a computer system that had access to the centralized information source.

In Canada, emergency responders will most likely call CANUTEC to get information on the products involved regardless of whether the shipping documents and printed emergency response information are available at the site. Centralizing the information gathering functions in CANUTEC has several advantages:

- Emergency responders only have to contact CANUTEC and CANUTEC will establish other contacts and compile information.

- Emergency responders could focus on other responsibilities such as securing the accident site while CANUTEC is gathering information.
- CANUTEC could respond in the most appropriate way to emergency responders with differing technical capabilities.
- CANUTEC can complement emergency information with its own expertise.

The Canadian Transportation Commission has mandated the use of the ERF for rail shipments of dangerous goods as classified by Transport Canada with regulated form and printing styles. Every full load of most dangerous goods shipped by rail must have an ERF, which provides emergency responders with basic information about the properties of the dangerous goods should they be involved in an accident. The ERF includes the shipper's name and phone number, the destination, and the location of the product (shipping or routing information). An ERF must be physically attached to a dangerous goods shipping document, which precludes its replacement by an EDI system. But, as the ERF is intended for emergency responders, there are several disadvantages to using physical forms, including availability, potential destruction in an accident, omission, time wasted looking for the form, and misreading or misinterpreting the information.

A Japanese company has started a service called the Industrial Waste Electronic Manifest Data Management System to improve and modernize the waste-disposal industry. Using the global positioning system (GPS) and a communications satellite, the service tracks and monitors the movement of transportation vehicles and the waste loaded on them to ensure that the waste is properly handled. Each transporting vehicle is equipped with a satellite communications controller, an antenna, a GPS locating unit, a barcode reader, and a dedicated terminal. The service provides a system scaled to the needs of the user and promotes modernization of the business's operations systems.

2.1.1.3 Implementing EDI Systems

The planning phase of an EDI application consists of analyzing the current process, developing work flows for the EDI application, and developing an EDI implementation plan. Pilot EDI programs typically involve transitioning a small number of trading partners to an EDI application with one or two transaction sets for a short period of time.

The main cost categories when implementing EDI-based applications are hardware for the EDI gateway, software, cost of modifying the current application systems, telecommunications charges, trading partner outreach program costs, and ongoing support and maintenance costs. Some of the cost savings from EDI-based applications are savings in labor costs, elimination of mailing costs, and reduction of document management costs. Other benefits of implementing EDI systems are reduction in data entry error rates, improved cash management, elimination of communication lag time between agency and customer, improved customer service, and expandability of the system to other functions.

A large multinational retailer uses EDI to manage the flow of information, purchase orders (POs), and invoices. This helps the retailer provide better customer service, increase the productivity of its workers, and save on costs. In order to become a supplier to this retailer, a company must be willing to acquire an EDI system that conforms to the retailer's standards. By requiring all suppliers to use EDI, the retailer shows its commitment to EDI and the benefits it receives by conducting business electronically.

Two companies researched were able to use EDI applications to become more cost-effective businesses. Switching to EDI applications allowed both companies' employees to become more efficient and to focus on different aspects of the business.

Another company researched began using EDI systems based on requests from its largest customers. It used EDI as an opportunity to redevelop the way it managed customer information. Because it was a less-than-truckload (LTL) carrier, it had to be able to quickly receive and transmit information since a single shipment could contain goods from over a dozen shippers. The company used a new, standardized EDI system to send and receive thousands of invoices every day.

2.1.2 Synopses of Stakeholder Interviews

The stakeholder interviews are summarized by mode and function in Subsection 2.3.1. The questions used to structure the interviews are included in Appendix B, and the detailed interview responses are included in Appendix C. In total, there were approximately 50 direct interviews conducted, not counting surveys of specific carrier groups by their respective associations. Most of these interviews were conducted by telephone or in person, while some individuals were provided copies of the questions in advance and were called or e-mailed to gather additional information about their responses or to clarify the information provided.

It should be noted that in preparing for and conducting interviews on this project, questions were centered on getting insight into current hazmat shipment data management throughout the supply chain. No vision, description, or high-level concept of operations of a future ESP system were offered. Thus during interviews, stakeholders offered feedback based on what they envisioned an ESP system might be. Consequently, some of the responses, such as the perception that driver data entry is needed, are not consistent with this report's conclusions.

The interviews involved (1) 22 organizations, including government agencies, carrier and trade associations of various

modes, and a council; (2) 23 carriers of all modes, and (3) four national emergency response organizations. Motor carriers were represented in three sectors as described in Appendix C. There were some additional interviews, such as with a wireless technology provider.

2.2 Detail of Task 2 (Develop Sample Process Maps)

2.2.1 Overview

This activity demonstrated the transportation of hazmat across various modes in both graphical and narrative form. The process activities and relationships were shown at a relatively high level and were intentionally generic in nature because individual industries, carriers, shippers, or transportation intermediaries may have unique processes or requirements in place for their handling of hazmat shipments. The process maps followed the swim lane approach, in which each role was depicted as a separate lane. In general, hazmat shipments are distinguished from general cargo shipments in two ways: additional documentation requirements and special equipment or loading requirements.

Carriers across various represented modes treat hazmat shipments with special care starting at the point of shipment booking. Carriers will either route booking requests to a special department with trained personnel or, alternatively, will have bookings reviewed after the fact by trained personnel. Carrier databases are used to varying degrees in managing this process, depending upon their sophistication. In many cases, all documentation required for hazmat transportation is generated from the carrier system based on the booking information. Documentation and electronic notification to forwarding or interlining carriers are often generated from the carriers' systems. Some respondents advised that the shipper's certification is only required to be retained by the originating carrier. Rather than passing the certification to a forwarding or interlining carrier, the originating carrier will present a hazmat BOL or other documentation.

Special equipment or loading requirements are involved in hazmat shipments. Stowage and loading plans for LTL, ocean, and air carriers are especially critical because these conveyances (trips or voyages) combine a multitude of shipments and commodities. Proximity and handling of hazmat commodities in mixed conveyances are of critical importance. Carriers prepare stowage plans or hazmat manifests to enable emergency responders to quickly identify the location of particular commodities in these conveyances.

Through the information obtained by reviewing the relevant literature and discussions with stakeholders, an initial sample process map was developed that incorporated the specific elements that are present in most shipment types. This initial process map was ultimately used as a basis for developing distinct process maps for a number of unique shipment profiles.

The process maps that follow share many commonalities and relatively few differences. The key differentiating factors are the number of carriers and number of intermediaries involved [the use of a freight forwarder, as an example, as depicted in the air process map (Figure 5)]. A shipment that is tendered directly by a shipper to an integrated carrier is mapped showing the activities of intermediaries and other carriers falling in the "Carrier (Air)" swim lane. Descriptions are provided for the elements of each process map in Subsection 2.2.7.

2.2.2 Truckload

The truckload (TL) process flow shown in Figure 1 is straightforward and serves as a useful model for understanding the basic interrelationships between shipper (consignor), carrier, and receiver (consignee). There are only one carrier, one vehicle (typically), and three parties involved. The represented business processes between consignor and consignee are generalized. In TL shipments, the documents, including the shipper's hazmat certification, will move with the shipment.

2.2.3 Less-Than-Truckload

The LTL flow shown in Figure 2 is very similar to the TL flow. This representation shows a generic transportation movement segmented into pickup, line-haul, and delivery with intermediate carrier cross-docking activity. Documents, including the shipper's hazmat certification, will move with the shipment.

2.2.4 Rail

The rail process flow is represented in Figure 3 without either intermediaries or interlines. Similar generic activities to LTL occur, but under different names. Document flow is represented here as moving with the shipment. The ocean intermodal process map (Figure 4) represents the role of the railroad in an ocean intermodal move.

2.2.5 Ocean Intermodal

The ocean intermodal process flow in Figure 4 represents a highly complex movement involving numerous carriers and intermediaries. The shipment booking process involves multiple layers, with the consignor booking to the ocean carrier who in turn places bookings with other parties involved in the transportation and handling. Some supply chains involve other intermediaries—consolidators or non-vessel operating common carriers/consolidators (NVOCC's)—that are not represented here. The shipper's hazmat certification is not

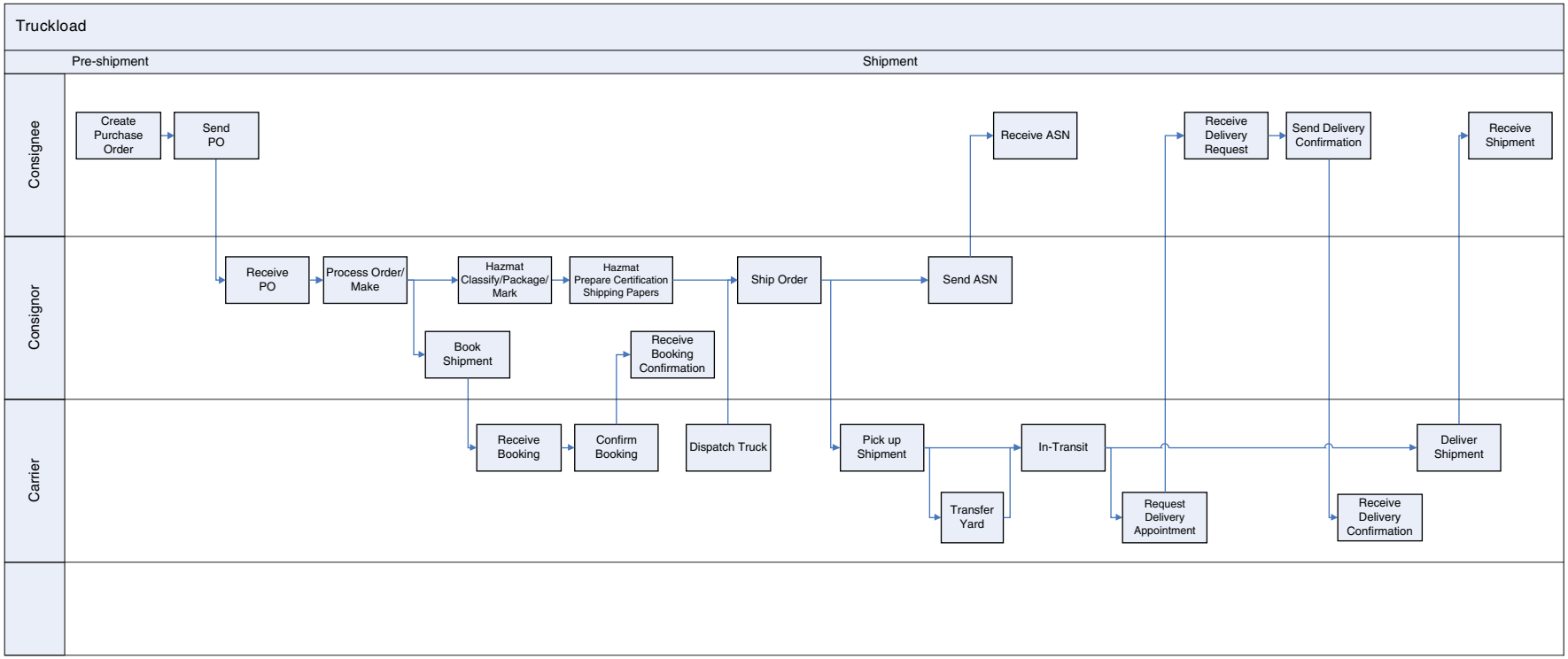

Figure 1. Truckload process map.

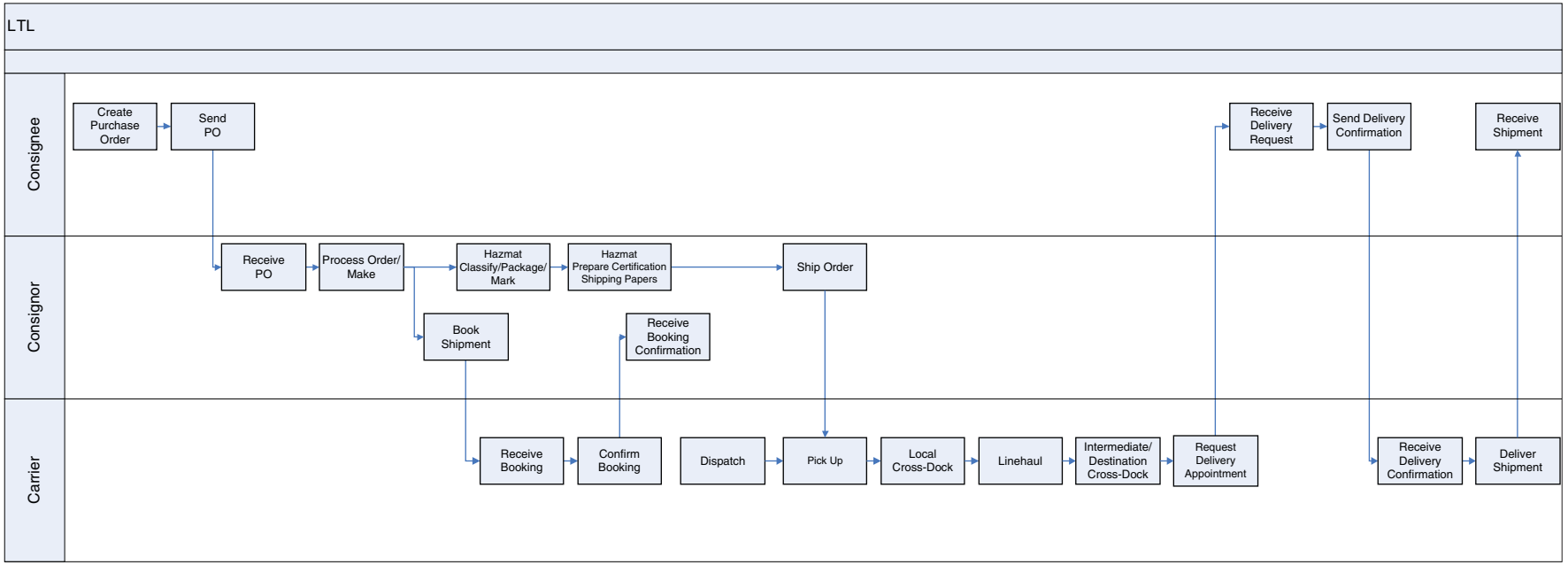

Figure 2. Less-than-truckload process map.

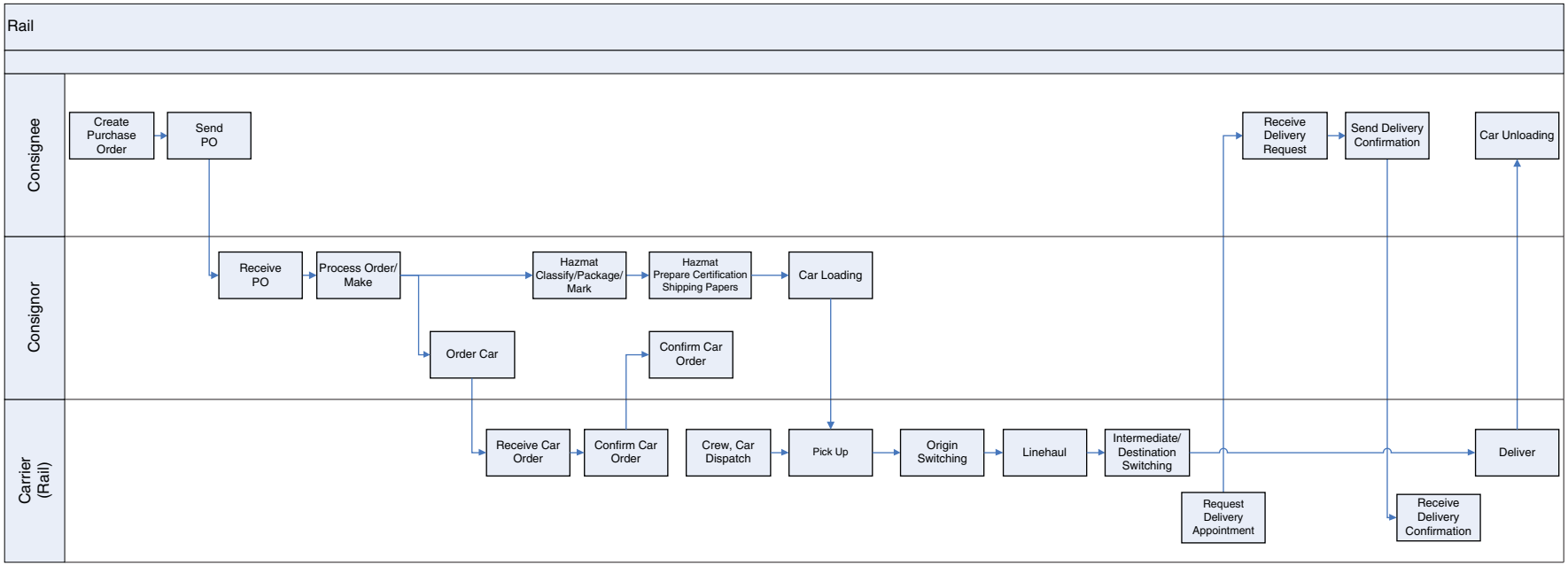

Figure 3. Rail process map.

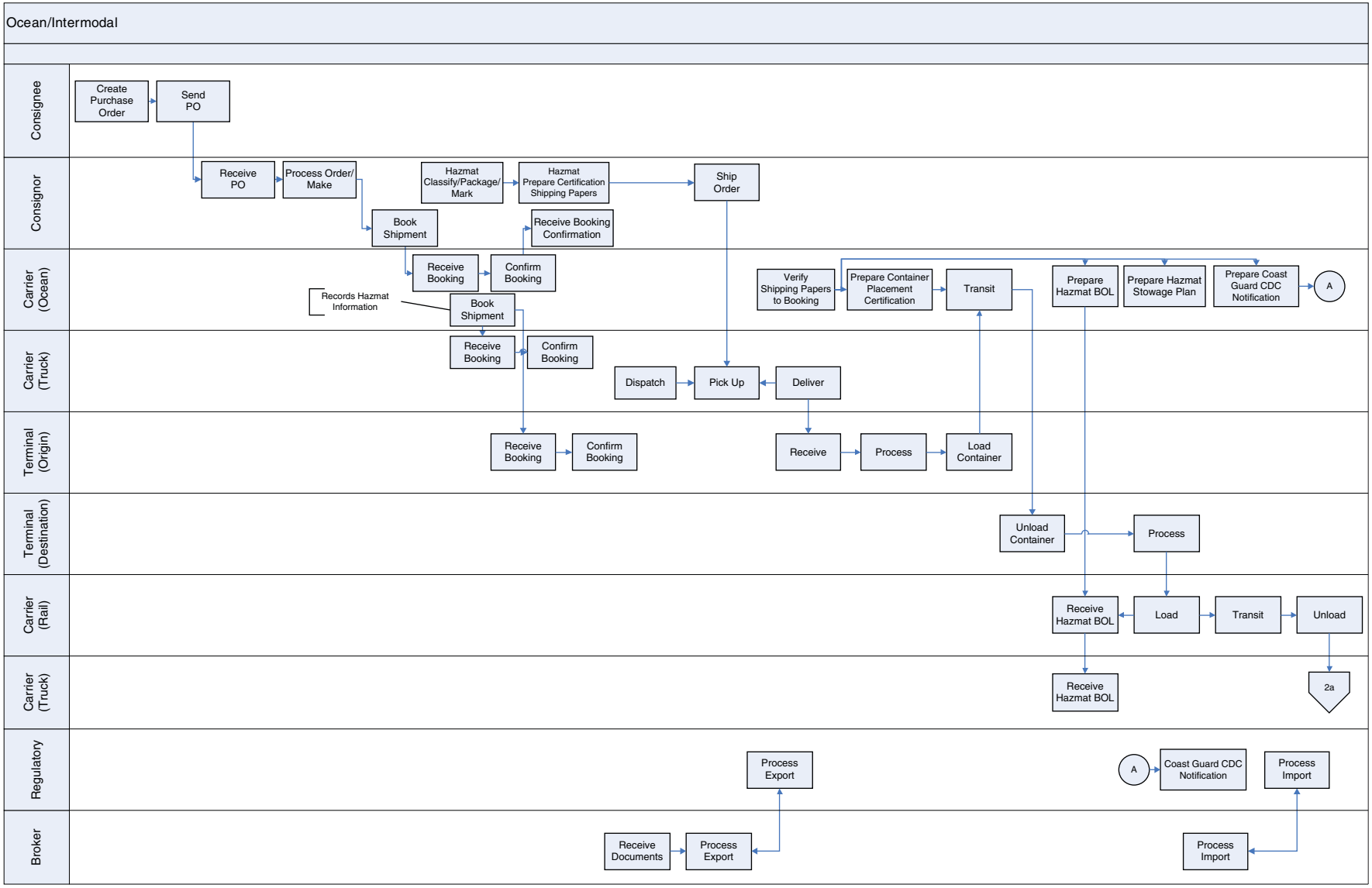

Figure 4. Ocean intermodal process map.

transferred from the ocean carrier to forwarding or interlining carriers and intermediaries. A hazmat BOL represents the document that conveys necessary information to these parties. As with air freight, the carrier follows a cargo check-in process that compares the receipt to the booking and prepares a stowage plan and hazmat manifest.

2.2.6 Air

The air freight process flow in Figure 5 represents a highly complex movement involving numerous carriers and intermediaries. The relationships modeled here involve a freight forwarder acting as the intermediary between the consignor and air carrier. The freight forwarder also coordinates truck transportation. There are a number of process variations with air cargo transport that are not represented. As the party dealing directly with the consignor, the freight forwarder takes the initial booking and, in turn, places bookings with other parties. As with the ocean intermodal process, the carrier (or terminal) follows a check-in process that compares the receipt to the booking and prepares a load plan and hazmat manifest.

2.2.7 Process Map Element Descriptions

This subsection describes each of the activities found in the preceding sample process maps, including the primary party or parties responsible for performing each activity. In some cases, the terminology for similar activities differs by mode, and these differences are noted. Table 1 provides a description of the process map elements, including activity identifiers, roles, and definitions.

2.3 Detail of Task 3 (Submit Interim Report)

The draft interim report (product of Task 3) covered all activities in Tasks 1 and 2. It included the following major sections:

- Introduction,
- Background Research and Information Gathering, and
- Sample Process Maps.

Comments from the HMCRP project panel were incorporated into the revised interim report, and with HMCRP authorization, preparation of the Task 4 road map proceeded. The details from the Task 1 and Task 2 research and the synthesized findings that resulted from the interim report are captured in this section. As mentioned in Section 2.1, a more detailed discussion of the interviews conducted appears in Appendix C. Some observations found in the road map resulted from later interviews.

2.3.1 Summary of Findings on Benefits, Impediments, and Other Key Issues

The project's revised interim report provided an in-depth look at what stakeholders felt about ESP in terms of their needs and interests. In total, there were approximately 50 direct interviews conducted, not counting surveys of specific carrier groups by their respective associations. The major stakeholder groups were:

- Shippers
- Carriers, including:
  - Motor carriers, both TL and LTL
  - Railroads
  - Air carriers
  - Ocean carriers
- Regulatory personnel
- Emergency responders

This subsection describes both the benefits identified from successful implementation (or that can be expected) and the issues that are likely to create problems with successful implementation for the purposes of augmenting or replacing the existing hazmat communication system.

It should be noted that while there are considered to be four major stakeholder groups, there are differences in the findings related to stakeholders within each group. For example, some regulatory personnel may be primarily involved with safety and others with security.

2.3.1.1 Benefits

The primary benefits to carriers are through the reduction of operational costs, primarily in back office clerical activities. The quantification of such savings would depend greatly on the level of process automation for the implementing carrier and its partners (customers and interlining carriers) and the type of solution implemented. Such alternatives could include but would not be limited to:

- Third party-hosted or carrier-hosted;
- Web portal access for shippers, data interchange, or e-documents; and
- Stand-alone application or fully integrated with the carrier's operating system.

The back office activities that are streamlined through the automation of shipping documents and business-to-business transactions include:

- Data entry;
- Copying/scanning/transmittal;

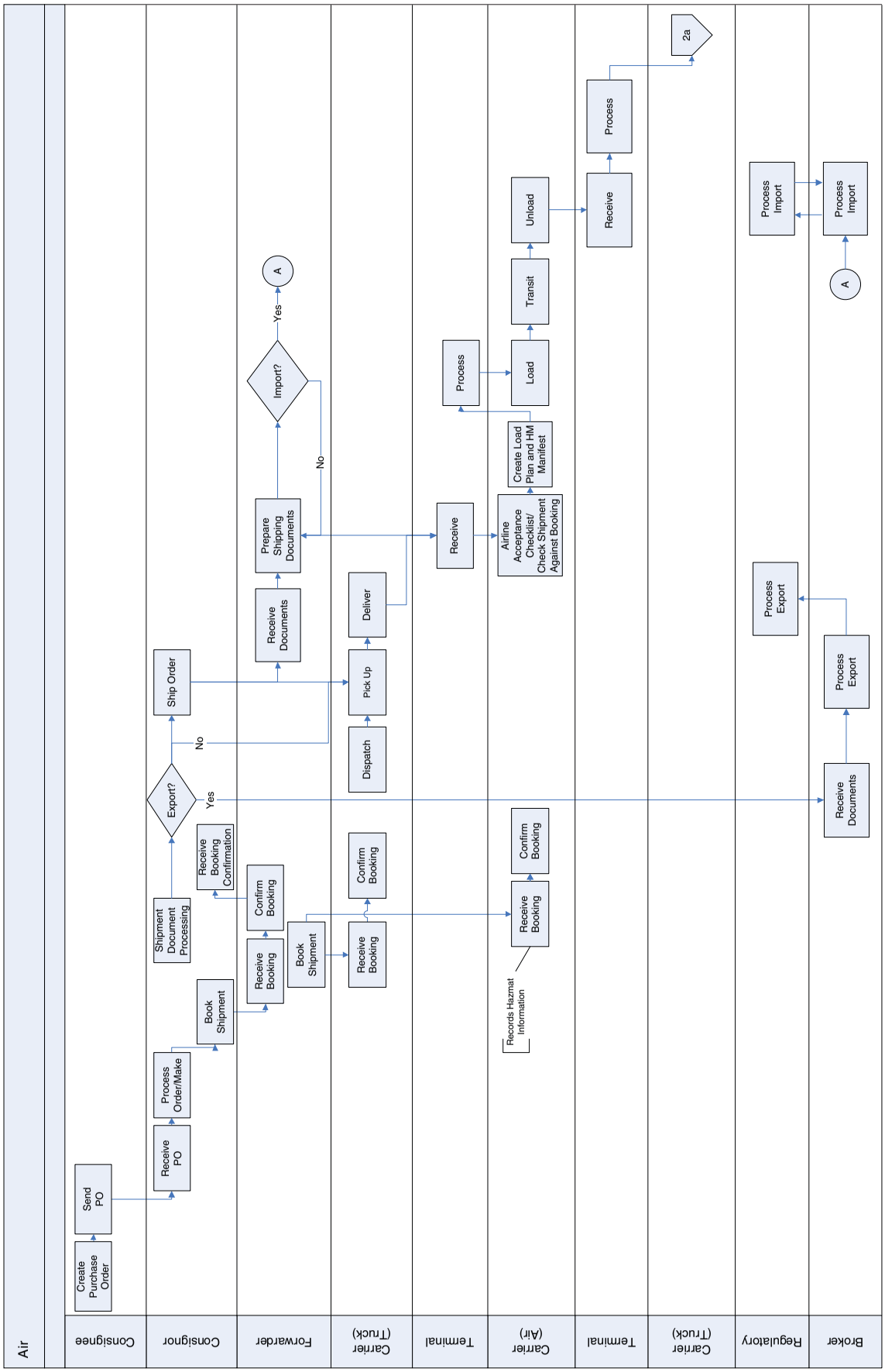

Figure 5. Air process map.

Table 1. Process map element descriptions.

Activity Identifiers	Role	Definition
Create PO	Consignee (receiver)	The consignee will create a PO, which is a legally binding document used to track shipped goods and link them with invoices. The PO provides the PO number, a description of the goods, the quantity ordered, and delivery dates (earliest and latest), and identifies the shipper, broker, and container freight station for delivery as well as buyer-specific information such as the brand and/or division placing the order.
Send PO	Consignee (receiver)	The purchasing arm of the consignee will forward the PO to the consignor. This can be done through fax, e-mail, file transfer, or traditional letter mail.
Receive PO	Consignor (shipper)	The consignor will then confirm receipt of the PO by telephone or one of the aforementioned methods.
Process order/make	Consignor	The consignee will check whether the item is in stock. If it is, it will issue stock for shipping. If not, the vendor will begin the production process for its manufacture in accordance with the PO. This item will then be considered the consignment.
Book shipment (order car for rail)	Consignor	The consignor will select a carrier for the consignment and send the carrier a booking. The booking will include information about the product, its destination, and delivery dates. Additionally, it will include information on the types/quantities of hazmat.
Receive booking (receive car order for rail)	Carrier	The carrier will accept the booking and plan the means of transportation for the consignment.
Confirm booking (confirm car order for rail)	Carrier	The carrier will then send confirmation to the consignor and schedule a pick-up time.
Receive booking confirmation (confirm car order for rail)	Consignor	The consignor will receive the booking confirmation and prepare the consignment for shipping at the scheduled pick-up time.
Record hazmat information (ocean and air)	Carrier	The carrier will note specific information for the proper receipt, documentation, handling, stowage, and reporting associated with hazmat shipments. Trained designated hazmat personnel will take, or later validate, the booking.
Hazmat shipment: classify/package/mark	Consignor	If the consignment contains hazmat, the consignor will mark the shipment in accordance with federal, state, or international regulations.
Hazmat shipment: prepare certification shipping papers	Consignor	Additionally, the consigner will prepare hazmat shipping papers, which include some of the following information: identification number, PSN, hazard class, packing group, additional descriptions, emergency response numbers, and shipper's certification.
Dispatch (crew, car dispatch for rail)	Carrier	The carrier will dispatch a truck (or rail crew, locomotive, and car) to pick up the consignment from the consignor at the scheduled pick-up time.
Ship order (car loading for rail)	Consignor	The consignment will be loaded onto the truck or rail car, accompanied by hazmat shipping papers.
Pick up shipment	Carrier	The consignment will be picked up by the carrier, which can be a separate activity from the loading. In the case of rail, the car is retrieved by a locomotive and crew.
Deliver shipment	Carrier	The carrier (a) transfers the shipment to the next party or (b) completes the delivery of the consignment to the buyer.
Receive shipment	Carrier	The carrier or intermediary accepting transfer of the shipment from another carrier.
Verify shipping papers to booking (ocean) Airline acceptance checklist (air)	Terminal, carrier	Upon receipt, the carrier or its representative (terminal) will verify shipping documents and markings to the booking to ensure a match.
Prepare container placement certificate (ocean)	Carrier	The ocean carrier will complete a certificate completed for handling containerized hazmat shipments.
Process shipment	Terminal	A terminal receives a shipment on behalf of an ocean or air carrier and processes the shipment—sometimes involving container loading—for loading onto the craft or vessel.
Prepare hazmat BOL (ocean)	Carrier	A BOL prepared by the ocean carrier with description and disposition instructions to be tendered to interline or on-forwarding carriers.

(continued on next page)

Table 1. (Continued).

Activity Identifiers	Role	Definition
Receive hazmat bill of lading (ocean)	Carrier	Receipt of the hazmat BOL by the interline or on-forwarding carrier.
Prepare hazmat stowage plan (ocean)	Carrier	A vessel stowage plan prepared by the ocean carrier that identifies the location of all hazmat on board the vessel. This will include description and quantity of each item as well.
Prepare U.S. Coast Guard (USCG) certain dangerous cargo (CDC) notification	Carrier	The USCG requires pre-arrival notification of CDCs under 33 CFR 160.204. CDC listing is not a comprehensive list of all hazmat items.
Create load plan and hazmat manifest (air)	Carrier	Similar to the ocean carrier stowage plan, the air carrier will create a load plan and create a hazmat manifest that describes the location, description, and quantity of all items on the aircraft. The pilot will carry a copy (sometimes abbreviated) of the hazmat manifest.
Send advance shipping notification (ASN)	Consignor	Publishing the ASN is a key point in the delivery of the consignment. This message contains key information such as gross weight and delivery date/time. It identifies the goods being shipped and their quantity, style, size, and color.
Receive ASN	Consignee, carrier	The ASN will be used to prepare for receipt and processing of the shipment.
Local cross dock (LTL)	Carrier	Unloading consignments from an incoming truck or rail car and loading these consignments directly onto outbound trucks with little or no storage in between. This may be done to change type of conveyance, to sort material intended for different destinations, or to combine material from different origins into transport vehicles (or containers) with the same, or similar, destination.
Origin switching (rail)	Carrier	Rail car switching from local to line-haul trains.
Transfer yard (TL)	Carrier	A different driver or interlined carrier may be used from the one that made the pickup. The transfer of the trailer occurs at the transfer yard.
Load, unload container (rail, ocean)	Terminal, carrier	Process of moving containers on or off ships or rail cars.
In-transit or line-haul	Carrier	The primary movement of the consignment from the point of origin or transfer to the point of destination or transfer. When more than one carrier, vehicle, or driver are involved, this does not typically include the pickup and delivery of the shipment. For ocean and air shipments, this refers to the port-to-port movement.
Intermediate/destination cross dock (LTL)	Carrier	Intermediate or destination terminal unloading of consignments from an incoming truck and loading these consignments directly onto outbound trucks with little or no storage in between.
Intermediate/destination switching (rail)		Rail car switching from line-haul trains for local delivery or for transfer to other lines or interlining rail carriers.
Receive documents (air, ocean)	Broker	A customs house broker receipt of documents necessary to submit to the customs authority for export or import clearance.
Process export (air, ocean)	Broker, regulatory	The process of submitting and clearing consignment documentation for export.
Process import (air, ocean)	Broker, regulatory	The process of submitting and clearing consignment documentation for import.
Receive USCG CDC notification	Regulatory	Receipt by the USCG of the CDC.
Request delivery appointment	Carrier	As the shipment is nearing the consignee's delivery point, the shipper will request a delivery appointment.
Receive delivery request	Consignee	Upon receiving of the delivery request, the consignee will continue preparations for the receipt of the consignment.
Send delivery confirmation	Consignee	If the consignee is ready for delivery, it will confirm the delivery appointment with the shipper.
Receive delivery confirmation	Carrier	The shipper will then ensure that the consignment is delivered at the correct place and time.
Deliver shipment	Carrier	The carrier (a) transfers the shipment to the next party or (b) completes the delivery of the consignment to the buyer.

- Filing, retrieval, and file maintenance;
- Error correction; and
- Partner communication.

Survey interviews asked participating carriers to estimate the total time or cost associated with their processing of hard copy shipping papers. Responses varied. A sample of responses is given in Table 2, which illustrates the range of impact depending on the level of automation and mode-specific processes and practices. It is unclear why the range of estimated impacts varies so greatly, particularly with the ocean carrier.

The primary benefits to government are through the streamlining of document (shipping paper) acquisition and review, as well as a reduction in data entry errors if ESP information can be integrated with roadside inspection software and other relevant reports to be completed, such as crash and incident reports. There likely will also be a reduction of operational costs through efficiency gains, particularly with the ability to move ESP data electronically to stakeholders with a need to know more quickly and accurately than is done today so that they may be acted upon more quickly. The quantification of such savings would depend greatly on the level of process automation for the particular government entities and the type of solution(s) implemented.

The primary operational cost benefits that stakeholders would expect to realize include:

- Reduced administrative costs related to data entry;
- Reduced administrative costs related to handling, tracking, filing, and retrieving paper shipping papers (in terms of both time and storage space);
- Faster booking process;
- Improved data accuracy;
- Improved data sharing; and
- Better record retention (fewer misplaced or lost records).

Secondary operational cost benefits include:

- Improved customer service,
- Improved ability to resolve quantity discrepancies,
- Reduced affects from staff turnover, and
- A more effective audit trail provided by secure electronic document handling.

Table 2. Impact of processing time avoided by ESP over hard copy shipping papers.

Respondent	Estimate of Impact
Air carrier	1 hour
Air carrier	40 min to 1 hour, 40 min
Integrator	5 min
Ocean carrier	Minutes to hours

Safety benefits are expected to accrue largely to the emergency response community. Timely and effective access to electronic hazmat information may eliminate the need for emergency responders to approach the vehicle in a fire, spill, or under other hazardous circumstance to retrieve the hard copy shipping papers with emergency response information.

Primary safety benefits include:

- Quicker access to hazmat information;
- Increased accuracy in transcribing data onto relevant documents (i.e., roadside inspection reports, crash and incident reports);
- Ability to more quickly notify appropriate parties with relevant ESP data; and
- Facilitation in providing hazmat information to alternate transportation facilities, such as when aircraft are diverted to alternate airports.

Secondary safety benefits include:

- Ability to provide advance notice to shippers that certain materials will not be accepted—for example, due to a facility's inability to process a certain class of hazmat.

Regulatory benefits will depend on the modifications made or parameters established by oversight agencies to accept ESP as an alternative to hard copy papers.

2.3.1.2 Impediments

Research conducted in Tasks 1 and 2 of HMCRP Project 05 engaged many organizations, both within and outside of the four primary stakeholder groups of shippers, carriers, regulatory agencies, and emergency responders. The terms "compliance" and "enforcement" in this document are used with regard to regulatory compliance or law enforcement stakeholder organizations that may need to identify what hazmat is on a vehicle. Neither term is used in the sense of enforcing compliance with the unified system described in this road map.

The findings of the project's interim report (*14*) documented organizations' thoughts, concerns, observations, and hopes for ESP as an alternative to the paper-based communication system. A number of interviewed organizations are already using some form of e-commerce. The interim report noted their experience and success with the systems they use. There were differences of opinion among participants regarding the degree and approach needed to a more inclusive ESP solution. Similarly, there were differences in the details of the implementation they felt would be optimal for their organizations.

The primary concerns and potential impediments stakeholders raised included:

- Concerns about access to data when power is disrupted, such as might occur during a major incident, which is also when the system is most likely to become overloaded.
- The necessity for good cost–benefit data to facilitate a move toward ESP.
- Implementation and operational costs for some segments of the industry might not justify costs for the carriers.
- Availability of current hazmat information during roadside inspections.
- Concern that regulators will monitor the electronic data and issue fines for incomplete or inaccurate data.
- How responders in urban and rural locations would retrieve the information and in what form.
- The ability for all emergency responders to access ESP information.
- The ability for responders to determine quickly whether a given shipment is accompanied by electronic or paper shipment information.
- Assignment of responsibility for data integrity and accuracy.
- The confidentiality of carrier/shipper proprietary information (potentially mitigated if such information could remain housed on company systems).
- The ability to realize benefits if only some parties in the supply chain use electronic data sharing; partial carrier industry acceptance may cause confusion for shippers regarding when electronic information sharing is possible.
- Availability of electronic documentation to all parties in the chain of custody.
- Level of technology adoption in the government/enforcement/response community and the ability to ensure that data are shared with all who have a need to know in a timely manner. For a significant period of time, many government personnel will not be equipped with the appropriate technology to take advantage of ESP, so how these stakeholders will continue to function effectively in their job duties is a significant issue.
- A full understanding of the regulatory, legal, and information system needs/activities necessary to allow for the implementation of ESP in government. Protecting business-sensitive information and ensuring that it does not end up in the wrong hands is critical. Identifying individuals and agencies with a need to know and providing accessibility for these individuals to the proper information will be a large task.
- A potential hindrance to adoption is the creation of multiple delivery modes, such as XML and UN/EDIFACT in addition to existing American National Standards Institute (ANSI) X12 standards, which are widely implemented worldwide.
- Concern that since the U.S. Environmental Protection Agency (U.S. EPA) is considering electronic hazardous waste manifests, what they implement may not be compatible with the current railroad EDI system.
- Need for a champion to standardize ESP across all modes.
- Driver data entry accuracy and training.

Concerning the last bullet, it should be reiterated that no high-level concept of operations of any specific ESP system was provided or implied during interviews, although driver data entry was perhaps inferred by some respondents.

Subsequent to the interviews associated with the interim report, a hazmat transportation industry subject matter expert noted that high turnover with carriers is also an impediment.

2.4 Detail of Task 4 (Submit Draft Road Map)

Comments from the project panel on the draft road map resulted in a significant revision. The revised draft road map included the following major sections:

- Background/Overview
- User Needs, Stakeholder Organizations, and Related Initiatives
- Context and Issues
- Current Electronic Commerce Systems Versus Needs
- Solution Alternatives
- Road Map Recommended Actions
- Methodology for Proof-of-Concept Exercises Designed to Test Implementation Strategies and Functionality
- Summary/Conclusions

The revised draft road map included the Task 5 proposed proof-of-concept methodology in order to compress the schedule. Comments from the project panel on the revised draft road map were incorporated into the final version of the draft road map, and preparation of the draft final report proceeded.

The findings from Task 4 research that built on Tasks 1 through 3 and led to development of the road map concept are documented in this report in Chapter 3: Findings and Applications. The resulting road map is discussed in Section 4.1.

2.5 Detail of Task 5 (Propose Methodology for Proof-of-Concept Exercises)

As mentioned in Section 1.1, the Task 5 methodology for proof-of-concept exercises was developed concurrently with

Task 4 and was included with the road map document. It appears as Section 4.2.

2.6 Detail of Task 6 (Submit Road Map and Draft Final Report)

The road map with methodology for proof-of-concept exercises is included in this report, which also includes responses to project panel comments on the revised draft road map.

2.7 Detail of Task 7 (Respond to Panel Comments/ Submit Final Report)

All findings are included in this report and its appendices.

CHAPTER 3

Findings and Applications

Chapter 3 progresses through a series of discussions on twelve topics to help frame a deeper understanding of ESP, leading to the conclusions. These topics are:

1. Stakeholders and user needs summary;
2. U.S. DOT initiatives related to ESP;
3. Other initiatives and actions related to ESP;
4. Contexts and issues;
5. Discussion of ESP implementation challenges and trade-offs;
6. Electronic commerce system standards and standards bodies/organizations
7. Data creation/intake methods;
8. Existing electronic interchange systems;
9. Current electronic commerce methods meeting hazmat transport user needs, and their challenges;
10. Solution alternatives,
11. Attributes of desired state system; and
12. Gap analysis between current and desired state.

3.1 Stakeholders and User Needs Summary

There are four primary stakeholder groups involved with ESP: shippers, carriers, regulatory agencies, and emergency responders. (While freight forwarders work closely with both shippers and carriers, for convenience their role is included with shippers, the group with which they are most closely aligned.) A single hazmat shipment from its origin to destination may involve intermodal transportation, cross international borders, and otherwise engage a number of the stakeholder groups. The interim report contains a more detailed examination of the various stakeholders, their experience with and impressions of ESP, and their interactions with other stakeholders.

Shippers and carriers are more concerned with the commercial, logistical, freight management back office nature of ESP benefits. Shippers (who may also be product manufacturers) offer hazmat for delivery to a consignee. They verify that the shipment complies not only with 49 CFR but other mode-specific regulations. Business operations need additional information such as information on non-hazardous materials, other parties in the supply chain, billing and financial data, and expected delivery time. Carriers accept shipments and execute the contracted needs of the shipper, transporting the goods to the consignee or to an interline carrier.

As a general statement, regulatory compliance/enforcement and emergency response personnel need situational, front-end access to information about the contents of a shipment. This group may include roadside inspectors. Policy-wise, there are a number of government organizations such as EPAs (whether federal or state) and other government organizations that issue regulations. It should be noted that no other federal or state agency can mandate specific shipping documents because the U.S. DOT has preemptive authority for all hazmat in transportation.

Emergency responders primarily need specific information on the materials present, types of containers, quantities of materials, and potential interactions with other materials in the shipment.

Table 3 characterizes the basic user needs for each primary stakeholder group.

3.1.1 Hazmat Transport Stakeholder Organizations and Trade Associations

This subsection describes organizations and trade associations representing the four main stakeholder groups involved in ESP, their roles, and their needs. It should be noted that this listing is not intended to be all-inclusive; rather it identifies illustrative larger, more nationally known organizations.

Table 3. User needs characterization.

Stakeholder Group	User Needs
Shippers	• In-transit visibility • Data sharing with supply chain partners • Regulatory compliance • Paperwork reduction/reduced administrative expense • Hazmat/dangerous goods shipping paper creation • Commercial information security
Carriers	• In-transit visibility • In-transit records compliance • Paperwork reduction/reduced administrative expense • Data sharing with authorized interlines • Record retention compliance • BOL, manifest, and freight bill creation • Commercial information security • Anti-theft/-sabotage/-terrorism security
Regulators	• In-transit records compliance • Record retention compliance • Shipment, vehicle, and driver documentation
Emergency responders	• Specific information on materials present, types of containers, material quantities, and how to get timely expert information on potential interactions with other materials in the shipment • Awareness of product name • Emergency contact information • Receipt of information quickly and ideally at safe stand-off distance

3.1.1.1 U.S. Shipper and Carrier Industry Associations and Working Groups: Initiatives Related to Electronic Commerce

A number of associations across the marine, trucking, rail, and air communities, along with the key shipper organizations, are primarily focused on policy development. Most associations have stated support for electronic data interchange to improve safety, security, operational efficiency, and regulatory compliance. Some associations interviewed pointed to continued impediments to more efficient electronic commerce. Even with key electronic commerce initiatives such as the International Air Transport Association's (IATA's) e-freight and the rail industry's almost complete use of paperless transactions via EDI (reportedly over 95%), conflict points or impediments exist. E-commerce may not be widely embraced by the freight forwarder community, who see it as creating more work for them to provide more efficiency for the beneficiary carrier. There are some major global forwarders who have been and are adopting IATA e-freight. As mentioned in Subsection 1.2.1, the largest freight forwarders have invested in proprietary systems and developed IT systems that communicate on behalf of shippers and customers. Even with the rail industry's high penetration, intermodal partners in marine and trucking point to rail's use of Standard Transportation Commodity Code (STCC) as an impediment to multimodal adoption.

IATA's e-freight and the International Vessel Operators Dangerous Goods Association's (IVODGA's) Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping have focused on efficient multimodal data interchange. Their working groups have involved collaboration across several modes.

Table 4 lists and characterizes hazmat transportation industry trade associations.

3.1.1.2 Regulatory Organizations (Customs and Safety Compliance)

Regulatory stakeholders. Regulatory stakeholders are composed of representatives from both government and the private sector. The government sector includes agencies that develop and enforce hazmat regulations as well as those whose function is to ensure that the regulations are enforced as efficiently and effectively as possible. The primary enforcement agency for hazmat transportation in the United States is the U.S. DOT. However, since the agency is composed of administrations with distinctive functions, any useful description of the U.S. DOT must be broken down to a discussion of the various administrations. These include modal administrations such as the FHWA, FAA, and FRA and safety administrations such as FMCSA and PHMSA. A key agency responsible for border safety and security is the CBP. Other North American federal organizations include Transport Canada, the Canada Border Services Agency (CBSA), the Mexican Secretariat of Communications and Transportation (Secretaría de Comunicaciones y Transportes, or SCT), and Mexican Customs (Aduanas).

Regulatory stakeholders in the private sector are composed of organizations whose members have a strong interest in ensuring that regulations are developed that will best accomplish their intended purpose, and that once promulgated,

Table 4. Industry trade associations and characterization.

Organization Name/Website	Industry Served	Electronic Commerce Initiatives	Impact/Initiatives Related to Hazardous Materials/ Dangerous Goods ESP
International Air Transport Association (IATA): www.iata.org	Passenger and cargo airlines	• IATA publishes transportation standards [Cargo Interchange Message Procedure (i.e., Cargo-IMP)] focused on communications with airlines. • XML standards development • E -freight has replaced 20 commercial and regulatory documents with electronic equivalents. Focus is on expanding the number of users. • Member of the Global Air Council Advisory Group (GACAG)	• Declaration for Dangerous Goods Data message included among the IATA standards. • IATA has developed XML requirements of the Shippers' Declaration for Dangerous Goods data standards (SDDG-XML). • Dangerous goods declaration among the IATA e-freight electronic document forms available.
Air Forwarders Association (AFA): www.airforwarders.org	Air forwarding: indirect air carriers, cargo airlines, and affiliated businesses	Supportive of electronic data interchange and the Electronic Universal Waybill	Included among electronic commerce position
Airlines for America (A4A) (formerly Air Transport Association): www.airlines.org	Airline	Supportive of electronic data interchange	Included among electronic commerce position
International Federation of Freight Forwarders Associations (FIATA): www.fiata.com	International forwarding and logistics	Supportive of electronic data interchange Member of GACAG	Included among electronic commerce position
International Air Cargo Association (TIACA): www.tiaca.org	Air cargo industry, including airlines, forwarders, airports, ground handlers, trucking companies, customs brokers, third-party logistics forms	Supportive of electronic data interchange in international air cargo, involvement in electronic commerce standards development, member of GACAG	Included among electronic commerce position
Global Air Cargo Advisory Group	Air cargo industry group that includes IATA, TIACA, FIATA, and GSF	Supportive of electronic data interchange in international air cargo, involvement in electronic commerce standards development	Included among electronic commerce position
National Tank Truck Carriers (NTTC): www.tanktruck.org	Tank truck carriers	Supportive of electronic data interchange	Included among electronic commerce position
Commercial Vehicle Safety Alliance (CVSA): www.cvsa.org	North American government and industry motor vehicle safety and security	Information Systems Committee addresses commercial motor vehicle information system needs of CVSA.	Hazardous Materials and Information Systems Committee explores initiatives and new technologies.
American Trucking Associations (ATA): www.truckline.com	Trucking	Supportive of electronic data interchange	Included among electronic commerce position
Association of American Railroads (AAR): www.aar.org	North American railroads	Promotes use of electronic data interchange AAR's RailInc subsidiary is a leading provider of electronic data interchange for the rail industry Automatic Equipment. Identification (AEI) Committees include EDI Technical Advisory Group (TAG).	Committees include Hazardous Materials Bureau of Explosives (BOE) committee.
American Waterways Operators (AWO): www.americanwaterways.com	Tugboat, towboat, and barge operators	No electronic commerce initiatives indicated	None stated

Table 4. (Continued).

Organization Name/Website	Industry Served	Electronic Commerce Initiatives	Impact/Initiatives Related to Hazardous Materials/ Dangerous Goods ESP
International Vessel Operators Dangerous Goods Association (IVODGA): www.ivodga.com [formerly Vessel Operators Hazardous Material Association (VOHMA)]	Ocean common carriers	Working with international, government, and industry partners to develop and implement a program to remove impediments to intermodal/international transportation and facilitate e-commerce	Association's focus is solely on dangerous goods/hazmat. Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping program addresses standards development and use of the multimodal shipper's declaration. The initiative has involved representatives from all modes of transportation.
Dangerous Goods Advisory Council (DGAC): www.hmac.org	All carrier modes	No electronic commerce initiatives indicated	Nonprofit organization devoted to promoting safety in the national and international transportation of dangerous goods
American Chemistry Council (ACC): www.americanchemistry.com	Chemical industry, including manufacturing, transportation, and distribution	No electronic commerce initiatives indicated	None stated
National Association of Chemical Distributors (NACD): www.nacd.com	Chemical distribution, including distributors, manufacturers, carriers, and service providers	No electronic commerce initiatives indicated	None stated
Global Shippers Forum (GSF): http://globalshippersforum.com	International organizations with members from more than 50 countries	Part of GACAG	None stated
Council on Safe Transportation of Hazardous Articles (COSTHA): http://www.costha.com	Industry association of global companies that are involved in the manufacture and transport of hazmat/dangerous goods	No electronic commerce initiatives indicated	Participates with IVODGA and U.S. DOT on the Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping initiative
Institute of Hazardous Materials Management (IHMM): http://www.ihmm.org	Not-for-profit organization that administers credentials in hazmat management	No electronic commerce initiatives indicated	None stated
Alliance of Hazardous Materials Professionals (AHMP): http://www.achmm.org	Leading experts in environmental, health, safety, and security management; hazmat; and waste management	No electronic commerce initiatives indicated	None stated

these regulations will be enforced effectively. Prominent private-sector organizations are represented by such organizations as Commercial Vehicle Safety Alliance (CVSA) and the World Customs Organization (WCO). Regulatory stakeholders in the private sector also include trade associations that include regulatory concerns among a suite of priorities such as business and competitive issues. These organizations typically represent a particular mode or modal niche. The ATA, AAR, and IATA represent this type of stakeholder.

Table 5 lists and briefly describes representative regulatory stakeholders in the public and private sectors. The list has been designed to select those regulatory stakeholders considered to be the most important and influential. Table 5 includes stakeholder organizations representing all of the major modes in both the public and private sectors. CVSA and WCO also appear in Table 4 as trade associations.

3.1.1.3 Emergency Responder Stakeholder Organizations and Associations

Emergency responder organizations represent firefighters, emergency responders, paramedics, and other emergency

Table 5. Representative regulatory stakeholders in the public and private sectors and their characterization.

Regulatory Stakeholders in the Public Sector (U.S. DOT)			
Agency Name	***Mode***	***Description of Agency***	***Regulatory Role***
FMCSA: http://www.fmcsa.dot.gov	Truck	FMCSA's mission is to prevent commercial motor-vehicle-related fatalities and injuries.	Encourages strong enforcement of regulations and develops new regulations
PHMSA: http://www.phmsa.dot.gov	All	PHMSA works to protect the public and the environment by ensuring the safe and secure movement of hazmat to industry and consumers.	Develops and enforces regulations for the safe transport of hazmat.
FAA: http://www.faa.gov	Air	FAA ensures safety and security of airline operations in the United States.	The FAA has enforced hazardous-materials regulations for aviation since the passage of the Hazardous Materials Transportation Act in the late 1970s.
FRA: http://www.fra.dot.gov	Rail	FRA administers railroad assistance programs and conducts research and development in support of improved railroad safety.	The FRA promulgates and enforces rail safety regulations.
Regulatory Stakeholders in the Public Sector (U.S. Department of Homeland Security)			
Agency Name	***Mode***	***Description of Agency***	***Regulatory Role***
USCG: http://www.uscg.mil	Marine	The USCG is the only military organization within DHS. The USCG protects the marine economy and the environment, and rescues those in peril.	Ensures enforcement of hazmat regulations with a focus on pollution prevention and mitigation
CBP: http://www.cbp.gov	All	One of the DHS's largest components, with a priority mission of keeping terrorists and their weapons out of the U.S. It also has a responsibility for securing and facilitating trade and travel.	The agency enforces hundreds of U.S. regulations, including those related to the safe shipment of all cargoes at ports of entry. Also conducts the ACE program that uses e-manifests.

medical personnel. These organizations help members prepare for, respond to, and recover from all emergencies, disasters, and threats to the security of the United States, including hazmat incidents. They may provide leadership, professional development, networking, and lobbying.

There are safety and security aspects of ESP information for all four stakeholder groups. However, the HMCRP Project 05 SOW notes that "shipping papers also contain specific hazard information, standardized so that emergency responders may identify appropriate measures to be taken in the event of a hazmat incident." Thus, emergency responders are a stakeholder group that has special needs and expectations of an ESP implementation beyond aspects of commerce or regulatory concerns. Table 6 lists the major stakeholder organizations associated with emergency preparedness and response involving hazmat incidents.

Table 5. (Continued).

Regulatory Stakeholders in the Public Sector (Non-U.S. Entities)			
Agency Name	***Mode***	***Description of Agency***	***Regulatory Role***
CBSA: http://www.cbsa-asfc.gc.ca	All	This federal agency is responsible for law enforcement and customs services at the border.	Enforces customs regulations to ensure the safe and secure transfer of cargo. Also conducts the ACI program that uses e-manifests.
Aduanas: http://www.aduanas.gob.mx/aduana_mexico/2011/home.asp	All	This Mexican federal agency, the counterpart of CBP, is responsible for law enforcement, customs, and immigration services at the border.	Enforces customs and immigration regulations
Regulatory Stakeholders in the Private Sector			
Agency Name	***Mode***	***Description of Agency***	***Regulatory Role***
CVSA: www.cvsa.org	Truck	Nonprofit organization of federal, state, and provincial government agencies and representatives from private industry in the United States, Canada, and Mexico	Serves to bring together state/provincial and Mexican officials with truck/bus industry interest and federal governments to solve problems related to ensuring highway safety.
WCO: www.wcoomd.org/home.htm	All	The only intergovernmental organization exclusively focused on customs matters. Recognized as the voice of the global customs community. Noted for its work in development of global standards.	The enhancement of customs enforcement and compliance activities

3.2 U.S. DOT Initiatives Related to ESP

The following U.S. DOT initiatives are related to the objectives of HMCRP Project 05 in particular and to ESP in general.

3.2.1 Hazardous Materials – Automated Cargo Communications for Efficient and Safe Shipments (HM-ACCESS)

A related initiative that was in progress concurrently with the HMCRP Project 05 research is PHMSA's HM-ACCESS program. Per the program's Roadmap brochure (*15*):

> The HM-ACCESS initiative aims to identify and eliminate barriers to the use of paperless tracking and hazard communications technologies, thereby:
>
> 1. Improving the availability and accuracy of hazard and response information for shipments and packages which are tracked electronically;
> 2. Improving the speed by which information is available to emergency responders when accidents occur;
> 3. Improving the security of imported containers through better knowledge of shipments and reduced potential for diversion; and
> 4. Allowing American companies to compete more effectively in the global economy by using the best tools available.

PHMSA held an HM-ACCESS public meeting on October 12 and 13, 2009. Its purpose was to give stakeholders an opportunity to provide input to the HM-ACCESS initiative and its planned demonstration project. The four dozen participant entities included federal, state, military, and other government organizations; safety

Table 6. Emergency responder organizations, associations, and characterization.

Organization Name	Description of Organization/Role
International Association of Fire Chiefs (IAFC): http://www.iafc.org	IAFC represents the leadership of over 1.2 million firefighters and emergency responders. IAFC members are experienced in firefighting, emergency medical services, terrorism response, hazmat spills, natural disasters, and search and rescue. IAFC provides a forum for its members to exchange ideas and information related to the above-mentioned competencies as well as about new products and services available to emergency responders.
International Association of Firefighters (IAFF): http://www.iaff.org	IAFF represents more than 298,000 full-time professional firefighters and paramedics who serve 85% of the nation's population. In addition to city and county firefighters and emergency medical personnel, the IAFF represents state employees, federal workers, and fire and emergency medical workers employed at certain industrial facilities.
International Association of Emergency Managers (IAEM): http://www.iaem.com	IAEM, which has more than 5,000 members worldwide, is a nonprofit educational organization dedicated to promoting the "principles of emergency management" and representing those professionals whose goals are saving lives and protecting property and the environment during emergencies. IAEM's mission is to advance the profession by promoting the principles of emergency management, as well as serving their members by providing information, networking, and professional development opportunities.
Disaster Preparedness and Emergency Response Association (DERA): http://www.disasters.org	DERA is a membership organization founded as a nonprofit association linking professionals, volunteers, and organizations active in all phases of disaster preparedness and emergency management. DERA remains an independent, nongovernmental organization with dual missions of professional support and disaster service. DERA also provides extensive networking opportunities for its members and has been actively involved in providing emergency assistance in response to several recent disasters.
National Emergency Management Association (NEMA): http://www.nemaweb.org	NEMA is a nonpartisan, nonprofit 501(c)(3) association dedicated to enhancing public safety by improving the nation's ability to prepare for, respond to, and recover from all emergencies, disasters, and security threats. NEMA is the professional association for emergency management directors from all 50 states, eight U.S. territories, and the District of Columbia. NEMA provides expertise in comprehensive emergency management, serves as an emergency management information and assistance resource, and advances emergency management through strategic partnerships and innovative programs.
American Chemistry Council, Transportation Community Awareness and Emergency Response (TRANSCAER): http://www.transcaer.com	TRANSCAER is a voluntary national outreach effort that focuses on assisting communities to prepare for and to respond to a possible hazmat transportation incident. TRANSCAER members consist of volunteer representatives from the chemical manufacturing, transportation, distributors, and emergency response industries, as well as the government.
American Chemistry Council, CHEMTREC: http://www.chemtrec.com	CHEMTREC is an information resource and solutions provider for hazmat response. CHEMTREC serves as a 24-hour emergency call center resource for obtaining immediate response information for incidents involving hazmat. CHEMTREC is linked to the largest network of chemical and hazmat experts in the world, including chemical and response specialists, public emergency services, and private contractors. CHEMTREC also assists shippers of hazmat with compliance with government regulations.
Transport Canada, CANUTEC: http://www.tc.gc.ca/eng/canutec/menu.htm	CANUTEC is an arm of Transport Canada (the Canadian counterpart to U.S. DOT) that gives expert advice on dangerous goods accidents to promote public safety in the transportation of dangerous goods by all modes of transport in Canada.
Spill Center: http://www.spillcenter.com	Spill Center is a nationwide, 24-hour emergency resource organization dedicated to reducing environmental liability for companies that become spill generators. The Spill Center website provides spill generators with information on cleanup contractors as well as guidance for completing all required regulatory reports and how to thoroughly document incidents.
Chlorine Institute, Inc. (CI): http://www.chlorineinstitute.org	CI is a technical trade association of companies that are involved in the production, distribution, and use of chlorine, sodium and potassium hydroxides, and sodium hypochlorite, and the distribution and use of hydrogen chloride. Because of chlorine's nature, its widespread and varied use, and the potentially serious consequences associated with a release, the promotion of its safe handling has long been an accepted responsibility of its producers, packagers, distributors, and users. CI is the focal point for their combined efforts. CI's North American producer members account for a majority of the total chlorine production capacity of the U.S. and Canada.

Table 6. (Continued).

Organization Name	Description of Organization/Role
AHMP: http://www.achmm.org	AHMP, formerly the Academy of Certified Hazardous Materials Managers (ACHMM), is a professional association with a membership of more than 4,000 experts in environmental, health, safety, and security management. AHMP is the only national organization devoted to the professional advancement of the hazmat management field.
Hazardous Materials Association http://www.hazmatbc.ca	The Hazardous Materials Association is a nonprofit association of professional contractors and other concerned organizations or individuals involved in the hazmat industry in British Columbia. It promotes compliance with regulatory board requirements through education, training, and support for the voluntary standardization and upgrading of hazmat handling procedures. The Hazardous Materials Association represents the interests of its members by providing a forum for discussing issues relevant to the hazmat handling industry.

associations; industrial companies and associations; and a media organization. PHMSA has benefitted HMCRP Project 05 by sharing the minutes and briefings from the meeting and associated workshops, which supplemented and strengthened project interview and other research findings. The specific HM-ACCESS design that will result is being determined; many current and developmental systems that are relevant are mentioned in the HM-ACCESS road map. A dialogue was opened between HMCRP Project 05 participants and HM-ACCESS management to facilitate cooperation.

3.2.2 Intelligent Transportation Systems (ITS) Strategic Research Plan, 2010–2014

The ITS Strategic Research Plan (*16*) describes a number of related initiatives that are listed in the following, some of which involve V2V, V2I, and I2V communication for safety using dedicated short-range communications (DSRC).

3.2.2.1 Connected Vehicle Program

Connected vehicle mobility applications provide a connected, data-rich travel environment. The network captures real-time data from equipment located on board vehicles (automobiles, trucks, and buses) and within the infrastructure. The data are transmitted wirelessly and are used by transportation managers in a wide range of dynamic, multimodal applications to manage the transportation system for optimal performance. One of the visions for the Connected Vehicle Program is to participate in international standards harmonization activities focusing on standards "around the vehicle platform"—that is, any standards needed to provide connectivity between vehicles and between vehicles and infrastructure.

3.2.2.2 Dynamic Mobility Applications Program

The DMA program seeks to identify, develop, and deploy applications that leverage the full potential of connected vehicles, travelers, and infrastructure to enhance current operational practices and transform future surface transportation system management. DMA are the next generation of applications that transform mobility by providing transportation managers and system operators with real-time monitoring and management tools to manage mobility between and across modes more effectively and provide travelers the ability for dynamic decision making. These applications capitalize on vehicle infrastructure connectivity (e.g., data from vehicle probes and other real-time DSRC and non-DSRC data sources). The vision for DMA research is to provide significant improvements to mobility by (1) introducing innovative methods for operating existing transportation systems based on the availability of new data sources and communications methods, and (2) creating opportunities for greater multimodal integration.

One DMA area of interest is electronic manifest data collected from commercial vehicles that are involved in an incident that would help to identify load contents and whether there are hazmat risks. U.S. DOT's DMA program wants to develop a feature called Incident Scene Pre-Arrival Staging Guidance for Emergency Responders. U.S. DOT recognizes that providing situational awareness to public safety responders while en route can help establish incident work zones that are safe for responders, travelers, and crash victims alike while being less disruptive to traffic. Situational awareness information can also provide valuable input to responder and dispatcher decisions and actions. There are a range of data elements related to situational awareness that are currently available from public and private sources that could be accessed, processed, and provided to public safety responders. This application would provide a range of data to responders through their mobile devices to help support public safety

responder vehicle routing, staging, and secondary dispatch decision making. Among the many data elements desired are:

- Current weather conditions that would help responders avoid staging downwind from hazmat incidents.
- Electronic manifest data collected from commercial vehicles that are involved in an incident that would help to identify load contents and whether there are hazmat risks.
- Crash data generated though in-vehicle systems that can assist responders. Examples of these data are the number of passengers, seat belt usage, airbag status, point of impact, type of vehicle involved (e.g., alternate fuel vehicle), air-bag deployment, types and location of airbags within vehicle, and delta velocity of vehicle involved in crash.

3.2.2.3 Smart Roadside and Wireless Roadside Initiatives

U.S. DOT continues to develop the Smart Roadside Initiative (SRI), which is a partnership of the FHWA and FMCSA. The SRI is the development of roadside infrastructure for commercial vehicle operations that employs technologies for information sharing. In the vision for SRI, commercial vehicles, motor carriers, enforcement resources, highway facilities, intermodal facilities, toll facilities, and other nodes of the transportation system collect data for their own purposes and share the data seamlessly with relevant parties in order to improve motor carrier safety, security, operational efficiency, and freight mobility. This vision will be achieved through the application of interoperable technologies and information sharing between in-vehicle, on-the-road, and freight facility systems. The SRI thus has potential as a means by which ESP for hazmat being hauled by a commercial vehicle could be passed to a roadside inspection station operated by a regulatory agency.

FMCSA is also conducting the Wireless Roadside Inspection (WRI) initiative. The WRI initiative is intended to provide FMCSA investigators and inspectors with a greater amount of information when auditing a motor carrier or inspecting a motor carrier's vehicle. In recognition of the importance of standardized data, FMCSA has developed a set of safety data message sets transmitted by DSRC, which may provide a foundation for providing hazmat information during roadside inspections.

3.2.3 Commercial Vehicle Infrastructure Integration (CVII) Program

As an effort related to the ITS strategic plan initiatives described in Subsection 3.2.2, the State of New York Department of Transportation has a program known as the Commercial Vehicle Infrastructure Integration initiative. At its foundation is a network that uses DSRC to support V2I and I2V communications for cooperative system capability. CVII is another example of an initiative by which it may someday be possible to have information on hazmat cargo remotely passed via V2I communications from a truck to a transponder that uploads the hazmat information to a regulatory agency station.

3.3 Other Initiatives and Actions Related to ESP

3.3.1 IATA E-Freight

IATA launched its e-freight initiative in late 2004. IATA e-freight is designed to free the air cargo supply chain from the up to 38 pieces of paper than can accompany the average air freight shipment. IATA e-freight has been aligned with the WCO and the UN customs modernization initiatives. IATA e-freight has launched local implementation pilot programs on key trade lanes linking a number of participating countries in support of the industry's desire to free the airfreight supply chain of the need to transport paper in parallel with freight. IATA is also working with industry and other governments to benchmark innovative e-customs initiatives. IATA collaborates with regulatory authorities, civil aviation authorities, freight forwarders, carriers, and airports. IATA does not provide an e-commerce system but rather a standardized messaging process. Much about the process IATA has followed to encourage e-commerce adoption appears applicable to ESP implementation.

3.3.2 IVODGA–U.S. DOT Partnership Initiative: Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping

The objective of this joint initiative is to work with government and industry partners to develop and implement a program to remove impediments to intermodal/international transportation and facilitate e-commerce (*17*). The working group and other volunteers supporting this initiative are from the ocean carrier, rail, trucking, and air cargo industry companies and associations; U.S. DOT modal and safety administrations; and the USCG. Among other results, their efforts have explored a list of data elements needed for interoperability of dangerous goods transport documentation.

3.3.3 Rotterdam Rules

The Rotterdam Rules of 2009 (i.e., United Nations Convention on Contracts for the International Carriage of Goods Wholly or Partly by Sea) provide a legal framework that takes into account the many technological and commercial devel-

opments that have occurred in marine transport since the adoption of those earlier conventions, including the development of electronic transport documents and facilitating e-commerce through the use of electronic documentation (*18*).

3.3.4 Globally Harmonized System of Classification and Labeling of Chemicals (GHS)

The GHS is a worldwide initiative to promote standard criteria for classifying chemicals according to their health, physical, and environmental hazards (*19*). The GHS will help ensure more consistency in the classification and labeling of all chemicals, thereby improving and simplifying hazard communication. The GHS is not a regulation or a standard; compliance with the GHS is voluntary for each country, but companies in countries that do not adopt the GHS will be at a disadvantage when doing business internationally. The GHS is due out in 2015, and every participating country will have provided a variant of the MSDS.

3.3.5 TSA Highway Security-Sensitive Materials (HSSM) Security Action Items (SAIs)

TSA provides voluntary security practices as measures that should be considered for implementation by motor carriers transporting Tier 1 HSSM and Tier 2 HSSM (*20*). The HSSM are lists of hazmat classes/division and associated quantities transported by motor carriers that are of greatest interest to TSA for security reasons (*21*). If the motor carrier adopts these security practices, TSA recommends that the practices be included in security plans when they are developed, implemented, and revised. The security practices are voluntary in order to allow highway motor carriers to adopt measures best suited to their particular circumstances, provided the measures are consistent with existing regulations, laws, or directives.

3.3.6 TSA Trucking and Freight Rail Security Grant Programs

Starting in 2008, TSA has awarded grants under its Trucking Security Program (*22*) and Freight Rail Security Program (*23, 24*) designed to strengthen the nation's critical infrastructure against risks associated with terrorism. For trucking security, these grants focused on the purchase and installation or enhancement of equipment and systems related to tractor and trailer tracking systems. The trucking security grants supported the adoption and implementation of security initiatives such as tractor and trailer tracking systems, panic button capability, tractor activation capability, and communications plans, as well as the development of security plans and monitoring and analysis systems and centers.

The freight rail security grants provided funding to Class I, II, and III railroad operators that transport rail security-sensitive materials (RSSM) (i.e., bulk PIH/TIH) through designated "high-threat urban areas" to perform vulnerability assessments and security plans and/or conduct security training for railroad frontline employees. The freight rail security grant program also funded owners and offerors of railcars that ship PIH/TIH to acquire and install GPS locating and alert-reporting systems on those railcars, and to owners of rail bridges that span the Western Rivers System.

3.4 Contexts and Issues

This section begins with a characterization of hazmat transport by mode to provide context. It then expands on findings from earlier interviews to identify and explore key considerations that bear on the road map solution. These considerations are real-world influences or conditions that must be factored into the road map concept. Despite the difficulties of implementing ESP, there are no logical or legal impediments involved. However, the research recognizes that a single solution that will meet the needs of all stakeholder groups to an appreciable degree would be very difficult to achieve, and for it to even be possible, considerable trade-offs must be considered. Thus, the research promotes the benefits of a unified ESP system view that supports interoperability and exchange of standardized e-commerce for hazmat transportation of all carrier modes, carrier types, and hazmat classes without duplicate data entry.

Some of the foremost impediments to hazmat ESP implementation are the same impediments to ESP in general. Industry groups are reluctant to implement e-commerce until they believe it will significantly improve their operations by simplifying business, improving service, and reducing costs (*25*). For example, at a high level these impediments include resistance to change, complex processes, and lack of an entity to bring stakeholders together and encourage and compel them. Currently the beneficiary of e-commerce tends not to bear the cost of ESP, and thus the resulting sender-pay model does not encourage implementation. IT solutions are focused on taking away paper, but not necessarily the paperwork; while documents can be made electronic, if they have to be read anyway for accuracy, the cost–benefit advantage of electronic transmission is diminished. Taking a process that is done manually and making it electronic will not work as well as changing the process.

Too many solutions are focused on a single method; there is not a one-size-fits-all solution that has arisen, which is why there is a market for companies to reformat or translate ESP. There is resistance to central tracking or a central

database, which is largely due to the perceived possibility of comingling or other inadvertent disclosure of company business-sensitive information such as its customer base and shipment origin–destination information. Requirements for systems that will significantly add to transportation costs in a fiercely competitive marketplace are a concern (i.e., as an unfunded mandate). The following topics examine these and a number of other key challenges.

3.4.1 Characterization of Hazmat Classes by Mode of Transport

Statistics on the annual hazmat ton-miles shipped in the United States can be obtained from the 2007 hazmat Commodity Flow Survey (CFS) published by the U.S. Census Bureau, whether via the American FactFinder source (*26*), the U.S. DOT Bureau of Transportation Statistics (BTS) 2007 CFS Hazmat Report (*27*), or the BTS's Hazardous Materials Highlights for the 2007 CFS (*28*). Table 7 (*29*) shows hazmat shipments by mode in 2007, including pipeline (a mode that is not relevant to ESP). Table 7 is extracted from Table 1a of the 2007 CFS. The bolded entries sum to the totals shown in the first row. The entries below these bolded entries show the major components of the totals. The "Air" row totals for ton-miles are considered too uncertain to show but are included in the total ton-miles, rows 1 and 2. The estimated ton-miles for pipelines are also included in the totals but are not shown in the "Pipelines" row because of uncertainty arising from the unavailability of the pipeline network map in the public domain. The pipeline estimate included in the totals takes into consideration the origin and destination zip codes and the great circle route distance between them. For these reasons, some air and pipeline entries in Table 7 are shown as having insufficient data.

Table 8 (*30*) compares characteristics of hazardous and nonhazardous materials shipments, by mode and by tons and ton-miles. Table 8 is extracted from Table 4 of the 2007 CFS. As with Table 7, the hazmat totals include contributions from air and pipeline that are shown in the totals in rows 1 and 2 but not in the rows showing the individual air and pipeline entries.

Table 9, condensed from Table 8, presents for each major mode the total ton-miles of all cargo shipped and the number of ton-miles represented by hazmat transport, also provided as a rounded percentage. Table 9 shows that hazmat carried as a percentage of total ton-miles is 8% and 7%, respectively, for both highway and rail transport, and 24% for ocean transport. There is not sufficient information for a similar comparison with air transport.

Table 10 illustrates the top four classes and divisions of hazmat transported by mode.

Table 7. Hazmat shipments by mode in 2007.

Mode of Transportation	Value (Million $)	Tons (Thousands)	Ton-Miles (Millions)	Average Miles per Shipment
Total	**1,448,218**	**2,231,133**	**323,457**	**96**
Single modes	**1,370,615**	**2,111,622**	**279,105**	**65**
Truck	837,074	1,202,825	103,997	59
For-hire truck	358,792	495,077	63,288	214
Private truck	478,282	707,748	40,709	32
Rail	69,213	129,743	92,169	578
Water	69,186	149,794	37,064	383
Air (includes truck and air)	1,735	S	S	1,095
Pipeline	393,408	628,905	S	S
Multiple modes	**71,069**	**111,022**	**42,886**	**834**
Parcel, U.S. Postal Service, or courier	7,675	236	151	836
Truck and rail	7,052	11,706	10,120	779
Truck and water	23,451	36,588	12,380	1,020
Rail and water	5,153	5,742	2,937	1,506
Other multiple modes	27,739	56,750	17,297	233
Other and unknown modes	**6,534**	**8,489**	**1,466**	**58**

S = Insufficient data to estimate

Table 8. Hazardous versus nonhazardous materials shipment characteristics by mode of transportation in 2007.

Mode of Transportation	Tons			Ton-Miles		
	Total (Thousands)	Hazardous Percentage	Nonhazardous Percentage	Total (Millions)	Hazardous Percentage	Nonhazardous Percentage
Total	**12,543,425**	**17.8**	**82.2**	**3,344,658**	**9.7**	**90.3**
Single Modes	**11,699,128**	**18.1**	**81.9**	**2,894,251**	**9.6**	**90.4**
Truck	8,778,713	13.7	86.3	1,342,104	7.7	92.3
For-hire truck	4,075,136	12.1	87.9	1,055,646	6.0	94.0
Private truck	4,703,576	15.0	85.0	286,457	14.2	85.8
Rail	1,861,307	7.0	93.0	1,344,040	6.9	93.1
Water	403,639	37.1	62.9	157,314	23.6	76.4
Air (includes truck and air)	3,611	S	90.2	4,510	S	96.1
Pipeline	650,859	96.6	3.4	S	S	S
Multiple modes	573,729	19.4	80.6	416,642	10.3	89.7
Parcel, U.S Postal Service, or courier	33,900	0.7	99.3	27,961	0.5	99.5
Truck and rail	225,589	5.2	94.8	196,772	5.1	94.9
Truck and water	145,521	25.1	74.9	98,396	12.6	87.4
Rail and water	54,878	10.5	89.5	47,111	6.2	93.8
Other multiple modes	113,841	49.8	50.2	46,402	37.3	62.7
Other and unknown modes	271,567	3.1	96.9	33,764	4.3	95.7

S = Insufficient data to estimate

Table 9. Hazmat transport as a percentage of total ton-miles by mode.

Mode	Total Ton-Miles (Millions) – All Cargo	Total Ton-Miles (Millions) – Hazmat	Percentage of Hazmat Ton-Miles to All Cargo Ton-Miles
Highway	1,342,104	103,997	8%
Rail	1,344,040	92,169	7%
Ocean	157,314	37,064	24%
Air	4510	(S)	(S)

S = Insufficient data to estimate

Table 10. Top classes/divisions of hazmat transported by mode.

Mode	Hazmat Classes/Divisions			
Highway	Class 3: Flammable Liquid and Combustible Liquid	Division 2.2: Nonflammable Gas	Class 8: Corrosive Materials	Class 9: Miscellaneous Dangerous Goods
Rail	Class 3: Flammable Liquid and Combustible Liquid	Class 8: Corrosive Materials	Division 2.1: Flammable Gas	Class 9: Miscellaneous Dangerous Goods
Ocean	Class 3: Flammable Liquid and Combustible Liquid	Class 8: Corrosive Materials	Class 9: Miscellaneous Dangerous Goods	Division 2.1: Flammable Gas
Air	Class 7: Radioactive Materials	S	S	S

S = Insufficient data to estimate

Table 11. Summary of shipments by hazardous material and mode.

Mode	Top Hazmat (% of Ton-Miles) of Dangerous Goods Transported				
Highway	Gasoline (36%)	Flammable liquids (25%)	Diesel fuel (9%)	Elevated temperature material (8%)	Compressed nitrogen (7%)
Rail	Gasoline (24%)	Sulfuric acid (16%)	Elevated temperature material (15%)	Compressed hydrocarbon mix (11%)	Sodium hydroxide solution (8%)
Ocean (marine)	Diesel fuel (48%)	Flammable liquids (19%)	Gasoline (17%)	Sodium hydroxide solution (10%)	Elevated temperature material (4%)
Air	Radioactive (43%)	Resin solution (29%)	Flammable liquid – corrosive (14%)	Sodium hydroxide solution (14%)	

Table 11 summarizes the top five hazmat substances shipped by mode, ranked from left to right. The percentages are the percentage of total ton-miles shipped via that mode. Materials used for fuel dominate the highway and ocean (marine) mode, representing over 70% of the highway transport and 84% of the ocean transport. For rail, sulfuric acid and sodium hydroxide represent a significant fraction of the ton-miles shipped. Because of the time-sensitive nature of radioactive shipments, primarily for medical purposes, radioactive material shipments represent the biggest single class of materials shipped by air. These data are from the CFS on shipments performed in 2007 and published in 2008. Since 2008, the number of shipments of ethanol by rail has increased significantly; if the survey were taken in 2011, the *flammable liquids* category probably would be one of the five most commonly shipped materials by rail.

The data in Table 10 and Table 11 (viewed in the context of Table 9) show that the related cargos of gasoline, flammable liquids, and diesel fuel account for the majority of hazmat carried by surface in the United States, as measured by ton-miles. The totals are 70% by highway, 24% by rail, and 84% by ocean. Quantities of flammable liquid cargo carried by air would, of course, be relatively small.

3.4.2 Prevalence of Hazmat Incidents Versus Emergency Responder Needs

There is no one source of data comprehensively detailing hazmat incidents for all modes. There are many sources that tabulate hazmat incidents, but a consistent source that summarizes the number across all modes at a summary level is Table 2-20 of the 2008 State Transportation Statistics Report published by BTS (*31*). Table 12 lists total reported hazmat incidents for the United States by mode for 2007, condensed from that source. The total includes incidents for which the state is unreported and excludes incidents occurring in a U.S. territory or foreign country. There are other sources for one or more of these numbers but none for all.

The Motor Carrier Management Information System (MCMIS) crash file reports all serious truck and bus crashes and contains fields for listing whether the vehicle was placarded, indicating the presence of hazmat. For an accident to be classed as serious, one or more of the following conditions must occur: one vehicle must be towed from the scene, there must be a fatality, or there must be an injury requiring treatment at a medical facility. It is believed that the BTS data are for all truck accidents, even minor ones, and therefore the totals for highway should be reduced to about 4,000 if only serious truck accidents are considered. (It should be noted that when considering the likelihood of encountering a placarded vehicle involved in an accident, the BTS number is more appropriate.)

The number of spills shown in Table 13 was estimated using the Hazardous Materials Information Reporting System (HMIRS). The HMIRS data, which include all modes, are dominated by accidents in which a spill of hazmat occurred. Consequently, only a small percentage of all serious hazmat accidents are found in the database. HMIRS data are not

Table 12. Number of reported hazmat incidents by mode: 2007.

Mode				Total
Highway	Rail	Air	Marine	
16,889	748	1,523	61	19,221

(Not including pipelines or bulk, non-packaged marine incidents)

Table 13. Summary of hazmat incidents by mode.

Mode	Annual Ton-Miles (2007 Hazmat Commodity Flow Survey, Table 1a) millions	Number of Incidents/Year (State Transportation Statistics, 2008 BTS Table 2-20)	Number of Incidents Involving Spill (HMIRS 2005–2006)	Fatalities Associated with Crashes (Highway: MCMIS 2005–06; Rail and Air HMIRS 2005–06)	Injuries Associated with Crashes (Highway: MCMIS 2005–06; Rail: RAIR 2005)	Property Damage Associated with Crashes (Highway and Air: HMIRS 2005–06; Rail: RAIR 2005)
Highway	103,997	16,889	3,951	66/22	14	$77M
Rail	92,169	748	1,080	17/10	105	$20M
Marine	37,064	61	N/E	N/E	N/E	N/E
Air	S	1,523	890	0/0	N/E	$0.3M
Totals	233,230*	19,221	5,921**	83/32**	119***	$97.3M**

N/E = No estimate; marine mode data is not reported to U.S. DOT but rather released to the USCG using U.S. EPA hazmat pollutant list; air mode data is not tabulated.

S = Insufficient data to estimate.

*When multimodal shipments (e.g., air and highway, rail and marine, marine and highway) not shown are added to the single mode shipments in column 2, the total ton-miles are 323,457.

**Not including marine mode.

***Not including marine and air modes.

available for after 2006; they are still being compiled but are now web-based, and only data on individual accidents can be obtained. The fatalities and injuries for highway are reported using MCMIS, and since all serious injuries and fatalities must be reported in the MCMIS crash file, these numbers are considered reasonably accurate. The data for the other modes are from HMIRS. HMIRS only reports injuries associated with exposure to the hazmat, so this is not a good source for obtaining an estimate of all injuries associated with hazmat incidents.

In Table 13, column 4 lists the total number of en route spills reported annually to PHMSA. The 890 spill incidents associated with air transport were all en route and not associated with an airplane crash. The fifth column is divided into two numbers; the first number is the total number of fatalities reported, and the second is the number of fatalities attributed to exposure to the hazmat. Thus for highway, there were 66 total fatalities associated with trucks hauling hazmat, and 22 of those fatalities were attributed to exposure to the hazmat. Since the dominant form of hazmat being transported by highway is Class 3 flammable liquids, it is very likely that many of those 22 facilities were the result of a subsequent fire and people being unable to escape from their vehicles. The sixth column shows the number of individuals hospitalized because of exposure to the hazmat following a traffic or rail accident/derailment.

The property damage for hazmat incidents was taken from the HMIRS for highway and air, and from Rail Equipment Accident/Incident Reports (RAIRs) for rail. Note that the damage estimates were only for those crashes in which a spill of hazmat occurred. If damage figures for all hazmat crashes were included, the costs would be much higher. The total in HMIRS for rail was $17 million; since the RAIR number of $20 million is the higher number, it is shown in Table 13.

Overall the numbers shown in Table 13 are considered to be reasonable. They are certainly better than order-of-magnitude estimates, but there is believed to be a lot of underreporting throughout the entire field. Thus some of the values, particularly the injuries and property damage, might be low. As recently as 2003, the Census Bureau produced hazmat commodity flow reports for each state, but that practice ceased by 2007. The ton-miles of noncombustible, nontoxic compressed gases are assumed to be higher than the national average in the farm states. U.S. DOT allows ammonia used for agricultural purposes to be placarded as Division 2.2, classifying it as a nontoxic, nonflammable gas.

The data are not clear as to the fatalities, injuries, and property damage resulting from hazmat release, which would be a subset of the fatalities, injuries, and property damage resulting from crashes shown in Table 13. Those data would be important for cost–benefit analysis related to solutions for first responder needs. Even assuming underreporting, subjectively those figures appear small. To a great degree, the low frequency is undoubtedly due to safety and security initiatives undertaken by the hazmat industry and government, and some of the industry initiatives have been voluntary. However, the consequences of a major hazmat release can be severe and result in deaths, injuries, and substantial property damage. The general feeling among stakeholders is that an ESP system that is effective and affordable would be of interest.

3.5 Discussion of ESP Implementation Challenges and Trade-Offs

3.5.1 Differing Needs and Perceptions

There are four major stakeholder groups, whose differences and needs were characterized in Table 3 and their representative organizations described in Subsection 3.1.1. Each of the four primary stakeholder groups has a different set of needs and expectations for ESP information. A system that addresses all of these needs and expectations will have to be both highly versatile and affordable. One of the most difficult challenges regarding implementation of an ESP system that will benefit each of these stakeholder groups is solving the larger problem of e-commerce interoperability, including standards and guidance. Another is finding a way to bridge their differences.

Research conducted in earlier tasks of HMCRP Project 05 engaged many organizations, both within and outside of the four primary stakeholder groups of shippers, carriers, regulatory agencies, and emergency responders. (As mentioned in Subsection 2.3.1.2, the terms "compliance" and "enforcement" in this document are used with regard to regulatory compliance or law enforcement stakeholder organizations that may need to identify what hazmat is on a vehicle.) The findings of the project's interim report documented organizations' thoughts, concerns, observations, and hopes for ESP as an alternative to the paper-based system (*32*).

Some members of the hazmat transportation community, including a number of interviewed stakeholder organizations, are already using some form of e-commerce for shipping transactions. The interim report noted their experience and success with the systems they use. While these e-commerce implementations have been delivering useful results, each approach has generally been developed or incorporated to serve a particular transportation mode or business case, and to a great extent they are not electronically compatible with one another. Further, there were differences of opinion on the type of implementation that stakeholders felt would be optimal for their respective organizations, as well as differences among participants regarding the approach needed for a more inclusive ESP solution. Indeed, there is not unanimity among the stakeholders on the need for—or usefulness of—ESP, sometimes even within the same stakeholder group.

An e-commerce system that is currently in use by an entity involved with a certain mode of hazmat transportation often cannot be easily translated to other transportation modes because the modes are generally using different approaches. Standards that could facilitate smoother and more complete exchange of data among these differing systems are not yet sufficient to support widespread interoperability among ESP systems.

The HMR, IMDG code, and ICAO technical instructions allow the use of electronic transmission techniques. But there is still a de facto requirement for many shippers to generate hazmat shipping papers prior to accepting cargo. It should be noted that as long as hard copy shipping papers are effectively required for most hazmat shipments, they remain an acceptable form that reduces the incentive for going paperless.

3.5.2 Cargo Transfers and Multimodal and International Shipments

A single hazmat shipment from its origin to destination may be handed off multiple times to different vehicles in the same mode, for example with a TL shipment crossing the United States. The hazmat shipment may be interlined, which may be to another vehicle in the same mode or in a different mode. Transfers may include breaking up the cargo, which presents its own set of challenges to an ESP system keeping track of the shipment. Rail tank cars are often transferred to other trains, including those of other railroads, and may take a quite circuitous route to the destination. Airplanes receive hazmat cargo that arrives and departs by truck. The marine mode receives hazmat cargo that may arrive and depart by truck and/or rail. This handover to other vehicles/other modes that may have different e-commerce systems creates an interfacing challenge to an ESP system. Hazmat that crosses an international border may be required to have an advance e-manifest notification to CBP or CBSA.

3.5.3 Business Needs Versus Regulatory and Emergency Response Needs

A widely compatible ESP system needs to be capable of providing solutions that do not just address U.S. DOT requirements for the elements of hazmat shipping papers. The ESP focus for hazmat transportation solutions lies in the benefits that can accrue from improved electronic commerce rather than just electronic compliance with U.S. DOT hazmat regulations and requirements in isolation. In other words, an ESP system that only facilitates exchange of information that is found on required hard copy hazmat shipping papers along with associated emergency response information is not a sufficient solution; the overarching electronic commerce advantages such as in-shipment visibility must be strengthened to have a compelling reason for ESP.

There are differences in the information needed to support business operations versus the information needed to support regulatory or emergency response actions. A key distinction is that emergency responders need information only when an incident occurs, whereas business transactions take place for every shipment; thus shippers and carriers will be involved whenever there are ESP. The concerns of shippers and carriers

are generally efficiency, visibility, and accountability. Business operations need additional information such as information on nonhazardous materials, other parties in the supply chain, billing and financial data, and expected delivery time. Significant benefits from an ESP system also need to be available to stakeholders such as regulators and the emergency response community, in addition to logistics firms. The needs of regulatory and emergency response personnel, while not identical, are fundamentally different from stakeholders, whose primary interest is business efficiencies. Regulatory and emergency response personnel also share some similarities insofar as both desire remote identification of hazmat cargo. Regulatory personnel and emergency responders need information about hazmat on a situational basis. Emergency responders primarily need specific information on the materials present, types of containers, material quantities, and potential interactions with other materials in the shipment. In many cases the manufacturer of the material is a very useful source of information.

Regulatory personnel are concerned with the types and quantities of hazmat and whether the hazmat is being carried safely and legally. Their need for this information is generally at a site where the paperwork and credentials can be verified in a controlled setting. Regulatory personnel are involved with safety and security of dangerous substances. Knowing via electronic means what substances in what quantities are being transported would certainly be an administrative advantage for them that would also have safety benefits.

There are safety and security aspects of ESP information for all four stakeholder groups. However, the SOW notes that "shipping papers also contain specific hazard information, standardized so that emergency responders may identify appropriate measures to be taken in the event of a hazmat incident." Thus, emergency responders are a stakeholder group that has special needs and expectations of an ESP implementation beyond aspects of commerce or regulatory concerns.

3.5.4 Emergency Responder Communications Challenges

The approach described in this road map recognizes the importance that the ESP system must give to emergency responders. The needs of an emergency responder team are clearly very high on those occasions when they are on the scene of a potentially catastrophic hazmat spill or incident of national significance with unclear circumstances. For these personnel, the ability to know quickly and accurately what substances and quantities they are dealing with is more than a logistics or administrative advantage—it may mean the difference between safety and life-threatening risk.

When a hazmat accident occurs, emergency responders primarily need specific information on the type and quantities of materials present, types of containers, emergency contact information, and potential interactions of the hazmat with other materials it may have come in contact with. In many cases the manufacturer of the material is a very useful source of information for emergency responders. As mentioned in Subsection 1.2.4.2, U.S. DOT requires all hazmat shippers to provide constant monitoring of an emergency response telephone number while the hazmat is being transported. In the event of a hazmat accident or incident, to ensure that they are acting on correct information, it is important for the emergency responder and the carrier/transporter to call the number in the emergency response information document before taking any action.

The following information drawn from the *Emergency Response Guidebook* outlines recommended actions for emergency responders who are first to arrive at the scene of a transportation incident involving hazmat (*33*):

> Identify the Hazards
>
> Placards, container labels, shipping documents, MSDSs, Rail Car and Road Trailer Identification Charts, and/or knowledgeable persons on the scene are valuable information sources. Evaluate all available information and consult the recommended guide to reduce immediate risks. Additional information, provided by the shipper or obtained from another authoritative source, may change some of the emphasis or details found in the guide. The Guide provides only the most important and worst case scenario information for the initial response in relation to a family or class of dangerous goods. As more material-specific information becomes available, the response should be tailored to the situation.
>
> Assess the Situation.
>
> Consider the following:
>
> - Is there a fire, a spill or a leak?
> - What are the weather conditions?
> - What is the terrain like?
> - Who/what is at risk: people, property, or the environment?
> - What actions should be taken: Is an evacuation necessary? Is diking necessary?
> - What resources (human and equipment) are required and are readily available?
> - What can be done immediately?
>
> Obtain Critical Information.
>
> Following is the short list for critical information needed on the hazmat shipment:
>
> - Your name, call back telephone number, FAX number
> - Location and nature of problem (e.g., spill, fire)
> - Name and identification number of material(s) involved
> - Shipper/consignee/point of origin
> - Carrier name, rail car or truck number
> - Container type and size
> - Quantity of material transported/released
> - Local conditions (weather, terrain, proximity to schools, hospitals, waterways, etc.)
> - Injuries and exposures
> - Local emergency services that have been notified

The more clearly the hazard is identified, the more effective and efficient the initial response will be. The MSDS discusses the types and level of hazards presented by the material as well as personal protective measures for responders and procedures for confining, containing, and recovery of the material. Having the MSDS information available electronically would be a great benefit to emergency responders.

In recent years, safety and security concerns have given rise to initiatives such as research investigating the feasibility of replacing hazmat placards on railcars with electronic systems (*34*) and developing a national truck tracking center prototype (*35*).

Vehicle and shipment tracking using GPS or a global locating system (GLS) has proliferated for tracking high-value motor carrier cargo over the past 10 years and is increasingly being used for hazmat railcar and barge tracking. Ideally, hazmat vehicles such as railcars and truck tank cars would have sensors to detect overturning and chemical release. The sensors would automatically report detailed information including GPS/GLS location and other accident details to the shipper and carrier as well as the nearest public safety answering point. It is possible that electronic manifest data could be accessed from hazmat vehicles belonging to carriers participating in the TSA truck and freight rail security programs described in Subsections 3.3.5 and 3.3.6, respectively. This automated, event-driven reporting would be somewhat analogous to the reporting of a passenger car equipped with a General Motors OnStar or Ford SYNC in-vehicle communications system. This is what has been envisioned by the U.S. DOT DMA program described in Subsection 3.2.2.2. The DMA system could also generate and archive data that would be useful in resource management and pre-staging planning.

The desire to get accurate hazmat shipment information to emergency responders quickly in the event of an incident has been a vexing challenge for decades. If the hazmat vehicle operator is incapacitated and the vehicle cannot be approached to secure the hard copy shipping papers, in the best case, mitigation is delayed; in the worst case, emergency responders' or nearby citizens' lives may be at risk because of the uncertainties of what has been or perhaps is about to be released, possibly including the ramifications of mixing hazmat. The placard may not be visible even with binoculars due to darkness, fire, smoke, fog, brush, vehicle structural damage, or position. When responding to a high-consequence event, emergency responders have a need for knowledge of hazmat contents that is more urgent from the safety and security viewpoint than any of the other stakeholder groups.

Personal computers (i.e., laptops), personal digital assistants (PDAs), and cell phones are being used increasingly by emergency responder and law enforcement personnel; PCs are now in many of their official vehicles. Communications bandwidth has been made available to deal with increasing demands from emerging communications such as WiFi systems (see Appendix D for a description of WiFi technology that can benefit stand-off detection of ESP by emergency response and regulatory compliance personnel). Standards are increasingly being advanced to facilitate ease and effectiveness of mobile communication. Nevertheless, recent government initiatives to reduce driver distraction need to be considered as part of any large deployment effort.

The cost to a shipper or carrier of a major hazmat incident (whether accidental or intentional) can be considerable, and more rapid mitigation can help protect the carrier against loss. The swift availability of ESP information to emergency response personnel will support more rapid mitigation of serious hazmat incidents. The use of ESP allows railroads to provide information to emergency responders in multiple ways. Shipping papers can be faxed or e-mailed to emergency responders in an incident if the papers are not available through the train crew. They can also be sent to PDAs. This has improved the safety of dealing with hazmat incidents (*36*).

3.5.5 Beneficiary Pays Versus Sender Pays

Any expense in the supply chain will ultimately be passed on to the consumer. However, for ESP to be more widely embraced, the entity that receives the greatest benefit from e-commerce transactions needs to be the entity that bears the expense. This is the concept of "beneficiary pays." The freight forwarder, shipper, or carrier could pay for ESP. The shipper is already paying for cargo transport and does not want to pay more. Unless the beneficiary organization of an e-commerce transaction pays for the service, there is limited incentive for its use. That has been reported to be the case at least with air cargo, in which air freight forwarders (i.e., senders) currently bear the brunt of the expense of e-commerce transfers, although they do not reap the primary benefit of the service (*37*). Unless costs of e-commerce are more equitably aligned with beneficiary organizations that realize the major share of the advantages, voluntary adoption of e-commerce—and thus ESP—transfers will not be likely to occur.

3.5.6 Tracking Versus Business Data Confidentiality

In addition to the expense of any technology system, a key concern with ESP perceived by many is the challenge of protecting proprietary information such as customer names, locations, and the type and quantity of hazmat that is being transported. With greater availability of proprietary information in an ESP system, there is concern that a centralized tracking system (i.e., one not under the control of a carrier or its technology vendor) can be vulnerable to improper dissemination and use of information. Passwords could be

stolen and sold, and the proprietary information could be made available to competitors. Furthermore, if not well protected, ESP could make information more accessible to terrorists seeking to identify and steal or release certain cargo. There is a need for legislative support and tort reform to protect parties using ESP from system failures that arise from government activities. There is also the perception of risk from the government collecting information about all cargo and tracking all shipments, which some may feel would be Big Brother-type intrusion. While safety and security concerns may lead the government to want more advance information about hazmat shipments, some stakeholders do not like the idea of government being able to track their shipments and otherwise have greater visibility into their operations. Alternatively, some stakeholders (e.g., those manufacturers and carriers participating in the TSA truck and freight rail security programs) feel that the security of their cargo is enhanced when government has more visibility over their hazmat cargo movements.

There is a subtle distinction between in-transit visibility and tracking. Sophisticated parcel tracking that consumers commonly access online is point-to-point, in which presence of the shipment is updated each time it arrives at a reporting location such as a transfer point. That frequency is perfectly acceptable for business purposes. For certain bulk hazmat shipments such as PIH/TIH that may be in transit for long periods and in locations with dense populations where they may be susceptible to hostile actions, TSA has shown interest in greater in-transit visibility.

Over the past decade, many motor carriers have incorporated GPS- or GLS-based locating systems that use satellite or cellular communications or that may have the capability to use both. These locating systems can effectively track vehicles used to transport cargo. For motor carriers, the GPS/GLS equipment is more often hardwired to a truck's electrical supply, although some carriers use trailer-mounted, battery-powered GPS/GLS units that may be supplemented with solar power. Aside from locomotives, railcars with these locating systems generally depend on batteries with power management engineering strategies. These locating systems were incorporated initially because of the business efficiencies that they brought to the industry. Increasingly, GPS-/GLS-based locating systems are being tied to event-based reporting such as detection of a chemical leak, unauthorized opening of a hatch or container, or departure from a geo-fenced boundary. GPS/GLS locating systems on trucks are sometimes accompanied by in-vehicle panic buttons, which provide helpful information in the event of a hazmat incident, but they still require information to be relayed by the shipper or carrier to law enforcement or other emergency responders.

With this capability, GPS/GLS locating systems are increasingly being used for safety and security purposes, particularly with respect to high-value shipments such as electronics and dangerous shipments such as certain types of hazmat. And increasingly, GPS-/GLS-based locating systems are being used for rail and barge transportation of hazmat. A GPS/GLS device can be hardwired to a locomotive or tugboat, and on a tank car or barge a battery-powered version that is perhaps supplemented by solar power is needed. GPS/GLS service is provided by a vendor, which generally works closely with the carrier. Either the vendor (usually) or the carrier may own the tracking data, but it is not shared with others except by special permission from the vendor and carrier.

In an analogous way, the marine Automatic Identification System (AIS) is an automated tracking system used on ships and by vessel traffic services (VTS) for identifying and locating vessels by electronically exchanging data with other nearby ships and VTS stations. AIS provides a means of tracking hazmat cargo on oceangoing vessels from port to port. While AIS can be used to track shipments, that is not its primary function.

Airlines operate within a closed-loop, high-security context in which the tracking of shipments is handled differently from the ground transportation modes.

The railroads' Automatic Equipment Identification (AEI) system is an electronic recognition system in use in the North American railroad industry. The AEI system uses trackside radio frequency identification (RFID) readers to identify railcars (including hazmat tank cars) passing by on a train. Nearly all railcars in the United States now have AEI transponders mounted on their sides, which identifies them. The resulting transponder identification data are manipulated by vendors and provided to railcar owners for management of their rolling stock assets. The AEI car location messaging (CLM) information can be used for determining that a rail shipment is somewhere between two RFID reader stations, although in some places the readers may be far apart. Under certain rare circumstances, the information on a railcar's contents and general location may be helpful for emergency response actions, but the AEI data are not available on a real-time basis. However, ESP allows railroads to check the accuracy of their train consists when departing yards because cars are scanned by AEI. ESP have permitted increased accuracy in the final product by enabling automated comparison of the ESP entries to a standardized shipping description database that AAR maintains and that the railroads use in their billing/shipping paper process (*38*).

As mentioned in Subsections 3.3.5 and 3.3.6, TSA has been processing grants to encourage and facilitate use of GPS-/GLS-based systems by rail carriers and motor carriers that haul certain quantities and types of hazmat. In fact, TSA has developed a national hazmat truck tracking center prototype (*39*) and has provided a universal communication interface for transmission of hazmat cargo manifest data.

3.5.7 Central Database Versus Distributed Processing

Some stakeholders have reservations about the ability of an ESP system incorporating a central database to securely protect business-sensitive information. While central databases are in use for e-commerce and are less costly than acquiring the capability for distributed processing, the vulnerability is seen as higher with a central database. Also, some entity must pay for the operation of a central database. Hosted cloud computing has the potential to bring new capabilities to ESP systems.

3.5.8 Capital, Operational, and Maintenance Cost Elements

Often, the reasons given for lower interest in ESP have been the perceived extra cost and sophistication required to operate within an e-commerce system. Systems that provide effective e-commerce are already in use; however, the cost and complexity of making existing systems more widespread within the hazmat transport community are considered prohibitive to many of the stakeholders. For a widely compatible ESP system to be considered successful, one litmus test is that significant benefits need to be available to small users that operate on tight margins, such as LTL motor carriers with 20 or fewer trucks. These small users feel that they cannot afford the requisite expense of a highly capable e-commerce system. While the current paper-based shipping system they use has inefficiencies compared to a sophisticated ESP system, the paper-based system is familiar, approved, and works as intended for emergency response.

Small operators feel that investing in a highly capable ESP system is beyond their financial capabilities. The expense is not just in hardware and software but also in training, operations and maintenance, licensing, and upgrades. While the capabilities of sophisticated end-to-end tracking have been demonstrated, for example, in the EFM program, a high degree of en route visibility is not achieved inexpensively. A motor carrier with fewer than 20 trucks is far less able than a Class 1 railroad to afford the investment of a system that gives such visibility. For a voluntary move to ESP capability, the return on investment (ROI) would have to justify the outlay against the hard copy system.

Capital and maintenance costs can be alleviated for businesses that use hosted solutions. These are also referred to as "software as a service" (SaaS) or "cloud computing." The significant up-front investment for firms is removed, although startup implementation costs are generally applied by the service provider. The user pays monthly usage fees, which can include a minimum number of transactions or messages for the period, with additional excess usage charges. Another benefit of this approach is that the cost of upgrading or adding functionality can be minimal. Firms of all sizes and across almost all industries have adopted this solution.

3.5.9 Sophistication and Technology Adoption

The level of computer and Internet-based communications skills required to support an ESP system with high en route visibility is greater than what is currently needed for hard copy transactions. The trucking industry has made an investment to bring communications technology to the cab and keep the driver in close contact with the dispatcher. Truck-mounted satellite systems allow motor carriers to keep track of the truck's location, send new orders, send messages to a large number of recipients, and train drivers through exercises (*40*). Nevertheless, there is a reluctance to have drivers make shipment data entry because of the additional training required and the potential for mistakes to be introduced by someone who enters data infrequently. There is also sensitivity to, and legislation focused on, any device that may distract the driver of a moving vehicle in an unsafe manner.

3.5.10 Voluntary Adoption Versus Regulation or Other Forcing Functions

Stakeholder organizations have limited incentive to voluntarily adopt ESP when hard copy shipping papers remain a valid alternative to ESP and are currently required to be carried inside hazmat-transporting vehicles. This situation would be reversed if government or industry took steps to compel adoption of ESP as an alternative to paper. There have been a number of instances of regulation or forcing functions in the United States.

As an example of regulation, CBP's ACE program requires that companies importing cargo into the United States by highway, their customs brokers, freight forwarders, or truck carriers must inform CBP about the details of their shipments in an electronic format prior to the arrival of the goods at border crossings. Motor carriers over the past several years have had to comply with the requirement for submission of an e-manifest to CBP. CBP announced their intent and helped prepare the way for the requirement for the e-manifest. The lesson is that customs organizations worldwide can help facilitate incorporation of e-commerce, including ESP, if they require it and help facilitate its adoption.

In June 2003, a large multinational retailer (see Subsection 2.1.1.3) announced its plan to implement RFID technology in its supply chain within a 20-month period. The retailer made clear how to comply with the technical requirements

for its RFID system, which were based on an international standard. It gave suppliers other guidance and timelines with which to comply, but their insistence on the RFID system was firm. The retailer's commercial influence in the market was such that its suppliers had a big incentive to meet the stated requirement so as not to be left behind, and those who wanted to do business with the retailer took steps to meet the RFID requirement (*41*). While the result ultimately was not quite as planned, the process the retailer followed demonstrated the ability of a powerful private-sector entity to compel implementation of new technology in its industry and how to go about it.

There is no single private entity in the hazmat transportation world comparable to the aforementioned retailer in its ability to force adherence across the industry and among all modes. However, trade associations could work together to facilitate adoption of standards and plans to accelerate adoption of ESP. Among hazmat carriers, the North American Class 1 railroads let customers know that they needed to make transactions electronically if they wished to have goods shipped by rail. They too published guidelines and other helpful information (*42*). Consequently, virtually every rail shipment transaction is now conducted through EDI-based e-commerce. Per the U.S. DOT requirement, trains must still carry paper copies of ESP and a few other examples of paper copies, such as for certain movements of hazardous waste. However, these are now the rare exception. The rail industry compelled its customers to work with them in attaining near-complete paperless status.

The transportation industry recognizes the potential of wise regulation to level the playing field (i.e., bring about a needed improvement that keeps one company from inadvertently having an unfair advantage over another and that affects all parties concerned more or less equally). The concern over an unlevel playing field arises when a particular segment of the transportation industry perceives that a regulation will result in a competitive disadvantage against other modes and can occur within the same mode (i.e., the relative ability of a small versus a large firm to meet the regulation). Industry is also understandably concerned when it perceives that regulation will result in an unfunded mandate in order to comply. It also needs to know that voluntary acceptance of ESP will not result in a disadvantage with respect to a competitor that does not accept ESP.

3.6 Electronic Commerce System Standards and Standards Bodies/Organizations

In order to facilitate both existing and future methods of communication, it is necessary to emphasize the use of standards to achieve interoperability and common exchanges as applicable. Standards are important at many layers in solutions that support electronic exchange of information. For example, consider the act of simply exchanging a document with a third party that is not on a corporate network. The document is copied from the source computer to a universal serial bus (USB) drive and then handed to the third party, which subsequently inserts the drive into its computer and then copies the file. The third party then opens and reviews the file data. In this example, standards are necessary on many levels. First, there is the document content and the language it is written in. If both parties do not use the same language, information exchange is difficult or even impossible. Second, both computers recognized the file type and were able to access the information in the file. Here again, the use of common standards was essential for successful communication. Finally, the actual exchange took place using the USB drive. This required standards both physically, since both computers had to have the same connector, and electrically, so that the computer could send/receive the correct bytes of data. Without standards, this simple exchange could never have taken place. In order to facilitate interoperability among partners given many different methods of electronic communication, standards are essential. Even with standards, communication among partners still has its challenges.

The discussion in this section primarily focuses on the standards that are used to convey the content and format of information exchanges. This is because the use of those standards—when compared to the standards for the actual delivery of the electronic data (i.e., e-mail, file transfer protocol, web services)—is far less consistent and interoperable. And as described, while many different organizations have worked diligently to develop these standards, adoption varies across the industry, often depending on mode and even the specific country.

The following subsections identify and briefly describe the purpose, benefits, and any limitations of standards development organizations, the current and emerging standards that are well-suited for e-commerce solutions such as ESP, and finally, some of the industry and government trade groups that support standards utilization.

3.6.1 Standards Bodies and Organizations

This subsection lists several of the major organizations that have an impact on the standards used in today's e-commerce environment. All of these organizations are international in their charter and have produced standards that have the potential, or have been shown to provide, improved information and e-commerce on a global basis. Unfortunately, however, many of these same standards from different organizations serve similar purposes, and in some cases compete or conflict with each other.

3.6.1.1 United Nations Centre for Trade Facilitation and Electronic Business (UN/CEFACT)

UN/CEFACT is primarily responsible for the development of the Core Component Library (CCL), which is the building block for many of today's XML-based standards, including electronic business XML (ebXML), universal business language (UBL), and the Trade Data Elements Directory (TDED), one of the leading resources for defining and standardizing data elements used in e-commerce. UN/CEFACT is also the shepherd for the UN/EDIFACT standard, which along with the Accredited Standards Committee (ASC) X12 version of EDI, constitutes the most widely used standard for electronic data exchange.

3.6.1.2 World Customs Organization

The WCO is noted for its work in areas covering the development of global standards, the simplification and harmonization of customs procedures, trade supply chain security, the facilitation of international trade, the enhancement of customs enforcement and compliance activities, anti-counterfeiting and piracy initiatives, public–private partnerships, integrity promotion, and sustainable global customs capacity building programs. The WCO also maintains the international harmonized system goods nomenclature (*43*) and administers the technical aspects of the World Trade Organization (WTO) Agreements on Customs Valuation and Rules of Origin (*44*). Many customs agencies, including CBP, operate IT systems that require specific ESP to be submitted to them in order to authorize the entry of goods into a country.

3.6.1.3 International Organization for Standardization (ISO)

ISO is the world's largest developer of standards, having published over 18,000, and is responsible for many of the standardized practices in place today in numerous industries, including the supply chain.

3.6.1.4 Organization for the Advancement of Structured Information Standards (OASIS)

OASIS has its roots in the original standard generalized markup language (SGML) standards community and continues to this day to focus on many of the document markup language-centric standards (e.g., XML), as well as positioning itself, along with the World Wide Web Consortium (W3C; see next subsection), as a major contributor to the web service's body of standards. Web services are one of the emerging technologies that facilitate secure business-to-business (B2B) electronic data exchange. OASIS is also responsible for the UBL standard, which is described in greater detail in Subsection 3.6.2.3.

3.6.1.5 World Wide Web Consortium

The World Wide Web Consortium, as its name implies, has primarily been responsible for the standards that support the overall Internet as it exists today. This includes the familiar hypertext transfer protocol (http) common to nearly all web sites today but also includes many of the B2B-related standards such as web services and security necessary to facilitate e-commerce. The W3C, along with OASIS, truly controls the standards for the Internet.

3.6.1.6 Digital Trade and Transportation Network (DTTN)

DTTN is not technically a standards organization but is instead an open platform for e-commerce. DTTN was original sponsored by the government of Hong Kong but is now privately operated through Tradelink Electronic Commerce Limited. DTTN consists of three layers: a series of core standards documents and protocols; an open, secure, and reliable messaging infrastructure; and support for third-party value-added services. It is the standards documents they have produced that warrant their inclusion in this standards organization discussion. DTTN supports multiple formats, including EDI (both ANSI X.12 and UN/EDIFACT), Cargo Interchange Message Procedure (CARGO-IMP), XML, and even simple comma-separated values (CSV) file format. DTTN also supports the standard protocols for SMTP, HTTP, file transfer protocol (FTP), as well as the applicability statements (AS) AS-1 and AS-2, common in the e-commerce community.

3.6.2 Electronic Commerce Standards

Following are several of the current and emerging standards that may be used for e-commerce.

3.6.2.1 EDIFACT/ASC X12

The EDIFACT standard, which is maintained by the UN/CEFACT committee, and ASC X12, which is governed by ANSI, constitute the international and North American versions of EDI information standards, respectively. Together they facilitate the majority of e-commerce data presently exchanged in the logistics community, particularly in the rail and ocean carrier segments. Both versions of EDI standardize the data elements, element grouping, layout, and coding for electronic documents and consist of a large library of standards documents or forms. These documents include both

mandatory and optional elements and components, and they often align with their paper counterparts.

EDI facilitates a fairly compact and efficient approach to encoding information in the message, using both row descriptors and a fixed position scheme. However, to facilitate this encoding, separate documentation is necessary to describe a specific trading partner's implementation of the EDI message. While this has long been the accepted practice and there are many tools to simplify the use of EDI in a company's e-commerce solution, the reality is that a large percentage of implementations are custom, and as such, the investment in developing interfaces to use EDI is relatively high compared to other options. However, the fact remains that it is the most dominant data exchange format in use today, and industry is comfortable with its continued use, which favors its long-term outlook. So while some may argue against a solution using EDI, this dominance and familiarity to the industry help secure it as one of the viable options in future ESP discussions.

3.6.2.2 Cargo Interchange Message Procedure

Jointly developed by IATA, its member airlines, and Airlines for America (A4A; formerly the Air Transport Association), Cargo-IMP is the official message source for specifications concerning space allocation, air waybills, flight manifests, accounting, status, discrepancy, embargo, customs, cargo accounts settlement systems (CASS) billing, dangerous goods, allotments, and surface transportation. Cargo-IMP also includes encoding and decoding lists of all approved codes and abbreviations (*45*).

3.6.2.3 Universal Business Language

UBL is a family of standard, international, open, royalty-free electronic XML business documents (currently there are 31), the purpose of which is to facilitate the exchange of information among supply chain trading partners. UBL has been developed under an OASIS technical committee.

UBL builds on the work done by UN/CEFACT and OASIS in developing the ebXML Core Component Technical Specification (CCTS) 2.01, also known as ISO 15000-5. UBL has been or is being adopted by several countries and multi-country consortia, including Denmark, Sweden, the North European cooperation (which includes Denmark, Sweden, Norway, Finland, Iceland, and the United Kingdom), the Pan-European Standards Organization for e-Business (CEN/ISS), and most recently, the European Union-sponsored Freightwise initiative. U.S. DOT has conducted and continues to conduct pilot tests and case studies based on UBL deployment as part of the EFM program.

The structure and library of data elements in UBL readily support the dissemination of hazmat ESP information and include this structure in many of the core documents, including BOLs, forwarding instructions, and waybills. Implementing UBL as a standard message format for the intake of information would not only facilitate the use of this global standard by a growing number of entities but would also encourage further adoption with associated benefits for the remainder of the supply chain community.

3.6.2.4 IEEE 1512 Family of Standards

The IEEE 1512 family of standards documents a series of Incident Management Message Sets and their underlying data elements as used by emergency management centers (EMCs), which can be the basis for communication of the hazmat information to emergency responders. Similar to UBL on the intake side, solutions based on IEEE 1512 continue to be implemented in major metropolitan areas such as New York, Houston, and Washington, D.C. IEEE 1512 was the underlying standard used in TSA's hazmat truck security pilot project that was developed for a national hazmat truck tracking center prototype. Use of IEEE 1512 facilitated the exchange of critical information to emergency responders using a message format that was built for that community.

3.6.3 International Conventions and Associations

In addition to the standards organizations identified in Subsection 3.6.1, there are many organizations, industry associations, and international conventions that exist (among other reasons) to promote the use of standard practices and procedures, and in some cases dictate the use of standards. A handful of those that were researched as part of this project are identified in the following.

The European Commission proposes to modernize the European Union customs code.

The Association of Southeast Asian Nations provides a single window agreement for faster clearance of goods.

The Global Air Cargo Advisory Group (GACAG) (*46*) is composed of representatives from:

- The International Air Cargo Association (TIACA),
- IATA,
- International Federation of Freight Forwarders Associations (Fédération Internationale des Associations de Transitaires, or FIATA), and
- Global Shippers Forum (GSF).

GACAG has formed recently and is an industry advisory group for the air cargo industry. Its purpose is to ensure that the air cargo industry has a unified voice in its dealings with worldwide regulatory authorities and other bodies whose

decisions directly affect air cargo. GACAG has invited the WCO to help promote global harmonization of electronic transactions (*47*).

3.7 Data Creation/Intake Methods

Project research has shown that the shippers and carriers involved in the handling and movement of hazmat span the continuums of size, capabilities, and technology familiarity. There are many differences in the way goods are handled and documented when comparing one mode versus another in highway, rail, marine, or air transportation; TL versus LTL shipments; government (e.g., Department of Energy or Department of Defense) versus commercial operations; and other considerations. Following is a discussion of the three main types of data intake options that could be electronically exchanged.

3.7.1 Scanned Electronic Versions of Copies

The first alternative method uses the original, most common, and readily available version of shipping papers: existing hard copies. As required, these hard copies are produced and carried with the shipment. They are available to an emergency responder or regulatory compliance/enforcement official, assuming access to the cab or operator/pilot compartment is available. To improve the availability of these hard copy shipping papers, an option may be for carriers, shippers, and other trading partners to take a current common step of faxing or scanning and e-mailing these scanned copies. This option may involve extending this process by making these electronic versions of copies available either as part of the shipment's current documentation package (via CD-ROM or other electronic media) or by submitting these to a common service that facilitates transport of hazmat. A number of companies currently provide this service.

3.7.2 Web Portal

A second method uses a web portal, which is basically a secure website tailored for a specific purpose/entity and, in most cases, maintained by a third party on behalf of the user. The web portal is a viable solution for shippers and carriers that are looking to evolve from a paper-based system but do not have the resources or need to implement in-house systems to produce BOLs and the corresponding hazmat shipping papers.

By implementing a portal solution complete with an online hazmat BOL capability, small and medium enterprises would have freely available systems in which they could generate and print BOLs directly from any Internet-enabled computer. E-BOL versions could be transmitted to trading partners that require or could accept them. At the same time the shipper or carrier benefits from this free service, the critical hazmat information would be retrievable. In principle, this method could even be used beneficially by a shipper or carrier that is not an adopter of an ESP system.

3.7.3 Electronic Submission

The third alternative method is that of a fully integrated electronic submission process that can leverage both existing and emerging information exchange technologies. While not all-encompassing, the use of EDI and/or a value-added network (VAN) make up a majority of the electronic information exchanges that presently take place between trading partners. And while not a perfect system, these present exchange mechanisms provide the foundation for building future systems, leveraging the legacy systems presently in use, and exchanging data between them. In the near future, this approach will also support emerging technologies and formats, such as the use of web services and XML, as these begin to penetrate and gain market share. The intent of fully integrated solutions and the corresponding data intake is to allow the partner to leverage the existing information exchanges already in place without the participants having to change their current business practices. At the same time, it encourages the adoption of emerging trends and standards by both existing and new e-commerce participants.

This data intake option is the desired long-term solution.

3.8 Existing Electronic Interchange Systems

As part of the research conducted to understand the current best practices in place for ESPs, many existing commercial, trade association-based, and government-sponsored solutions were identified. These solutions were divided into a handful of categories. Both the descriptions of existing systems and the representative examples follow. For the sake of objectivity, none of the commercial solutions are cited, but their functionality is described in general terms.

3.8.1 Description of Existing Systems

The majority of existing systems fall into one of the following major approaches currently in use for the exchange of e-commerce information:

- Direct partner-to-partner exchanges,
- Partner-to-partner via a VAN,
- Hosted system, and
- Variations.

3.8.1.1 Direct Partner-to-Partner Exchanges

In this approach, trading partners agree on the format and method of information exchange and implement the exchange directly between the partner's respective systems. The format and method of the information exchanged can take any form agreed to between the partners, including the use of XML-based messages and web services (as demonstrated in U.S. DOT's EFM program). In general, this approach typically includes an EDI document or a flat file, such as a Microsoft Excel spreadsheet, and the use of either FTP or e-mail to transmit the electronic document.

3.8.1.2 Value-Added Network

In a VAN approach, trading partners use a third-party forwarding or translation service to facilitate the exchange of information between parties, such that each party can maintain its existing document formats. The VAN serves to take in a document or file from one trading partner, in that partner's preferred electronic format, translate the data as necessary into a format that the receiving partner can read, and forward the document to the receiving party or parties.

3.8.1.3 Hosted System

A hosted system serves to consolidate all data intake under a single, often centralized system that allows for trading partners with little IT infrastructure to participate in e-commerce-type activities. A trading partner will typically log on to a service provider website and generate shipping documents, check status of shipments, and perform other functions. A variation of this approach is one where the trading partner may submit electronic documents to the hosted system, where they are used and kept by the system.

3.8.1.4 Variations

The research also showed that many partners implement systems that are a combination of the previous approaches. For instance, a large retailer may conduct direct B2B exchanges with their top Tier 1 suppliers but use a VAN to communicate with Tier 2 suppliers.

3.8.1.5 Examples of Existing Systems

The following are examples of noncommercial electronic data interchange systems, solutions, or practices:

- EFM,
- IATA e-freight,
- TradeNet,
- CBP's ACE e-manifest,
- CBSA's ACI e-manifest, and
- DTTN.

3.9 Current Electronic Commerce Methods Meeting Hazmat Transport User Needs, and Their Challenges

In addition to the e-commerce standards and practices cited previously, electronic document templates currently exist that support the transmittal of hazmat information. However, as noted in the following, there remain some challenges that must be addressed in order to fully support ESP exchange.

The transmittal of declarations for dangerous goods is currently supported by standards such as the UN/EDIFACT International Forwarding and Transport Dangerous Goods Notification (IFTDGN) and Rail Carrier Shipment Information Transaction Set (404) messages, both EDI message structures. The IATA e-freight initiative has also developed a standard for the declaration for dangerous goods. These standards support the transmittal of critical hazmat/dangerous goods information in the course of commercial transaction communications.

Presently, however, most hazmat/dangerous goods information is conveyed in free-form fields of other shipping documents, and the ability to check the integrity of that information—either before it leaves the originating system or before it is accepted by the receiving system—is lost. As a result, incorrect information is caught when it is later checked on the receiving end, or worse, is not caught until it is critically needed. This creates rework for both the sending and receiving parties, and its resolution needs to have high priority.

Not all of the systems referenced in Subsection 3.8.1 have specific modules, transaction sets, or forms to handle hazmat/dangerous goods information and to create compliant documents. The functionality of specific systems is driven by the needs of their users, which for some can represent only a secondary concern or need. Adoption of ESP standards and forms could lead to more of these systems developing functionality to support.

The communications methods described can also support declarations for dangerous goods and sharing of hazmat/dangerous goods information between parties. Web portals and e-documents, or electronic copies, are potentially lower-cost solutions to e-commerce information sharing. If set up and used properly, all of these methods ensure that necessary and critical information is conveyed.

3.10 Solution Alternatives

3.10.1 Solution Evaluation Framework Description

The solution evaluation framework addresses the attributes of an ESP environment in the context of the needs of the hazmat stakeholders. Select systems are referenced to provide an illustration of the current state, and references do not promote any particular solution. The framework addresses safety, emergency management, and operational aspects for single mode, multimodal, domestic, and international shipments. Stakeholders are defined as shippers, carriers, regulators, and emergency response entities and personnel.

The framework is structured to address technology and process elements in the three realms of inputs, data aggregation/sharing, and outputs.

Technology elements address data creation and input to the system, standardization, exchange and integration, access, and document creation. Hosted and SaaS applications are accessed by users for data input. Data elements can then be exchanged with carriers, consignees, and other intermediaries (such as customs brokers). Systems also allow for integration with order management applications to eliminate rekeying. Data may be standardized following EDI, e-mail file extension, UBL, or other standards, which improves the sharing of those data across multiple users. Data may be used to generate paper copies of shipping documents and/or may be exchanged with other parties electronically. Electronic exchange allows downstream partners to sometimes access the shipment information in advance, use it for operational planning or activities such as export clearance, and eliminate rekeying of the information for their own purposes. Document generation is considered very basic functionality; however, it does not have the benefit of creating any downstream process efficiency, nor does it ensure downstream data accuracy.

Process elements address how the technology affects the business processes. Data interchange results in the elimination of redundant data entry and reduction in data errors. Administrative cost is reduced not just because of the obvious reduction in data entry, but also the reduction in time identifying and correcting downstream problems that result from mis-keying. Solutions that offer transportation management capabilities across multiple modes, including the package environment, allow firms to implement, maintain, and train employees to use a single solution rather than multiple solutions. Electronic signatures and e-certificates replace hand signatures in many transactional environments. Electronic data interchange allows information to move faster than products, thus enabling downstream users to plan and synchronize activities (such as receipt and put-away or cross-dock). Electronic availability of data has benefits as well for emergency responders and regulatory agencies (such as CBP).

3.10.2 Attributes of Representative Current State System(s)

In Table 14, three commercial off-the-shelf (COTS) applications along with IATA e-freight are evaluated against the needs of hazmat ESP users. It should be noted that IATA e-freight is not a solution, rather it is a set of standards for electronic data sharing among air transport parties. Therefore, many of the attributes cannot be claimed by IATA e-freight since they would be dependent on the solution, not the standard. The three COTS solutions are all hosted. They vary significantly by company revenues, technical architecture, and target user communities. They all provide supply chain and transportation management capabilities.

All solutions support input of data either through their portal or through data interchanges with host operating systems. Similarly, outputs can either be in the form of data interchange, access through the portal, e-mails, or text alerts. Mobile device applications are still emerging; these are defined as moving beyond simple web browsing.

The process attributes of these solutions are a significant improvement in operating efficiency and data accuracy because of eliminating rekeying, employing digital signatures, providing data in advance of the physical shipment, and supporting regulatory compliance requirements. Document scanning (Subsection 3.7.1) can be employed to upload BOLs from the driver. Stored e-documents residing in a carrier's system can also be retrieved and locally printed to produce hard copies.

Support for emergency response personnel was not resident in the functionality of any of the COTS solutions evaluated but is well within the capability and architecture of each.

Table 14 examines technology and process attributes within the categories of (1) sources of data, (2) aggregation/sharing of data, and (3) uses of data. The designations regarding functionality are subjective; "key functionality" reflects a source's perception that a feature is a core element in differentiating or developing the solution. The results show that the three COTS applications are fairly comparable in capabilities.

3.11 Attributes of Desired State System

The desired hazmat ESP system will result from three main challenges having been resolved for ESP in general:

- An agreed-upon standard will be available that allows users in all transportation modes to interface with the ESP supply chain. Through the standard, the desired system will allow customers to use their data formats to successfully interface with other members in the supply chain to transmit a hazmat ESP. The standard will allow ESP from one mode to be handed over with permissions to an entity in another mode as well as in the same mode.

Table 14. Comparison of current state system functionality.

● = Key functionality, ◉ = Functionality, ○ = No functionality, **n/a** = not specifically addressed in the standard, but could be supported					
Sources of Data		**COTS Solution E**	**COTS Solution S**	**COTS Solution F**	**IATA E-freight**
Technology attributes	Data integration with originator's host system (ERP)	●	●	●	n/a
	Data messaging standards applied	◉	◉	◉	●
	Hazmat/DG classification standards applied	○	○	◉	●
	Web GUI interface for record creation (portal)	●	●	●	n/a
	Hosted application (Cloud)	●	●	●	n/a
	HM/DG application or module	○	○	◉	n/a
	Security encryption of documents, records	●	●	◉	●
	E-documents (scanning) capability	◉	◉	◉	n/a
Process attributes	Shipper-generated records	●	●	●	n/a
	Retail (parcel shipping) environment	◉	◉	◉	n/a
	Multimodal shipping environment	◉	●	●	●
	Digital signature capture	●	○	◉	○
Aggregation/Sharing of Data					
Technology attributes	Multimodal standards for data sharing	◉	●	◉	●
	Electronic data exchange between parties	●	●	●	●
	Electronic data exchange between interline carriers	●	◉	●	●
	Integration with carrier planning and operations systems (create DG manifests)	●	●	●	n/a
	Relative ease and cost of implementation (hosted service/SaaS)	●	●	●	n/a
Process attributes	Elimination of rekeying by interline carrier	●	●	●	n/a
	Data presented to interline carrier in advance of shipment tender	●	●	●	n/a
	Electronic signature acceptance	●	○	◉	○

(continued on next page)

Table 14. (Continued).

Uses of Data					
Technology attributes	Standardized electronic data format for emergency management	○	○	○	○
	Standardized electronic data format for regulatory compliance	●	●	●	●
	Web-enabled access	●	●	●	n/a
	Mobile device-specific apps	○	○	○	n/a
	E-mail messages, text message alerts	●	○	◉	n/a
Process attributes	Generates hard copy maintained by operator/driver	◉	◉	◉	n/a
	Electronic data available to emergency management personnel	○	○	○	n/a
	Supports customs (export/import) clearance	●	●	●	●
	Supports other business transactions	●	●	●	●

DG = Dangerous goods, GUI = Graphical user interface, ERP = Enterprise resource planning

- Governance will have been established that plans, prepares, facilitates, incentivizes, de-conflicts, and controls the process for all modes.
- Shippers will submit ESP documents in true electronic form that can be provided to freight forwarders and others in the supply chain.

The desired system will have at least a level of functionality in each of the 29 technology and process attributes shown in Table 14. Since a widespread IT infrastructure does not exist, the desired system will be technology-neutral. The desired system will not require software to be installed on a company's or organization's computer. It will accommodate a user's commercial encryption techniques.

Since traceability carries a business sensitivity context, it will be possible to provide different levels of detail on an ESP through the associated shipment's supply chain life cycle to different parties with appropriate permissions. Through technology advances such as encryption and other techniques, it will be possible to control this visibility in a way that can make clear to certain parties (such as a roadside inspector or auditor) the path of the hazmat along the supply chain, while masking the complete information from others who do not have a need to know.

The desired system recognizes and helps overcome the relative difficulties of any such system to being incorporated by organizations that operate with limited resources and technology sophistication, such as small motor carriers. It helps facilitate access to ESP by emergency responders (including emergency responder organizations that operate with limited resources, such as rural volunteer fire departments) during emergencies through permissions.

3.12 Gap Analysis Between Current and Desired State

The attributes in which the illustrative current e-commerce systems in Table 14 fall shortest of the desired system (based on attributes in which at least one of the three illustrative commercial systems has no functionality) are:

- Sources of data
  - Hazmat/dangerous goods classification standards applied
  - Hazmat/dangerous goods application or module
  - Digital signature capture
- Aggregation/sharing of data
  - Electronic signature acceptance
- Uses of data
  - Standardized electronic data format for emergency management
  - Mobile device-specific apps
  - E-mail messages, text message alerts
  - Electronic data available to emergency management personnel

In addition to the data elements, standardization and guidance to support desired-state ESP do not currently exist. Protocols to provide permission for authorized ESP accessing by certain parties such as emergency responders or roadside inspectors has not been established. Systems are not technology-neutral. In general, no provisions are made for electronic access by roadside inspectors or emergency responders. Proof-of-concept and more complete testing such as field testing has not been conducted.

CHAPTER 4

Conclusions

4.1 Road Map

4.1.1 What Needs to Be Accomplished to Realize a Standardized ESP System?

4.1.1.1 Stakeholder Buy-In

Shippers. For an ESP system to work most effectively, the shipper needs to be the entity making initial electronic data entry. That entry would facilitate use of ESP by all persons downstream in the hazmat shipment supply chain, out to and including the consignee. The shipper would need to have a compelling reason to take the additional step, and the additional cost should be borne by the party getting the benefit. Gaining greater acceptance of ESP among shippers is a key hurdle to ESP implementation.

Freight forwarders are mentioned in conjunction with this group because they are in most cases the next to handle ESP. Freight forwarders are generally a key interface with carriers. If they receive ESP from the shipper in electronic form, it is easy for them to maintain the integrity of the ESP in providing the documentation packet to the carrier. Their buy-in should be attainable since dealing with electronic forms should require less labor. If they do not receive ESP in electronic form, they currently have little incentive to themselves convert hard copy hazmat shipping papers to ESP.

Carriers. When the ESP is handed over to the carrier in electronic format by the shipper or freight forwarder, it is the job of the carrier to transport the hazmat to the consignee. Alternatively, the carrier may interline the shipment to another carrier, whether one of the same mode or a different mode. The carrier may have to break up the shipment, in which case ESP must have a process for digital signing and acceptance. After a hazmat shipment is split up, the ESP system needs a process to cancel out and destroy the original ESP documentation. This should not be more time-intensive than the current paper system. With greater in-vehicle communications, some motor carriers may want to involve the truck driver; thus, drivers may need to communicate with the dispatcher or perhaps the back office in supporting the electronic processing. Carriers will hopefully recognize the advantages of adopting ESP, although small motor carriers will have fewer margins in that regard than larger firms or Class 1 railroads.

Regulatory organizations. An inspection organization may be a nation's customs organization such as CBP, CBSA, or Aduanas. These organizations are interested in safety and security, and their primary concern is ensuring that they know what materials are crossing their respective borders. ESP will facilitate filing of the ACE e-manifest and may allow even greater advance notification for bulk quantities of more dangerous hazmat cargo. An inspection organization may be a roadside inspection agency such as FMCSA, CVSA, or state public safety department inspection agency. These roadside inspection organizations prefer to call up a vehicle's ESP information on a screen rather than searching though what may be dozens of pages of hard copy shipping information. The greater speed of an ESP process allows the roadside inspection agency to inspect a greater number of vehicles, spend less time with each getting the sought information on cargo, and thus have more time and resources to detect and focus attention on problem shipments.

Emergency responders. Emergency response personnel will welcome any initiative that improves their ability to get information about the contents of a hazmat shipment that is involved in an accident or incident more quickly and thus make a swifter, better-informed decision at the scene. With laptops, smartphones, and PDAs increasingly available to incident/emergency response personnel, the ability to connect to the Internet has become much greater in recent years. Assuming that the scene of an incident or accident is not in dark territory, where Internet and cell phone coverage is unavailable, this capability should allow them to have permissions to more quickly retrieve hazmat shipping papers when the paper copies are not safely accessible or are destroyed due

to the circumstances of an incident. That assumes they can first positively identify the hazmat vehicle to get information on which to search. If the incident or accident is in dark territory, conventional emergency response will apply.

4.1.1.2 Data Entry Requirements

A goal of a standardized ESP system is that shipment data be entered only once and shared among partners along the supply chain. Additionally, it is expected that these data be identified and populated in a consistent fashion throughout the lifespan of the data. Starting with the shipper, details of the shipment—particularly those with hazmat requirements—should be captured in electronic form and provided to other supply chain partners, such as the carrier, based on existing business relationships. In turn, each trading partner could use the provided electronic information, augmented to generate its own ESP and other related documents.

As discussed in Section 3.8, multiple approaches exist to support capture, transmission, and—as appropriate—persistence of this electronic information. Parties may generate messages directly from their own in-house system or use a VAN or even a portal to capture and disseminate information to other parties. Ideally, all of these partners would use the same standardized messages and delivery mechanisms, promoting greater interoperability. However, even in the absence of these standards, many benefits could be realized from any exchange of data so long as the information itself is understandable to the involved parties.

The CCL, as defined by UN/CEFACT, is one approach that could be used to ensure common definitions and use among parties. At a minimum, it provides for a fairly robust data dictionary that, even if it were the only standard used, would help ensure common understanding among partners when exchanging data electronically.

Presently the CCL and the requirements for hazmat ESPs do not directly correlate. However, with effort and the support of the global shipping community, a common, harmonized data dictionary could be defined.

4.1.1.3 Information Flow Parameters and Limits

Any solution to facilitate ESP must take into consideration not only the technical challenges associated with the exchange of the data but also the business sensitivity of the information being shared; it must adequately protect this information. Presently there are many existing B2B transactional formats and interfaces that serve the needs of the user community for which they are implemented and that could be considered for broader implementation. However, not all of them readily support integration with multiple platforms and partners, nor do they exhibit the necessary control or protection of data as warranted in this environment. An ideal solution would facilitate both of these needs: multiple platform support and the ability to limit data shared to the appropriate need-to-know organizations. The development of interfaces that enable the integration of ESP with existing B2B applications and open standards (e.g., EDI, UBL, and XML) will enable exponentially greater participation in this ESP concept.

4.1.1.4 Ability to Support Multiple Transportation Modes

The HMCRP Project 05 RFP stated that "The objective of this research is to develop a road map for the use of electronic shipping papers . . . for and amongst all transport modes." It is not sufficient to address the needs solely of the motor carrier industry, complex as they are. Trucking represents the first and last mile of nearly all of the nation's air and waterborne trade, and a significant portion of domestic rail traffic moves on business with trucking companies. The large number of motor carriers and their differences in size and technical capability set trucking apart from other carrier modes. However, providing a road map that only addresses moves that are entirely truck-borne will not help to solve the inefficiencies that affect the nation's supply chains. Both the air and marine industries, through the IATA e-freight and IVODGA Removing Intermodal Impediments initiatives, have been moving in the direction of multimodal standards for dangerous goods declarations.

The modes of rail, marine, and air already have addressed electronic equivalents of dangerous goods shipping declarations. The IMDG code and the ICAO Technical Instructions for the Safe Transport of Dangerous Goods by Air permit electronic transmission of dangerous goods declarations. The rail EDI 404 transaction set includes hazmat descriptive fields. IATA has established standards for the Declaration for Dangerous Goods data XML requirements for the SDDG and an IATA e-freight-compliant dangerous goods declaration. However, all of these initiatives and standards have fallen short of supporting true end-to-end compliance with dangerous goods documentation for carriage because they are unable to link all the other modes that are involved in the end-to-end movement of goods.

Approaches or solutions that address multimodal shipments can only do so effectively if they address standards for format and data elements established for these other major modes. There is not a single global standard on which the motor carrier industry can simply base an adoption. Therefore, the industry must look to all of these industries through their predominant trade associations for collaboration. A significant hurdle that must be addressed for an ESP that covers marine and rail intermodal shipments is the rail industry's use of the STCC. The STCC does not correlate in a one-to-

one relationship to UN numbers and is an impediment to end-to-end ESP for marine–rail movements. Ocean carriers are able to use electronic versions for their portions of moves, but the interchange with rail still relies on paper copies. While the ocean–rail interchange is showing signs of improvement, ocean carriers have frequent errors in data transmission due to the differences in UN numbers and STCC.

Because trucking is a critical component of international end-to-end supply chains, an approach to ESP for hazmat by the industry must take into consideration and integrate with multimodal standards to close the compliance loop.

4.1.1.5 Degree of In-Transit Visibility

The degree of in-transit visibility that may be available to adopters of ESP solutions is dependent on a number of factors, including the willingness of partners to share information and the timeliness and availability of the data. Putting aside the institutional challenges and assuming that data are protected as necessary and appropriate, the opportunity for improved visibility increases substantially as more parties associated with a shipment support electronic information exchange. U.S. DOT's EFM program is a case in point. Aside from the benefits resulting in the use of standards, the move away from batch data exchanges to a more real-time model greatly benefited the partners by making shipment information available on a timelier basis. This increased in-transit visibility allowed for better planning on the part of warehouse staff as well as in supporting order fulfillments, among other areas. These same benefits could be realized with the increased adoption of more near–real-time models such as EFM.

4.1.1.6 Adequacy of Standards

The adequacy of standards discussed in this report is a subjective topic. In terms of the underlying Internet standards used to facilitate the secure transport of electronic information, based on the implementation of electronic data exchange capabilities in other market segments such as finance and law enforcement, those standards appear to be adequate to support the needs.

However, there are some inadequacies. EDI was created on the premise that it would sufficiently meet users' needs without modification. However, as witnessed in current implementations of EDI, many users have extended or modified the standard documents to meet their specific business needs. Which of the changes were truly necessary versus which were simply preferred is unknown, but in either case the adequacy of these standards could be in question.

Those developing UBL seemed to have taken this need to heart. While the basic data elements in UBL are consistent with the same underlying data elements as EDI, the crafters of UBL have implemented an ability to extend UBL documents without breaking their underlying compliance with the specific XML schema. Since UBL and similar XML-based message formats are still in their infancy in terms of broad implementation, it has yet to be seen whether the approach embodied within them is truly adequate. At a minimum, with the presence of XML validation tools, there is much less likelihood that implementers will vary from the standard schema.

4.1.1.7 Degree of Interoperability with Other Electronic Commerce Systems

Similar to the emphasis on the use of standards to achieve interoperability among partners needing to exchange hazmat ESP, interoperability with other electronic commerce systems is highly dependent on the adoption of and adherence to standards. While use of EDI for electronic information exchange is reportedly still dominant, the use of XML is growing and has the potential to become the de facto standard. If so, it might be expected that interoperability will be dependent on the use of XML. Requiring that the implementation of the XML schema, such as that in UBL, be based on the UN's CCL takes that interoperability a step further by introducing a common underlying metadata dictionary. Finally, the use of current data exchange practices such as web services further increases the opportunities for interoperability.

4.1.1.8 Data/Communications Security

Security will always be a challenge in the ever-changing and expanding Internet and e-commerce communities. However, with the continued growth in online transactions come new approaches to satisfy the security needs of these user communities. While this report has not focused on the security needs of an ESP solution, the W3C, OASIS, and other entities have invested in the development of standards and processes to support implementation of security in other high-visibility industries such as banking and law enforcement. Additionally, there are numerous best practices that have been documented, ranging from the use of simple but encrypted secure-FTP capabilities to multistage biometric-based logons that are available for adoption in an ESP environment.

Compared with the industry's current commonplace approach to sending EDI documents over standard FTP or via e-mail, adoption of any of the more modern security mechanisms will result in an enhancement in security.

4.1.1.9 Safety and Operational Implications of Mixed Paper and Electronic Operations

The use of ESP allows railroads to provide information to emergency responders in many ways. In a rail hazmat accident or incident, shipping papers can be faxed or e-mailed to emergency responders if the papers are not available through the train crew. They can even be sent to PDAs. This has

improved the safety of dealing with hazmat incidents. It also allows railroads to check the accuracy of their train consists, when they are departing yards, as cars are scanned. ESP have permitted increased accuracy in the final product by enabling automated comparison of the ESP entries to a standardized shipping description database that AAR maintains and the railroads use in their billing/shipping paper process (*48*).

4.1.1.10 Regulatory Changes That Would Be Needed to Enable Use of ESP Records

PHMSA, under its former name as the Research and Special Programs Administration, issued a special permit to allow railroads to use ESP over 30 years ago. PHMSA recently issued a notice of proposed rulemaking adopting that into the regulations. It is likely that a similar regulatory action as that taken for railroads would provide commensurate benefits to other hazmat transportation modes.

4.1.2 Stoplight Chart of ESP Readiness

Table 15 illustrates the state of readiness for ESP implementation in stoplight format.

4.1.3 The Path Forward for the Use of ESP for Hazmat Shipments

Looking across the international and multimodal transportation community, much of what needs to be in place to realize a standards-based ESP solution already exists. Table 15 summarizes the state of readiness of eight key elements with only one component—interoperability with other electronic commerce systems—displayed as red, signifying a potential major hurdle.

Efforts such as IVODGA's Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping and IATA's e-freight should be referenced for valuable lessons. Both efforts took a multimodal approach and gleaned useful information regarding the use of data elements in place across multiple modes. IVODGA prepared a detailed multimodal mapping of these elements in its 3.12 Shipping Paper Worksheet for All Modes (*49*). Both efforts have faced challenges in realizing broad acceptance and adoption, yet how and why these challenges arose and what these organizations have done to address them will also yield valuable lessons for hazmat ESP. Among these lessons is that developing an approach and performance metrics that account for business processes and improve efficiency of participants along the transportation information chain are crucial. Also, stakeholder education leading to broad acceptance and adoption is critical to make the transition from research to practical application.

The path forward will entail a multiphase, multiyear effort requiring sponsors and champions from the public sector and associations representing key modes. The key elements of this effort involve:

1. Development of standards for e-commerce and data elements;
2. Proof-of-concept tests, field tests, and pilots; and
3. Cost–benefit analysis.

Table 15. ESP implementation state of readiness.

Readiness Element	Readiness	G/Y/R*
Stakeholder buy-in	Shippers and carriers must see a positive net cost–benefit ratio before adoption is likely. Challenges to data privacy and sensitivity must be overcome before regulatory and emergency responder stakeholders can expect to benefit.	Y
Data entry requirements	A data dictionary must be selected and subsequently extended to handle hazmat information.	Y
Information flow parameters/limits	Interfaces that enable the integration of ESP with existing B2B applications and open standards must be developed/adopted.	Y
Support of multimodal shipments	Marine and air have begun moving down the path of multimodal standards. Rail's use of STCC is a critical barrier.	Y
Degree of in-transit visibility	This visibility is dependent on willingness of partners to share information and the timeliness and availability of the data.	Y
Adequacy of standards	Standards exist to support nearly all aspects of an ESP solution, and it is simply a matter of choosing which best serves the user needs.	G
Interoperability with other electronic commerce systems	A multitude of current, disparate systems and no specific mandate to change preclude this from being readily implementable.	R
Data/communications security	Current security standards and best practices implemented in other industries are adequate to support e-commerce and ESP needs.	G

*G = Green, Y = Yellow, R = Red

Approaches for ESP compliance may be developed that offer alternatives to electronic data exchange. It would be premature to rule out these alternatives at this time. However, broad adoption that meshes with business processes and improves efficiency will need to incorporate electronic data exchange. Therefore, standards for e-commerce, including data elements, must be established in the path forward. While the standards needed to support ESP solutions have already been covered by IVODGA and IATA, interoperability with other e-commerce systems remains a key hurdle, as shown in Table 15.

A series of proof-of-concept exercises, field tests, and operational pilots should be conducted to assess the feasibility and functionality of alternative approaches. Section 4.2 provides a detailed methodology for the proof-of-concept exercises designed to test implementation strategies and functionality. The proof-of-concept exercises will be the first phase, and subsequent tests will narrow feasible options to those most likely to meet the goals and performance objectives of ESP.

Cost–benefit analyses should be a part of each test phase to ensure that practical and implementable solutions that meet business-level ROIs are being sought. Industry will not accept unfunded mandates or approaches that provide benefits to one participant segment while driving up the cost of another segment.

4.1.4 Timeline (Outline for a Path Forward)

Table 16 shows key milestones that need to be achieved for implementation of ESP. These are essentially sequential, although some overlap should be possible. With an aggressive approach, it may be possible for pilot ESP implementations to be under way within a decade.

4.1.5 Steps to Educate and Prepare Stakeholders for Technology Adoption and Implementation

One noteworthy example of an effort to promote paperless transactions is the path taken by IATA on its e-freight initiative. IATA's efforts toward the goal of paperless transactions have been in progress for years. The IATA e-freight initiative does not provide an e-commerce system but rather a standardized messaging process to support e-commerce.

IATA clearly identified the problem, the vision for its solution, and the justification for doing it. They published a vision and mandate for the initiative, along with a brochure and fact sheet. IATA defined terms, derived the business case with assumptions, and supplied a cost–benefit calculator. For the product, there were a handbook, self-assessment questionnaire, business process and standards information, message improvement program (MIP) strategy, and link to international conventions and standards.

IATA recognized the need for collaboration (i.e., getting an entire supply chain to work together to change the way it operates). They recognized that there was a lack of agreed upon electronic standards for all documents and that where electronic standards existed, they were not used consistently or with the level of quality required. IATA realized that there were legal aspects, particularly with how electronic data could replace paper and still meet legal/

Table 16. Milestones on ESP path forward.

Timeframe:	Near-Term		Mid-Term		Long-Term
Action/ milestone	Identify champion for ESP effort Review and consolidate products of prior related efforts (e.g., IATA e-freight, IVODGA's Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping, HM-ACCESS) Facilitate meetings of ESP stakeholder organizations	Discuss e-commerce standard(s) and data elements applicable to ESP Conduct initial cost–benefit analyses on elements of ESP implementation Conduct sponsored proof-of-concept test(s) Identify conceptual ESP system Conduct cost–benefit analyses on conceptual ESP system	Reach agreement on required ESP data elements Define e-commerce standard(s) applicable to ESP Accept e-commerce standard applicable to ESP	Conduct field tests of prototype ESP system Conduct limited and wider field tests of ESP standard and system Enact guidance	Conduct pilot implementations involving all transportation modes (i.e., highway, rail, marine, and air)

regulatory requirements. They recognized the importance of the business process with respect to how they would be able to operate without paper and still deliver to the end customer.

IATA gathered a strong coalition of leading stakeholders who were committed to their vision and to attaining it. They implemented pilot projects to establish the basic principles of their IATA e-freight business process and demonstrate that it could work. They built up their industry data readiness via the IATA MIP. They helped educate and assist their members in implementing the e-freight system, and they used a dashboard to illustrate how implementation of the system was progressing (*50*). The IATA e-freight approach is well thought out and comprehensive. There is much from the process that can be applied to the ESP initiative.

The objective of IVODGA's Removing Intermodal Impediments to Dangerous Goods & Hazmat Shipping program is to "work with government and industry partners to develop and implement a program to remove impediments to intermodal/international transportation and facilitate e-commerce" (*51*). This initiative has seen a great deal of improvement, especially with the HM-206F rulemaking on emergency response information in 2009. Improvements have resulted in a marked decrease in FRA citations and rework for ocean carriers. Most of the partnership lines communicate almost exclusively electronically.

For implementation of a multimodal ESP system to be successful, there must be an industry-wide approach that takes into consideration the perspectives of all stakeholders. There must be adequate funding to support the necessary activities. There must be commitment, cooperation, and collaboration. Perhaps most importantly, there must be a muscular champion who provides strong leadership, focus, and the determination to see the process to its conclusion. This champion could be from within industry or government, but without such a role success will be elusive.

4.1.6 What Industry Can Do to Overcome Impediments and Facilitate Movement Toward the Desired State

When industry decides to act voluntarily, it is important to have—or develop—a users' association to build consensus. Having a critical mass of organizations with different people, areas, backgrounds, needs, and agendas provides the rigor needed to get to a well-balanced plan that can solve the challenge. It is important to get them to sign up to a set of rules and work with customers to develop the best-practices process. Organizations have to be prepared to make some concessions for an equitable solution. Collaboration and coordination are critical to success.

4.1.7 What Government Can Do to Overcome Impediments and Facilitate Movement Toward the Desired State

Sometimes for a challenge of this nature it takes a government commitment to compel a solution. Governments have the greatest wherewithal to force change. Government has shown that it can help bring about new approaches to data transactions. With an eye to national security needs, CBP implemented the ACE program and instituted a requirement (with some exceptions) that an e-manifest for a commercial vehicle intending to cross into the United States be submitted prior to vehicle's arrival at the CBP port of entry primary inspection facility. CBP has limited the impact of implementing the ACE program. ACE meets CBP's needs and does not appear to have added significant cost to industry. Similarly, if customs agencies across the world agreed to start requiring paperless transactions, the stage would be set for a widespread ESP solution.

4.2 Methodology for Proof-of-Concept Exercises Designed to Test Implementation Strategies and Functionality

To recapitulate, for HMCRP Project 05, this activity was to compile "a methodology for proof-of-concept exercises designed to test the implementation strategies and functionality of [the] electronic hazmat documentation and data transfer system identified. . . . The deliverable is not expected to detail specific scenarios, but is intended to provide a framework, a guideline, and/or a series of questions through which future researchers may propose validation exercises."

4.2.1 Proof-of-Concept Exercises Process

The following provides the methodology by which the proof-of-concept exercises can be measured and evaluated:

I. Performance measures
   a. Exchange of hazmat ESP and manifest information between parties involved in transportation, including shippers, carriers, and consignees
   b. Report of transfer of the shipment between parties as well as its final delivery
   c. Frequent (i.e., near–real-time) exchange of information
   d. Compliance with international standards of data exchange, including the format and content of the message (e.g., UBL, UN-CEFACT) as well as the exchange mechanism (e.g., web services, FTP)

e. Compliance with international and/or industry standards for material identification and classification
f. Compliance with regulatory requirements
g. Data accessibility to authorized users/data and access protection from unauthorized users
h. Electronic (nonvisual) identification of land vehicles by emergency responders.
i. Near–real-time remote identification of hazmat quantity, hazard type, package description, emergency response measures, key contacts, and location
j. Positive cost–benefit ROI

II. Identify potential electronic data exchange systems for ESP; for example:
a. EDI
b. UBL
c. XML

III. Determine major characteristics and strengths and weaknesses of each system
a. System used for transferring data (e.g., Internet, e-mail)
b. Software requirements
i. Licensing difficulties and cost
ii. User-friendliness
iii. Current applicability to e-commerce
iv. Ability to be modified for e-commerce
v. Suitability for system under discussion
c. Technology (hardware) requirements
i. Current availability to potential users
ii. Hardware and operations and maintenance costs
d. Potential stakeholder acceptance and resistance
i. System oversight requirements
ii. Voluntary or mandatory program
iii. Cost to users for equipment and operation (future system)
e. Training required to operate by shippers and carriers
f. Applicability to each of the major modes
g. Applicability to regulatory oversight and compliance functions
h. Functionality between modes
i Roles of responsible parties (e.g., shippers, carriers)

IV. Identify system for testing the following:
a. Assessment of the system's applicability to hazmat shipments in the United States
i. System's achievement of performance measures
ii. Extent to which system strengths outweigh weaknesses
iii. Commitment of stakeholders to participate and support test
1. Clearly identified benefits of system (e.g., more effective information transfer)
2. Ability to overcome institutional barriers (e.g., resistance to potential imposition of a uniform system)
3. Reasonable cost of future system
iv. System that will be easily tested between at least two modes

V. Select scenario for test that meets the following criteria:
a. Scenario takes place in a geographically limited area (e.g., not to exceed 150 miles in diameter)
b. Two sub-scenarios included
i. Normal shipment
ii. Shipment with a major incident
c. At least two modes included
i. Truck-to-rail
ii. Rail-to-truck
iii. Test truck-shipper/rail-shipper combinations
d. Hazmat selected for test is representative of a large portion of total shipments.
e. Includes involvement of selected major stakeholders from government and private sectors. Note that state agencies could be substituted for federal entities.
i. For rail and truck interface consider the involvement of:
1. CVSA
2. ATA
3. AAR
4. FMCSA
5. PHMSA
6. FRA
7. National Emergency Management Association (NEMA)
8. International Association of Fire Chiefs (IAFC)
ii. Include shipper, carrier, consignee, emergency responder, and enforcement representatives that each have the following characteristics:
1. Current user of electronic data exchange
2. Technologically sophisticated
3. Shipping large quantities of hazmat or trained to respond to hazmat incidents
4. Has positive attitude about the future use of ESP to supplement hazmat shipping papers and to provide electronically transmitted manifest information

VI. Develop a table-top exercise in a workshop prior to field exercise
   a. Develop concept for table-top exercise
   b. Use computer simulation and models to represent real-life situations
   c. Select workshop facilitators
   d. Develop workshop materials for participants
   e. Select and invite participants who are representative of major stakeholders
   f. Use evaluators representing key stakeholders (including carriers, shippers, consignees, and emergency responders) to determine readiness for field test
   g. Select evaluation form to be used by table-top evaluators
   h. Conduct evaluation
   i. On the basis of evaluation, use selected system
   j. Make recommendation for conduct of limited field test
   k. Develop plan for limited field test

VII. Conduct limited field test of selected system following selected scenario
   a. Acquire software and hardware for test
   b. Identify a shipper, carrier, and consignee for the test
   c. Obtain commitment for use of vehicles
   d. Install hardware and software
   e. Develop training materials for participants
   f. Develop evaluation form to be used by evaluators
   g. Identify test evaluators (evaluators will include test participants and selected stakeholder representatives)
   h. Conduct normal and incident field tests

VIII. Evaluate field test and make recommendations for next step
   a. Combine evaluations from all evaluators
   b. Make recommendation to expand field testing of the ESP system
   c. Identify strengths and weaknesses of the ESP system identified in the test
   d. Develop specific recommendations to correct these weaknesses
   e. Develop recommendation for widespread adoption of system
   f. Obtain support of key stakeholders
   g. Identify funding sources and obtain funding

IX. Conduct wider field test of the selected system
   a. Develop plan for wider test of the system
   b. Include at least three modes in wider test
   c. Develop training materials for participants
   d. Implement wider test

4.3 Use of This Report

Any investment in technologies for business efficiencies can be quite large, and the ROI may be difficult to determine. With the information from this project, HMCRP and its stakeholders will have greater knowledge of ESP systems that are already bringing benefits to their users; the attributes that can result in greater interoperability of existing ESP systems; and the road map that describes the benefits of, and the path toward, creating a unified ESP system that supports interoperability and exchange of standardized electronic commerce for hazmat transportation.

One of the best ways to determine the success of this project is to measure the number of government transportation officials, shippers and carriers, emergency responders, and other stakeholders seeking the results of this study. A secondary means is to gauge the number of organizations that access and subsequently use the project's findings to inform their plans to incorporate ESP. Whether these data are captured through uploaded success stories or some other means is beyond the scope of this project.

A number of respondents on this project noted that it is very important to have good cost–benefit data. These data have been difficult to find. Therefore, going forward, it is recommended that cost–benefit analyses be undertaken to assist those organizations that wish to implement ESP.

4.4 Summary/Conclusions

4.4.1 Relevance of Larger e-Commerce

The key to implementing hazmat ESP for the benefit of all of its major stakeholder groups and for multimodal shipments is solving the larger challenges of e-commerce. E-commerce is currently being used quite successfully in some areas by groups using electronic document submission. However, these successful examples have developed largely in isolation from other modes and other stakeholders, and there is no common standard with adequate guidance to allow them to have that compatibility across multimodal domains.

4.4.2 Data Entry Origination

For ESP to be successful, data need to be entered once and reused to the greatest extent. To achieve that, entry of electronic data into ESP needs to start with the shipper. Only in this manner is it feasible for the electronic chain to be initiated and have the continuity throughout the shipment's life cycle required to meet ESP's potential. Origination with the shipper is not currently being done to a significant extent, which is a large obstacle. To resolve it, an alignment is needed so that the parties that reap the advantages of ESP will bear

their share of the responsibility for its expense (i.e., the beneficiary pays). Until that is achieved, there will continue to be little incentive for implementing ESP on a large scale despite the desires and best intentions of many proponents.

4.4.3 Data Accuracy

Accuracy of shipping paper information can be improved by incorporating techniques that provide greater quality control to shipping information. For example, if a receiving facility that is coded to receive a certain hazmat is not safe for offload of that hazmat, the mismatch can be automatically caught through an electronic system, which enhances safety. Misspellings or other mistakes can be caught through spelling checks or other associations that an electronic system can be configured to look for.

4.4.4 Business Information Visibility and Security

Security-sensitive and business-sensitive information will be protected through advanced processing techniques and commercial encryption practices. Safety and security will be enhanced by having information about en route shipments accessible, in emergency situations and with permissions, in ways that are not possible with paper copies. Information about bulk hazmat shipment progress and expected arrival can be known ahead of time, much as CBP's ACE program is notified of shipment arrival at the border ahead of time. The greater visibility is important for business efficiencies as well as safety and security purposes.

4.4.5 Standards and Guidance

The best features of current and future commercial solutions can be captured and used through effective standards and guidance. When total costs are properly aligned in a beneficiary pays model, savings should be achievable. For example, paper copies can be printed from highly accurate ESP as opposed to ESP resulting from laborious electronic keying of information from the paper copies by a stakeholder that does not realize a benefit. When ESP are in more widespread use, they will become more familiar and accepted, as electronic transactions were in the banking and financial industries, to name but two. The guidance process can be used to promulgate news of regulatory actions and provide useful information.

4.4.6 Emergency Responder Awareness

Safety will be improved by enabling access to ESP information in circumstances where securing access to hard copy hazmat shipping papers may not be possible. A costly delay could occur when shipping papers are destroyed or inaccessible due to the aftermath of a serious hazmat spill such as might result from a tank truck crash or rail tank car derailment. Depending on circumstances, delay in accessing paper copies may be considerable and occur at the moment of greatest need. Emergency responders and roadside inspection personnel will be able to have access to ESP through pre-arranged permissions appropriate to their need. This will allow quicker access to the information on the shipping paper, including emergency response-related information, in a manner that can supplement services already available to help emergency responders.

4.4.7 Intermodal Transfer

Hazmat shipping information will be more easily transferred to other modes, facilitating interlining. When shipments are split up en route, electronic signatures and approvals can help reduce confusion and provide greater visibility into what is to be delivered to the consignee, and when.

4.4.8 Cooperation and Achievability

Transmission of completely electronic ESP information cannot be attained overnight. Companies that exist to translate and reformat shipping data to facilitate e-commerce will continue to provide their services (perhaps focused more on shippers than freight forwarders), retain their market, and serve as catalysts to greater acceptance of ESP. Realizing these benefits can best be achieved through voluntary action. It will require cooperation and commitment among the stakeholder associations and groups that represent shippers, freight forwarders, carriers, and consignees of hazmat shipments, in consultation with regulatory compliance, enforcement, and emergency responder stakeholder associations and groups. The private sector is most concerned with business efficiency and cost savings. Industry knows the most appropriate technology solutions and standards that should be applied to the challenge and can implement them with great efficiency once accepted. It must be recognized that the level of cooperation envisioned is considerable. It requires achieving a critical mass of decision makers, screening and adopting best practices, and providing assistance and perhaps incentives in order to get voluntarily agreement.

4.4.9 Regulatory Considerations

If voluntary efforts fail to achieve desired results, government could intervene. That should be an encouragement for voluntary action, to ensure that the most appropriate technology and process solutions can be applied to the need. Government is primarily concerned with safety and security

and seeks to avoid regulatory actions that impede commerce. Stakeholders have mentioned that if regulation involving ESP is enacted, it should be used to level the playing field between adopters and non-adopters so that ESP adopters are not penalized in the process and that regulation does not impose an unfunded mandate.

4.4.10 Promotion and Collaboration

Trade associations and other stakeholder organizations can help define ESP implementation goals that benefit the larger hazmat transportation community as they advance the interests of their members. Key stakeholder groups could be allowed to sponsor and conduct the proof-of-concept exercises and follow-on tests, participate in collaboration to help promote achievable goals along the path to ESP implementation, and encourage participation in a global ESP implementation process. PHMSA, the other U.S. DOT safety organizations and modal organizations, regulatory compliance and enforcement, and emergency responder representatives would need to be part of the process even if industry takes the lead.

4.4.11 E-Commerce and ESP Adoption

Normally, it would seem that the solution to greater use of hazmat ESP would follow improvements in standards and other aspects of electronic data transfer, not drive the improvements or happen independently of them. However, the safety and security aspects of hazmat shipping have resulted in rules and regulations beyond the needs of commerce alone. Thus, improvements brought about by a reasonable system of hazmat ESP could be an inducement or even a model for larger incorporation of e-commerce. It is feasible that within a decade, hazmat ESP could be implemented and substantially in use by stakeholders, with a great degree of in-transit visibility.

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APPENDIX A

Acronyms, Abbreviations, and Terms

3PL	Third Party Logistics
A4A	Airlines for America (formerly Air Transport Association)
AAR	Association of American Railroads
ACC	American Chemistry Council
ACE	Automated Commercial Environment
ACHMM	Academy of Certified Hazardous Materials Managers
ACI	Advance Commercial Information
Aduana	Mexican Customs
AEI	Automatic Equipment Identification
AFA	Air Forwarders Association
AHMP	Alliance of Hazardous Materials Professional
AIS	Automatic Identification System
AMS	Automated Manifest System
ANSI	American National Standards Institute
AS	Applicability Statement
ASC	Accredited Standards Committee
ASLRRA	American Short Line and Regional Railroad Association
ASN	Advance Shipping Notice
ATA	American Trucking Associations
AWO	American Waterways Operators
B2B	Business-to-Business
BLEVE	Boiling Liquid Expanding Vapor Explosion
BOE	Bureau of Explosives
BOL	Bill of Lading
BTS	Bureau of Transportation Statistics
CANUTEC	Canadian Transport Emergency Center
Cargo–IMP	Cargo Interchange Message Protocol
CASS	(IATA) Cargo Accounts Settlement Systems
CBP	U.S. Customs and Border Protection
CBSA	Canada Border Services Agency
CCL	Core Component Library
CCTS	Core Component Technical Specification
CDC	Certain Dangerous Cargo
CEN/ISS	Pan-European Standards Organization for e-Business

CFR	Code of Federal Regulations
CFS	Commodity Flow Survey
CHEMTREC	American Chemistry Council
CI	Chlorine Institute
CLM	(Rail) Car Location Messaging
COSTHA	Council on Safe Transportation of Hazardous Articles
COTS	Commercial-off-the-Shelf
CSV	Comma-Separated Values
CVII	Commercial Vehicle Infrastructure Initiative
CVSA	Commercial Vehicle Safety Alliance
DCM	Dangerous Cargo Manifest
DERA	Disaster Preparedness and Emergency Response Association
DGAC	Dangerous Goods Advisory Council
DGM	Dangerous Goods Manifest
DMA	Dynamic Mobility Applications
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DSRC	Dedicated Short-Range Communications
DTTN	Digital Trade and Transportation Network
e-BOL	Electronic Bill of Lading
ebXML	Electronic Business Extensible Markup Language
e-manifest	Electronic Manifest
ECE	Economic Commission for Europe
EDI	Electronic Data Interchange
EDIFACT	Electronic Data Interchange For Administration, Commerce and Transport
EDP	Electronic Data Processing
EFM	Electronic Freight Management
EMC	Emergency Management Center
EML	E-mail File Extension
EPA	Environmental Protection Agency
ERF	Emergency Response Form
ERG	Emergency Response Guide
ERI	Emergency Response Information
ERP	Enterprise Resource Planning
ESP	Electronic Shipping Paper(s)
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FIATA	Fédération Internationale des Associations de Transitaires (International Federation of Freight Forwarders Associations)
FMCA	Federal Motor Carrier Association
FRA	Federal Railroad Administration
FTP	File Transfer Protocol
GACAG	Global Air Council Advisory Group
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
GLS	Global Locating System
GPS	Global Positioning System

GSF	Global Shippers Forum
GUI	Graphical User Interface
Hazmat	Hazardous Material(s)
HM-ACCESS	Hazardous Materials – Automated Cargo Communications for Efficient and Safe Shipments
HM/DG	Hazardous Materials/Dangerous Goods
HMIRS	Hazardous Materials Information Reporting System
HMR	Hazardous Materials Regulations
HSSM	Highway Security-Sensitive Materials
HTSP	Hazmat Truck Security Pilot
http	Hypertext Transfer Protocol
I2V	Infrastructure-to-Vehicle
IAEM	International Association of Emergency Managers
IAFC	International Association of Fire Chiefs
IAFF	International Association of Fire Fighters
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
ICS	Incident Command System
IEEE	Institute of Electrical and Electronic Engineers
IFTDGN	International Forwarding and Transport Dangerous Goods Notification
IMDG	International Maritime Dangerous Goods
IHMM	Institute of Hazardous Materials Managers
IMP	Interchange Message Protocol
ISO	International Organization for Standardization
ITS	Intelligent Transportation Systems
IVODGA	International Vessel Operators Dangerous Goods Association (formerly Vessel Operators Hazardous Material Association - VOHMA)
LERC	Local Emergency Response Committee
LTD QTY	Limited Quantity
LTL	Less-than-Truckload
MCMIS	Motor Carrier Management Information System
MIP	Message Improvement Program
MSDS	Material Safety Data Sheet
NACD	National Association of Chemical Distributors
NEMA	National Electrical Manufacturers Association
NGO	Non-Governmental Organization
NIMS	National Incident Management System
NOPIC	Notification to Pilot in Command
NOTIC	Notification to Captain
NOS	Not Otherwise Specified
NTTC	National Tank Truck Carriers, Inc.
NVOCC	Non-Vessel Operating Common Carriers/Consolidators
OAGi	Open Applications Group, Inc.
OASIS	Organization for the Advancement of Structured Information Standards
PDA	Personal Digital Assistant
PHMSA	Pipeline and Hazardous Materials Safety Administration
PIH	Poison Inhalation Hazard
PO	Purchase Order

PSN	Personal Shipping Number
RAIR	Rail Equipment Accident/Incident Report
R&D	Research and Development
RFID	Radio Frequency Identification
ROI	Return on Investment
RQ	Reportable Quantity
RSSM	Rail Security-Sensitive Materials
SaaS	Software as a Service
SAI	Security Action Item
SCT	Secretaría de Comunicaciones y Transportes (Mexican Secretariat of Communications and Transportation)
SDDG	Shipper's Declaration for Dangerous Goods
SGML	Standard Generalized Markup Language
SOW	Statement of Work
SRI	Smart Roadside Initiative
SSM	Security-Sensitive Materials
STCC	Standard Transportation Commodity Code
TAG	(EDI) Technical Advisory Group
TDED	Trade Data Elements Directory
TIACA	The International Air Cargo Association
TIH	Toxic Inhalation Hazard
TL	Truckload
TRANSCAER	Transportation Community Awareness and Emergency Response
TRANSCOM	U.S. Transportation Command
TSA	Transportation Security Administration
UBL	Universal Business Language
UN	United Nations
UN/CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
UN/ECE	United Nations/Economic Commission for Europe
UN/EDIFACT	United Nations/Electronic Data Interchange For Administration, Commerce and Transport
USB	Universal Serial Bus
U.S. DOT	U.S. Department of Transportation
U.S. EPA	U.S. Environmental Protection Agency
USCG	United States Coast Guard
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle
VAN	Value-Added Network
VOHMA	(International) Vessel Operators Hazardous Materials Association (now International Vessel Operators Dangerous Goods Association – IVODGA)
VTS	Vessel Traffic Services
W3C	World Wide Web Consortium
WCO	World Customs Organization
WRI	Wireless Roadside Inspection
WTO	World Trade Organization
XML	Extensible Markup Language

APPENDIX B

Initial Research Interview Summary and Guideline

The following interview guideline materials were used for the project's interviews. The introductory information was identical. However, questionnaires were modified for each of the interviewed groups, depending on the information that was sought from that group.

The groups consisted of:

- Questions for air, rail, ocean, and motor carriers contacted individually;
- Questions for motor carriers for whom questionnaires were distributed and collected by their trade association;
- General interview questions for associations, organizations, and agencies; and
- Questions for emergency responders.

The material included here follows the same order.

Interview Guideline for Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments HMCRP Project 05

Use of Electronic Shipping Papers for Hazardous Materials Shipments – a Study for the Transportation Research Board

Introduction

Battelle is conducting a research study for the Transportation Research Board of the National Academies to evaluate the use of electronic shipping papers for hazardous materials shipments. As you may know, carriers of hazardous materials must maintain paper shipping papers as part of the current regulatory framework stated in 49 CFR, Section 172. These shipping papers must be carried with the shipment for on-scene use by enforcement officials conducting inspections and by emergency response personnel at the scene of an accident or incident. This interview will provide the research team with insight into current hazmat shipment data management throughout the supply chain.

Responses by private companies will be treated as confidential by the project team and names will be not be published or identified with their responses without the expressed consent of the respondent.

Interviewee information:

Interview Date:
Interviewee Name:
Title:
Organization:
E-mail:
Phone:

Carrier Interview Questions

Company's handling of hazardous materials

1. What types of hazardous materials do you transport, if any?
2. Describe the significance of hazardous materials as a segment of your business:

Uses of electronic data sharing

3. Does your company receive electronic hazmat shipment information from shippers or other third parties (freight forwarders, third party logistics providers, interline carriers, etc.)? How does the availability of this information vary (by commodity type, size/type of customer, etc.)? Please explain.
4. For what percentage of your hazmat shipments do you receive electronic hazmat information? What types of data are typically contained in this information and what is the typical format (EDI/XML)?

5. At what point in your operations does your company convert paper-based hazmat information (shipper bill of lading) to electronic (prior to pickup, at time of pickup, when the shipment is cross-docked/reaches a company facility, after delivery, etc.)? Please describe.
6. Does your company currently transmit hazmat shipment data to any regulatory or governmental agency (for example, the ACE manifest)?
7. Does your company currently transmit hazmat shipment data to any other entities (for example, customers, partner carriers)?
8. Describe your use of electronic manifests, including both hazmat and non-hazmat shipments:
   a. With which parties are they shared (shippers, forwarders, third party logistics providers, interline carriers, terminal operators, regulatory agencies, etc.)?
   b. Do they meet regulatory as well as commercial purposes?
   c. What are the means for sharing electronically (file transfer, portal access, etc.)?
   d. How is access protected?
   e. What are the primary commercial and regulatory benefits of sharing manifest data electronically?
9. Are you aware of any relevant activities or studies that your organization has been involved with?
10. Does your organization have a current position specifically on electronic shipping papers or related to the more general use of electronic freight manifest information?
11. Describe the current process of processing (generating, filing, storing, and carrying) hard copy shipping papers:
    a. Attach, if you can, the total processing time or cost associated with their processing.
    b. The number of staff, or functions involved in processing shipping papers, and division of responsibilities for those staff.
12. Describe the costs that are associated with incorrect hard copy shipping papers, including the cost of re-filing.
13. Describe any costs associated with driver training, compliance monitoring, or oversight associated with their handling of hazmat shipping papers.
14. If carriers were allowed to maintain shipping papers electronically rather than the currently required printed copy:
    a. What benefits would you expect?
    b. What potential concerns would you have?
    c. Would these benefits and concerns vary by mode (highway, rail, air, or marine)?
15. Even if allowed, some carriers would continue to use hard copy paper shipping papers. Would the use of both kinds of shipping papers across the hazmat industry create any special concerns?
16. Would you envision specific issues or effects related to:
    a. Movement of hazardous materials
    b. Total transportation costs
    c. Safety and security
    d. Incident mitigation
    e. Preparedness of emergency response for incidents
17. How would you recommend electronic transfer of shipping paper information to enforcement officials or emergency responders be done (i.e., the technical aspects)?
18. What impediments do you see hindering the use of electronic shipping papers?
19. What specific actions would you recommend that might facilitate the implementation and use of electronic shipping papers?
20. Are there any specific individuals that you recommend we speak with about this topic? Who among your constituency might be particularly knowledgeable?
21. Are there specific documents or reports we should make sure to incorporate into our research?

Motor Carrier Questionnaire (Distributed and Collected by Trade Association)

Introduction

Battelle, a nonprofit research institute, is conducting a project for the Transportation Research Board of the National Academies to develop a road map for using electronic hazmat shipping papers to communicate between industry and the emergency response and enforcement communities. [Trade Association] is assisting Battelle by collecting insights from its members concerning current hazmat shipment data management throughout the supply chain.

All responses to this questionnaire will be confidential. [Trade Association] and Battelle guarantee that the information collected will be used without carrier names.

1. What types of hazardous materials (hazmat) does your company typically transport? Is your company responsible for transporting hazmat across different freight modes?
2. Does your company receive or generate electronic hazmat shipment information? If yes, proceed to Q3. If no, proceed to Q4.
3. Who typically generates this electronic hazmat data [customer, freight forwarder, third party logistics provider (3PL), interline/partner carriers, etc.]?
   What percentage of your customers and/or supply chain partners provide electronic hazmat information?

4. Does your company currently provide/receive advance notice of shipment delivery/availability to *(circle all as needed)* customers, interline/partner carriers, freight forwarders, or 3PLs?
   Does this include hazmat information?
   Is this information provided electronically?
   Please describe.
5. Does your company currently transmit hazmat shipment tracking data to any regulatory or governmental agency (for example, the ACE manifest)?
6. At what point in your operations does your company typically capture hazmat information (prior to pickup, when the shipment is cross-docked/reaches a company facility, after delivery, etc.)? Please describe.
7. Does your company generate an ETA for delivery?
   Is this information transmitted to customers or other companies?
   If so, how?
8. How does your company track shipments through your distribution network? What types of technologies are typically used (in-cab communication systems, trailer tracking, warehouse management systems, RFID, etc.)?
9. Does your company track hazmat versus non-hazmat shipments differently? Are there different tracking procedures for different types of hazmat?
10. Do your drivers update advance shipment notification information or pickup or delivery information via an in-cab communication system?
11. What are the greatest impediments to tracking hazmat shipments through your distribution network from the point of pickup to final delivery?
12. Does your company have short- or long-term plans to improve shipment tracking? If so, what types of technologies is your company considering?
13. What benefits/efficiencies could your company gain with improved, real-time, electronic hazmat shipment information?

General Interview Questions for Associations, Organizations, and Agencies

Battelle is conducting a research study for the Transportation Research Board of the National Academies to evaluate the use of electronic shipping papers for hazardous materials shipments. As you may know, carriers of hazardous materials must maintain paper shipping papers as part of the current regulatory framework. These shipping papers must be carried with the shipment for on-scene use by enforcement officials conducting inspections and by emergency response personnel at the scene of an accident or incident. I'd like to get some insight into how your organization is involved with or interested in electronic data sharing and how it might relate to hazardous materials shipping papers.

Ongoing or recent activities

1. Describe any electronic sharing of shipment data by your organization or its members.
   a. Include roles and responsibilities for the parties involved.
   b. What specific data elements are shared?
      What technologies, communications, and access restrictions are required?
   c. What are the specific benefits to you or your members from this data sharing?
2. Are you aware of any relevant activities or studies that your organization has been involved with?
3. Does your organization have a current position specifically on electronic shipping papers or related to the more general use of electronic freight manifest information?

Issues and concerns

4. If carriers were allowed to maintain shipping papers electronically rather than the currently required printed copy:
   a. What benefits would you expect?
   b. What potential concerns would you have?
   c. Would these benefits and concerns vary by mode (highway, rail, air, or marine)?
5. Even if allowed, some carriers would continue to use paper shipping papers. Would the use of both kinds of shipping papers across the hazmat industry create any special concerns?
6. Would you envision specific issues or effects related to:
   a. Movement of hazardous materials
   b. Total transportation costs
   c. Safety and security
   d. Incident mitigation
   e. Preparedness of emergency response for incidents

Implementation and operation

7. How would you recommend electronic transfer of shipping paper information to enforcement officials or emergency responders be done (i.e., the technical aspects)?
8. What impediments do you see hindering the use of electronic shipping papers?
9. What specific actions would you recommend that might facilitate the implementation and use of electronic shipping papers.

Follow-up

10. Are there any specific individuals that you recommend that I speak with about this topic? Who among your constituency might be particularly knowledgeable?
11. Are there specific documents or reports we should make sure to incorporate into our research?

Interview Questions for Emergency Responders

1. What shipment information is important to you when responding to a (potential) hazardous materials incident?
2. Describe your current process for obtaining that information.
3. In cases where the shipping paper is not available or is inaccessible, what do you do to obtain material information and how does the delay in getting that information affect your response?
4. If carriers were allowed to maintain shipping papers electronically rather than with the currently required printed copy:
    a. What benefits would you expect the emergency response community to receive?
    b. What potential concerns would you have?
    c. Would these benefits and concerns vary by mode (highway, rail, air, marine)?
5. Even if allowed, some carriers would continue to use paper shipping papers. Would the use of both kinds of shipping papers across the hazmat industry create any special concerns?
6. What would you need to know when responding to a scene about which type of shipping paper was in use?
7. What communication equipment do you have for use in the field (and what would you consider to be available to the typical responder)? (i.e., two answers for each):
    a. Equipment/devices
        i. Laptop
        ii. PDA or mobile phone
        iii. Other equipment
    b. Which of these devices has wireless Internet connectivity?

Given your current operational environment, do you have any preferences for how you would like to receive shipping paper information electronically?

APPENDIX C

Results of Initial Research Interviews

The following pages contain more detailed information from the initial interviews held for HMCRP Project 05. Appendix C is organized as follows:

Detailed information from interviews with representatives of stakeholder groups

- Motor carriers
- Rail carriers
- Air carriers
- Ocean carriers
- Emergency responders
- Roadside enforcement officers

Observations

- Effective practices
- Benefits and impediments

C-1 Detailed Information from Interviews with Representatives of Stakeholder Groups

C-1.1 Motor Carriers

Introduction

Participants from a broad cross-section of the trucking industry were given an interview guide and interviewed to determine the current use of electronic hazmat shipping information that is converted from paper and to specifically garner the industry's perception of the benefits of and impediments to the use of ESP. The resulting interview summary provided insight into current hazmat shipment data management throughout the supply chain.

Respondents represented 15 motor carriers in the three primary sectors of the industry, each with unique operating environments (i.e., TL, LTL, specialized). It should be noted that the majority of specialized carriers were bulk hazmat carriers (i.e., operating tanker trucks). Though several respondents represented carriers that hauled hazmat shipments exclusively, other carriers indicated that hazmat shipments were a small percentage of their overall business activity, which is reflective of the industry as a whole. In addition, industry regulatory personnel and relevant technology vendors were interviewed.

Types of Hazmat/Hazmat Packaging

The carrier population interviewed hauled most classes of hazmat, ranging from consumer-related hazmat (i.e., paint) to hazardous waste to explosives. In addition to bulk hazmat, other hazmat packaging types hauled by the carriers interviewed included palletized cartons and 55-gallon drums. Only one carrier indicated that they transport hazmat in intermediate bulk containers.

Intermodal/International Shipments

Of the interviewees, only 15% of carriers were involved in intermodal hazmat shipments. Of the five carriers that were involved in international hazmat shipments, each indicated that hazmat transport is a very small portion of their total company operations.

Conversion of Paper to Electronic Shipping Documents

In general, carriers may convert paper shipping documents (shipper BOLs) to an electronic format during three main activities: prior to pickup, at the point of pickup, or when the driver returns to a company terminal. However, respondents indicated that TL carriers, the predominant carrier type in the United States, derived little benefit from converting hard copy shipping documents to an electronic format and were therefore the least likely to do so.

Over half of the respondent motor carriers (53%) converted at least some portion (respondents could not specify an exact percentage) of paper-based hazmat shipping documents to an electronic format prior to pickup. It should be noted this does not suggest that 53% of the respondent motor carriers were already using ESP. These carriers were more likely to represent the specialized sector. Conversely, 20% of carriers converted paper to an electronic format at the point of pickup, while a smaller percentage of carriers (13%) converted to electronic format when the driver returned to a company terminal. Another 13% of carriers never converted paper hazmat documents to an electronic format.

A large majority of carriers interviewed (87%) received at least some type of advance notification of a hazmat shipment. It should be noted that many of these carriers did not receive advance notice from all customers and all shipments, so this did not suggest that ESP were implemented for 87% of the respondent motor carriers. Slightly less than half (42%) of these carriers indicated receipt of advance shipment information for a very small number of shipments/customers, while an equal number of carriers (42%) noted receipt of advance hazmat information from a majority of customers.

The detailed level of information provided by shippers (and thus captured by a motor carrier's internal systems) prior to pickup and how the carrier received the advance notice varied significantly. In general, carriers noted that larger, more technologically sophisticated customers were much more likely to provide some type of advance shipment notice information. Carriers also noted that shippers transmitted advance notice for only certain types of hazmat commodities (e.g., propane).

Nearly two-thirds (64%) of carriers received advance shipment notification via e-mail, phone call, or fax. These methods of communication required carriers to manually enter hazmat information into back office systems if the carrier chose to do so. There were 27% that received advance notification for hazmat shipments via EDI/XML, while only one respondent indicated receiving this information via company website (where shippers could enter the information). One carrier noted that customers were strongly encouraged to send data via XML (as compared to EDI) since this data format greatly reduced the level of effort and subsequent costs of interfacing disparate shipper/carrier back office systems.

The level of detail contained in advance notices varied significantly. In some instances, detailed hazmat information was provided (e.g., hazmat class, United Nations number) although it was more common for shippers to provide general shipment information (e.g., pallet count, shipment weight). Of the carriers that did receive advance hazmat shipment information, a large majority (79%) required drivers to validate shipment information at the point of pickup. If no advance notice was sent to the carrier, carriers may not have required drivers to validate specific hazmat information.

At the point of pickup, over one-third (36%) of carriers required drivers to verify with back office personnel shipment level detail, while the remaining carriers (64%) required drivers to verify shipment information via an in-cab communication system that, in turn, communicated with back office personnel and IT systems.

Outside of the CBP's ACE system, only two carriers transmitted hazmat data to governmental entities. These included munitions-related information and hazardous waste shipment details/tonnage.

Very few carriers interviewed (2) had formal plans to improve the use of electronic hazmat shipment information. While the preferences of the two that had formal plans or the remainder who did not were not identified, it is noted in this mode's impediments discussion that follows that the two most significant issues noted in this regard were the challenges of driver data entry of hazmat information and the capital and recurring costs of equipping drivers with handheld devices to enter hazmat-related information. (It should be noted that no concept of an ESP system, particularly one requiring driver data entry, was either stated or implied during interviews; rather, some respondents inferred driver data entry based on their own conceptions of what a system might entail.)

Of those that planned to improve the use of electronic hazmat shipment information, carriers cited in-cab communication systems equipped with an onboard paper scanner. In such a scenario, the driver keys in the hazmat information from the shipper BOL upon pickup and then scans the shipper's BOL. The in-cab communication system next transmits an image of the hard copy BOL to the carrier's back office systems. Finally, back office personnel retrieve the image and verify that the driver correctly entered the shipment/hazmat information. Several carriers noted that the current economic environment precluded major technology investment initiatives.

Converting to ESP

Only one carrier (a large specialized carrier) had already converted to a system of ESP. This carrier received advance notification of shipments, which included detailed hazmat information, and required drivers to validate shipment information at the point of pickup. It should be noted that this carrier received advance shipment notification from shippers via phone or fax but not in other electronic forms.

Six respondents noted that to convert to an ESP system, the carrier needs to:

- Encourage shippers to provide detailed hazmat shipment in an EDI/XML format prior to pickup,
- Equip all tractors with in-cab communication systems,
- Require drivers to enter shipment data into the system, and
- Hire and train in-house hazmat experts to verify the driver's data entry.

In-cab communication systems were frequently cited as a key technology needed for carriers to obtain hazmat ESP at the point of pickup. Respondents seemed to focus on the pickup location as the primary place where they obtain the hazmat information. A wireless communication provider was also interviewed to gain insight into how carriers use, or could use, these systems to transmit or verify hazmat shipment information. The wireless vendor indicated that carriers have great flexibility in the types of information that they may require drivers to enter via the use of form messages. Form messages can consist of data entry fields restricted to certain formats/types of data or the designation of required fields (e.g., the hazmat class or UN number).

Impediments to Converting

Respondents noted that the most significant issues with or impediments to converting to the use of ESP is driver data entry of hazmat information and the capital and recurring costs of equipping drivers with handheld devices to enter hazmat-related information. Other impediments include:

- Training of full-time and part-time drivers,
- The need for increased technology at company cross-docks,
- Receiving accurate and timely information, and
- Inability of most customers to send accurate data prior to pickup.

Benefits of ESP

Carriers perceived that the benefits that would result from the use of hazmat ESP may include administrative cost reduction related to the handling, tracking, and filing of paper BOLs; improvements to data accuracy; and reconciliation of quantity discrepancies. (It should be noted that improvements in data accuracy may depend on who is entering the data. It is likely that drivers are not as good at this as shippers, who have more familiarity with the product.) Less commonly cited benefits included improved customer service, the potential to mitigate delivery quantity issues (bulk), and providing carriers with advance notice of types of hazmat the carrier will not haul prior to dispatching a driver to a pickup (e.g., radioactive materials).

Concerns with ESP

The top concerns identified by carriers over the use of ESP included:

- The availability of hazmat information during roadside inspections,
- Driver data entry accuracy and training,
- Determination of how responders in urban and rural locations retrieve the information,
- Protection of the confidentiality of carrier/shipper proprietary information, and
- Determination of which party is responsible for data integrity/accuracy.

One of the top concerns expressed by a respondent was the availability of electronic shipping documents during a carrier compliance review and/or roadside inspection.

Impact of Electronic Shipping Documents

Carriers cited that a mandate to use ESP will likely reduce the pool of carriers that can haul hazmat and reduce the number of shippers that can ship hazmat. Though several respondents noted that the use of electronic shipment documents could reduce administrative and/or operational costs, carriers generally perceived that these savings will be much less than the cost to implement and/or participate in such a system. In addition to significant capital costs, carriers felt that they would be subject to several recurring costs, including:

- Technology device maintenance, tracking, and upgrading;
- Additional labor costs of back office personnel to verify shipper advance notice and driver data entry accuracy; and
- Ongoing driver and back office personnel training programs.

Safety and Security

Eight of 15 respondents agreed that the use of ESP could improve the safety and security of hazmat transport. (It should be noted that the underlying reasons for the perception of these respondents that safety and, especially, security could be improved was not clear.) Most of these carriers, however, noted that safety and security improvements will likely be small. Most carriers were of the opinion that the current system of paper-based documents provides adequately for the safe and secure transport of hazmat shipments.

At least one respondent noted that potential areas of improvement include data accuracy and more accurate trailer placarding. In contrast, one respondent noted that this type of system will have the opposite effect on safety and security by providing terrorists with a tool to increase the accessibility of information related to hazmat shipments.

In general, respondents believed that there could be at least some benefit from the use of ESP in incident mitigation or as part of the emergency responder preparedness efforts. Benefits cited by carriers included:

- A reduction in the number of responders dispatched to a scene (and the subsequent cost of the response), and
- A backup in case the hard copy shipping paper with emergency response information is missing.

However, two carriers indicated that there would be no benefit to this type of system, stating that the information is already available in paper form and that during an incident, if responders contact the carrier, the information can be provided quickly.

Possible Implementation

The majority of respondents recommended that an ESP system should begin with the original shipper (not a 3PL). In this type of system, the shipper creates a record of the shipment in a centralized database or website. If the shipper is unable to transmit the data electronically, then the shipper enters the information via a centralized web portal.

As the shipment moves through the carrier's distribution system, the carrier updates the shipment record upon pickup with the appropriate carrier/trailer information or with any pertinent shipment quantity or type discrepancies. The carrier updates the shipment record via EDI or XML. Carriers unable to receive or transmit hazmat shipment data enter data manually via a centralized web portal.

Respondents cited several notable challenges to the feasibility of ESP. These challenges included the technological limitations of smaller carriers and shippers, the need to train a very large group of drivers, data format consistencies, and the accuracy of data provided by both shippers and drivers.

Next Steps

Carriers cited several actions that need to be conducted on the use of ESP. One of the most commonly cited actions was to develop a system for only the most volatile/dangerous hazmat commodities (for example, radioactive materials). Carriers voiced their opinion that there was little need for ESP for the large amounts of consumer-based hazmat commodities (for example, paint cans or hair spray). This recommendation was offered by a regulatory representative as well.

There was strong support for the use of cost–benefit analyses with the use of ESP. Carriers noted that incidents involving hazmat releases occur very infrequently and that current practices sufficiently address the need to provide responders with hazmat commodity information. Lastly, several carriers intimated that the use of ESP is akin to a solution looking for a problem based on historical data or precedents.

To determine the perspective of regulatory/enforcement personnel for implementing such a system, two interviews were conducted with representatives of a regulatory agency. These respondents recommended several potential actions that could facilitate the use of ESP:

- Data standards, agreements, and protocols need to be clearly defined;
- Requirements of the electronic documents need to be explicitly defined;
- Electronic shipping documents from the marine mode may be used, in some cases, for highway shipments; and
- A system that keeps proprietary information on a carrier's system may mitigate the industry's concern of inadvertent disclosure of proprietary/confidential information.

C-1.2 Rail Carriers

Introduction

One Class 1 railroad and a railroad industry group representing several Class 1 railroads were interviewed (facilitated by a rail trade association) to determine the extent of their use of electronic hazmat shipping information. The information that follows represents the practice of those railroads.

Current Practice

1. Hazmat shipments are a small percentage of total traffic on a shipment basis, in the 2% to 6% range for different carriers and around 5% of U.S. originating carloads in 2008. Rail ships any hazmat authorized in 49 CFR 172.01 except for infectious waste, although intermodal shipments may be further restricted by carriers. This includes more than 2,250 different chemical commodity codes encompassing over 1.57 million shipments.
2. Virtually all shipment information is now electronic and has been for years, supported by a no-fax rule.
3. Electronic information is received from offerors, various third parties, and interline partners for over 90% of shipments. All U.S., Canadian, and IMDG code regulations are accommodated in current ESP.
4. Information comes in as EDI 404 BOL (i.e., Rail Carrier Shipment Information Transaction Set 404) and has information on containers, trailers, and boxes. It is also possible to send a flat file and convert it to EDI. XML is used in other industry transactions but not in the BOL aspect.
5. The key electronic data are the Electronic Data Interchange Rail Carrier Shipment Information Transaction Set 404 (EDI 404 BOL), and the EDI Rail Carrier Waybill Interchange Transaction Set 417 (EDI Waybill). EDI 417 is how information is shared. The EDI 410 freight invoice is how the railroad gets paid (although alternatively there can be automatic bank withdrawals). Interchange Transaction Set 418 (Rail Advance Interchange Consist) is used to transmit advance information on equipment being

interchanged to a connection rail carrier, from a consignor, or to a consignee. However, hazmat information, where applicable, is transmitted in other EDI data sets.
6. There is no requirement to transmit shipment data to regulatory or government agencies. Providing paper copies to emergency response agencies has been tried, but the volume proved to be overwhelming.
7. When requested by local emergency response agencies, railroads provide commodity flow information for a minimum of the top 25 hazardous materials being transported through their jurisdictions.
8. Some paperwork is still required. Hard copy shipping documents are carried by train crews, who need them in order to respond accurately about cargo in the event of an accident/incident. A train list is provided to each crew, and they must have a copy showing what is on the train. They will also have information on scheduled pickups with location, car number, and hazmat information for that car. Otherwise, information is stored in the waybill file. Waybills are maintained for 3 years and train lists for 5 years, in an electronic file.
9. Information that can potentially be used by emergency responders is updated whenever a railcar with a hazmat shipment goes by an AEI CLM RFID reader.
10. There are security components in the electronic transmission systems to preclude unauthorized access to sending or displaying information. Response agencies getting information during an incident or response or planning agencies getting commodity flow information are vetted.
11. Rail uses the term "shipping paper"; to the rail industry, "manifest" is a term used for hazardous waste. Hazardous waste is an area where there is not sole EDI use. Attorneys require paper for hazardous waste, so there is a hybrid system. (Railroads consider this an anomaly because they haul substances that are more dangerous than hazardous waste.) Moving a railcar that is not in technical compliance also requires papers; a railroad must get movement approval and store the document.
12. The hazmat community trades information well because they do not want things to happen that tarnish their industry.
13. There are two levels of training: (1) hazmat awareness training, and (2) function-specific training. There are generally three major training costs associated with shipment papers: (1) cost service center employees, all of whom must get hazmat awareness training, (2) EDI users, who require function-specific and other specialized training, and (3) operators of equipment, who get training on hazmat shipping papers on a biennial basis. Operating managers and engineers must be trained on an annual basis. Training is also required for long-haul drivers that support railroads.
14. There is an EDI Technical Advisory Group (TAG) composed of hazmat and EDI programmer data specialists. The American Chemistry Council and the IAFC are involved with regulations for shipping description. International groups are involved in the TAG.
15. There is an EDI working committee. EDI standards are changing and are updated every 2 years or so.

Benefits

1. In general, the rail carriers' perceived advantage from the EDI was that one person inputs it and it is sent to everyone who needs it (including the regulatory and inspection side if requested).
2. The actual benefits experienced have been that there are no more hard copies that clerks have to file, search out, and retrieve. Now a record can be pulled up in less than a minute.
3. There is no need for large physical storage space for records.
4. Previously, in the days of paper, some percentage of papers was misfiled, which could be perplexing and waste resources. Now, if documents are lost or destroyed, they can be easily regenerated.
5. EDI provides for sharing data more quickly in an emergency response situation.
6. Rail industry estimates put the total cost of handling paper documentation for the 5% to 10% of shipments that currently come in that way at $11 to $22 million per year.

Concerns with ESP

1. The biggest remaining headache involved with record keeping is that with a large workforce, it is difficult to keep up with changes such as death, retirement, resignations, and so on. However, electronic media makes that better, not worse.
2. The rail industry is beyond the stage of dealing with impediments. There are no concerns with ESP, outside of inconvenience from the exceptions that still require handling paperwork.
3. The U.S. EPA is considering electronic hazardous waste manifests. There is concern that what they implement will not be compatible with the current railroad EDI system.

Issues

1. While it is certainly desirable that emergency response agencies have quick access to information when there has been an accident or incident, they generally may not want information on a day-to-day basis. The Class 1 railroad respondent mentioned a time when the railroad faxed information on pending hazmat shipments to enforcement agencies prior to the passage of a train carrying

hazmat through its areas of concern, and the enforcement agencies were overwhelmed by the sheer volume of that advance information.
2. There are multiple delivery modes, such as XML and EDIFACT, in addition to existing ANSI X12 standards, which are widely implemented worldwide.
3. Shipper education will help facilitate the implementation and use of ESP.

Conclusions

1. ESP are being widely and successfully used by the rail industry.
2. Rail carriers and other participants in rail shipments exchange information well.
3. Rail carriers would be pleased if the last remaining requirements for paper were to disappear, but there is a sense by some that hard copy information carried by the train crew is still desirable for supporting emergency response.

C-1.3 Air Carriers

Introduction

A number of domestic and foreign airlines, domestic and international airline industry groups, a pilot group, and federal regulators were interviewed about the use of ESP in the air transportation of hazmat.

Current Practices

1. Cargo carriers (members of a certain air carrier association) accept all classes of hazmat for shipment. Since some members operate in support of the U.S. military, they carry hazmat under exemptions that are not allowed in commercial operations. Other freighter operators accept all non-bulk hazmat, excluding most explosives, toxic gas, toxic inhalation hazards, and infectious substances. Passenger carriers' hazmat acceptance policies range from very minimal hazmat exceptions to carrying everything permissible under the hazardous materials regulations. For the smaller/more restrictive carriers, the most common and frequently tendered hazmat is dry ice. The "partially will-carry" passenger airlines typically will not accept Division 1: Explosives (except 1.4, small arms ammunition); Division 2.3 Poisonous Gases; Division 6.1 and 6.2: Toxic Materials and Infectious Substances; Division 7: Radioactive Materials; items forbidden for air shipping in Section 4.2, columns I and K of the IATA Dangerous Goods Regulations; or items forbidden per 49 CFR 173.21.
2. Manual processes are time-consuming, involving rechecking records, handling missing paperwork, and creating necessary manifest documentation. The airline acceptance checklist is manually prepared at the time of cargo acceptance. Much of that information could be provided electronically.
3. There is minimal electronic sharing of hazmat data to airlines. Information is taken at the time of booking and manually entered into airline systems. Electronic controls, load planning, and document creation occur through internal systems utilizing these data. The flight crew notification document is carried by the crew.
4. In general, most members of this air carrier association are not yet receiving electronic hazmat shipment data from supply chain participants. One of the major integrated carriers (all-cargo aircraft) does require its shippers to upload electronic hazmat information, and most of its customers use the carrier-supplied software to accomplish this task. Other shippers use third-party software to generate the required data. Larger shippers often have in-house systems that have been programmed to provide the required data.
5. Except for the automated integrated member carrier of this air carrier association, no paper to electronic conversion occurs. The automated carrier currently only uses electronic hazmat information for pilot notification (NOTOC or NOPIC) and internal airline emergency response. As such, the electronic data are verified during hazmat acceptance or, if not present, converted from paper to electronic at the dangerous goods acceptance location.
6. There is extensive sharing of electronic shipment manifest data (non-hazmat) that they receive or create; it is shared downstream with interlines, regulatory agencies, airports, forwarders, and cargo handlers.
7. Shipment data for both hazmat and non-hazmat consignments are submitted via the Automated Manifest System (AMS). AMS is a multi-modular cargo inventory control and release notification system that interfaces directly with Customs Cargo Selectivity and In-Bond systems, and indirectly with the Automated Broker Interface, allowing faster identification and release of low risk shipments. However, the international manifest data elements do not include any hazmat detail. Most carriers use electronic air waybill/shipment manifest data with shippers, forwarders, and regulatory agencies.
8. Access to electronically shared data is protected by a third-party provider.
9. Shipper-certified copies are not forwarded to truckers for on-forwarding. Certified copies stay with airlines. BOLs are provided to truckers.
10. Emergency response takes on a different dimension when in flight because accidents are usually catastrophic.
11. When a plane is diverted, the new arrival airport must receive the DGM.

12. This air carrier association supports the following electronic data standards:
    - IATA (EDI) Declaration for Dangerous Goods message
    - IATA Shipper's Declaration for Dangerous Goods-XML (SDDG-XML) message
    - The 2009–10 edition of the ICAO Technical Instruction and the 50th edition of the Dangerous Goods Regulations will allow EDI as an alternative to paper SDDG's. Countries that adopt the ICAO Technical Instruction by reference in national legislation will, by default, permit EDI in place of paper SDDGs.

Issues and Benefits of ESP

1. ESP will create efficiency and lower processing costs by eliminating entry processes and will enhance data sharing. The airline acceptance checklist takes several minutes to complete, and many of the items are redundant to data that will be available electronically.
2. Manual errors due to rekeying will be reduced.
3. Critical hazmat information could be accessed more readily and quickly provided there were a communications capability present (e.g., Internet signal and power).
4. Improved visibility improves safety and responsiveness.
5. Document handling will be more secure and the audit trail more effective.
6. Significant storage space will be freed.
7. This air carrier association has developed the e-freight program, which is an industry-wide initiative involving carriers, freight forwarders, ground handlers, shippers, and customs authorities. Benefits of electronic documents cited by the air carrier association's e-freight initiative include:
    - Faster supply chain transit times: The ability to send shipment documentation ahead of the cargo can reduce the industry cycle time by an average of 24 hours.
    - Greater accuracy: Allowing one-time electronic data entry at the point of origin. Electronic documents are also less likely to be misplaced. These reduce the likelihood of flight and cargo handling delays caused by missing or inaccurate paperwork.
    - Better results for the environment through reduced volume of paper.
8. If the data are dynamic, linked to the shipment, and easily accessible whenever needed, as opposed to existing only on a shipping paper, there are additional concerns about programming and software integration.

Concerns with ESP

1. One concern was with partial acceptance of electronic format. Some countries, smaller carriers, or interlined modes may not accept electronic formats. This would require most carriers involved in international or multimodal supply chains to maintain hard copy shipping papers, thus diminishing the benefits of automation. Partial industry acceptance will be difficult for shippers to deal with (knowing when a paper document is required and when it is not).
2. CBP requires both electronic manifest transmission (AMS) as well as hard copies of paperwork, and there is no automated export air manifest system for air cargo shipments in ACE. Until the regulators allow a fully automated system and eliminate redundant paper requirements, there is no real benefit to electronic sharing of manifest data.

Implementation and Operational Issues

1. Cargo manifests are extensive. If the manifests are in an electronic format, the responders must be able to quickly identify the dangerous goods, what they are, how much are onboard, and where they are located.
2. How will this information be presented to emergency responders?
3. There are concerns that the data will be monitored by regulators, who will issue fines if data are incomplete or inaccurate.
4. Interlining could be more difficult if some carriers use paper and some use electronic means.
5. Concerns with partial acceptance of the electronic format (also listed previously as an issue). Some countries, smaller carriers, or interlined modes may not accept electronic formats. This will require most carriers involved in international or multimodal supply chains to maintain paper, thus diminishing the benefits of automation. Partial industry acceptance will be difficult for shippers to deal with (knowing when a paper document is required and when it is not).
6. The industry is moving forward under the air carrier association's e-freight initiative. Electronic documentation had the support of all the survey respondents, who were hazmat—not IT—professionals. The air carrier association is taking a multimodal approach, attempting to replace common transportation documents such as BOLs, packing lists, and commercial invoices in formats that can be shared across modes.
7. ESP must be developed using a standard accepted by all modes. A regulatory or industry group—a muscular champion—is needed. This includes an accompanying process design that describes how the data are to be used.
8. The regulations will have to allow for the use of ESP, and shippers have to be motivated or required to make the switch to a standardized electronic format. Large shippers will struggle with making changes to internal systems. Carriers will have to modify or build new systems to handle the electronic information, costing both time and money.

9. Dual and redundant paper/electronic systems should not be maintained indefinitely.
10. Implementation cost is a concern, particularly if the approach requires extensive hardware and or software investment. System compatibility could be an issue as well.
11. The use of XML alternatives will lower the cost of adoption.
12. The solution needs to be low in cost and easily implemented.
13. One concern is whether there is a sufficient safety benefit in the air mode. How many times in a year do emergency responders use the information on a real-time basis (e.g., aircraft crash)? What weight is placed on the information (hazmat vs. fire when loss of life is the issue)? What is the practical value when location of contents may be impossible to discern?
14. One impediment is the need to make the documentation available to all parties in the chain of custody.
15. Air carriers have heard comments from some pilots, for example, that the current amount of information on the NOTOC/NOPIC is far too much to sort through to find the really dangerous shipments. Perhaps only providing that information for a subset of materials would be more beneficial.

Conclusions

1. Electronic receipt of shipment data is not very common in current air operations; however, it seems that a considerable amount of downstream data sharing takes place with interlines, regulatory agencies, airports, forwarders, and cargo handlers.
2. Considerable cost savings are possible.
3. Inconsistent use throughout the supply chain will hinder effectiveness and adoption, particularly with respect to interlining.
4. Implementation cost is a concern.
5. Current regulatory requirements preclude an economic benefit, since paper is still required (for inbound international shipments).
6. Cargo manifests are extensive, and an easy, quick way to find the relevant information is important.
7. Some question the relative safety benefit in the air mode as compared to other modes.

C-1.4 Ocean Carriers

Introduction

A number of steamship lines, industry groups, and federal regulators were interviewed about the use of ESP in the marine transportation of hazmat.

Current Practice

1. General use of electronic data sharing for ocean booking, manifesting, loading, and status is extensive. Its uses are operational, commercial, and regulatory.
2. Few shippers or intermediaries (e.g., NVOCCs) share hazmat data electronically. For the large majority of hazmat shipments, data are input manually. This can result in data inaccuracy, at the very least creating rework as booking records are checked by hazmat compliance teams. The cost of processing hazmat shipments is very high because of the manual data entry and management of hazmat shipments through the entire process. Respondents could not accurately identify total cost, however.
3. Hazmat cargo is a significant revenue producer for ocean carriers (between 8% and 20% for the respondents' companies).
4. Hazmat data are captured at the time of booking. Some carriers will have general booking agents capture the hazmat data. These will be checked by hazmat compliance teams, and some will route customers to hazmat booking specialists.
5. Carriers are required to complete a container placement certification for hazmat containers as part of the receiving process.
6. Hazmat data are captured in carriers' internal operating systems with special flags for document checks and vessel loading procedures. The booking record is checked against the documents presented when the cargo is delivered to the carrier. Hazmat vessel manifests (DCMs) are prepared. The manifests are required for the voyage—actual shipper hazmat certifications are not.
7. Hazmat data are shared with terminals and vessel-sharing partners and with regulatory agencies (e.g., CBP), but only those data having descriptions such as shipper's or UN number.
8. Hazmat data are shared with rail and truck carriers. There is not a requirement to provide the shipper's certification to forwarding carriers. The originating carrier is required to retain the shipper's certification and only report the necessary information to forwarding carriers. The hazmat data provided to rail and truck carriers from ocean carriers reside electronically in the ocean carriers' systems.
9. Railroads interline a significant portion of import ocean cargo. Railroad EDI standards require the hazmat STCC to be used instead of the UN number. This can cause data and instruction conflicts. Some ocean carriers do not send EDI to the railroads because of liability concerns over the instruction conflicts, while others do send EDI and have built UN-STCC reference tables into their internal systems. All ocean carrier respondents were vocal about the railroad industry sticking by a standard that does not

enhance intermodal data sharing and operational efficiency. The ocean industry feels the rail industry mandating EDI is counterproductive as long as railroads insist on STCC numbers. The ocean industry supports use of the UN number, which is broadly accepted by motor and air carriers.
10. The USCG requires pre-arrival notification of certain dangerous cargo (CDC) under 33 CFR 160.204. The CDC listing is not a comprehensive list of all hazmat items.
11. Ocean carriers provide extensive training to almost all functional areas in the business (anyone involved in documents, information, cargo, and sales).

Issues and Benefits

1. All respondents indicated involvement in, and support for, Vessel Operators Hazardous Materials Association (VOHMA) initiatives. (VOHMA subsequently changed to IVODGA.) One respondent referred to Impediments to Intermodal Transportation meetings as a reference source for issues related to data sharing. Respondents also referred to PHMSA for related initiatives.
2. ESP will lower administrative costs, generate environmental benefits, and improve accuracy and speed in processing shipments from booking to transfer to interlining truck and rail.

Concerns with ESP

1. A chief concern with electronic data access is the availability of data if power or Internet access are lost.
2. Lack of multimodal standards is a chief impediment to data sharing. The rail industry was singled out as an example.
3. Possible up-front hardware or software investment to move to a paperless environment is a concern.
4. Mandatory adoption is a concern since it might exclude arrangements with partners or interline carriers (mostly motor carriers) that lack the capability to support ESP. Cost of entry for small trucking companies, upon which ocean carriers rely, will also inhibit widespread adoption.
5. Data security is a concern.

Implementation and Operational Issues

1. The ocean carrier industry favors multimodal standards and is supportive of the IATA e-freight initiative. Lack of data standardization—particularly with rail—is a significant impediment to multimodal data sharing.
2. Ocean carriers are removed from the issues of drivers and roadway emergency responders—all respondents having long ago moved away from operating domestic trucking operations.
3. Recommendations ranged from a centralized service (like CHEMTREC) to web-enabled handheld devices for emergency responders.
4. The DoD U.S. Transportation Command will need to participate in sharing of electronic hazmat data. (They are not doing so today.)
5. Implementation must be multimodal. ESP must be developed using a standard accepted by all modes. The promotion and support of a regulatory or industry group is needed.
6. High tech and expensive solutions are the hardest to adopt widely. No one in the industry wants to bear the cost, and they are concerned about solutions that inhibit adoption in emerging countries and with smaller trucking companies.
7. Emergency responders need instant access to actionable information. They cannot sort through manifests looking for items of interest.

Conclusions

1. General use of electronic data sharing among the steamship lines for ocean booking, manifesting, loading, and status is extensive. However, much of the shipper-provided data are input manually.
2. Railroads interline a significant portion of import ocean cargo. Railroad EDI standards rely on commodity codes not used by steamship lines. The ocean transport industry supports use of the UN number, which is broadly accepted by motor and air carriers.
3. Data availability during power disruptions is a concern.
4. Lack of multimodal standards is a chief impediment to data sharing.
5. Data security is also a concern.

C-1.5 Emergency Responders

It should be noted that while the interviews did not request emergency response stakeholders to consider ESP as a replacement for hard copy shipping papers, some respondents nevertheless considered the tradeoffs that would arise if the situation were an either–or choice.

Important Shipment Information for Response to a (Potential) Hazmat Incident

Emergency response personnel at the national level who were contacted agreed that at the scene of an incident, it is important to have the ability to identify the hazmat present through various means, including shipping papers, placards, labels, and containers. In addition to the basic information required by regulation, it is also important to be able to iden-

tify the transporter and have the ability to contact either the shipper or transporter for more information.

While all of the respondents agreed that information accompanying hazmat shipments must identify the type of material, the type(s) of containers, the amount of material, and compatibility with other materials in the shipment, the needs of the first of four national emergency response organizations referenced reach beyond the initial incident. In the case of the first of these emergency responder organizations, the respondents wanted to have information regarding the care, custody, and control of the material in order to mitigate not only the incident, but any legal actions coming out of it. All respondents also agreed that the information must comply with the regulations.

The respondent from the second emergency responder organization indicated that GPS should be used to provide incident location, severity, and other information for use in formulating a proper response.

Typical Process for Obtaining Hazmat Information

There was agreement that placards, labels, and shipping papers are the primary sources of information for responders. No advance shipment information is accessible (or legally mandated) at this time. Pre-notification of hazmat shipments has been preempted on many occasions over the years.

There are mechanisms in place today for emergency responders to gather additional information on the scene. These include contacting the shipper or transporter of the material and contacting emergency response information providers such as CHEMTREC.

The respondent from the first emergency responder organization expressed the opinion that in the future, it may be possible to have a memory stick device on the transportation vehicle that can be accessed for MSDS and ESP information through the use of a wireless reader.

Process for Dealing with Missing Shipping Information

When hard copy shipping papers are not available, emergency responders use visual cues. Shipping papers are one part of the identification system that includes shipping papers, placards, markings, labels, containers (i.e., in the case of bulk shipments), emergency response information, and emergency response telephone numbers per 49 CFR Part 172. Firefighters and other responders are aware that it is a multifaceted system designed to provide multiple means of identification.

Again, when shipping papers are not available, emergency response personnel can make calls to the transportation company or to CHEMTREC for information.

The respondent from the third emergency responder organization stated that in many cases when shipping papers are not available, response time is delayed while information is being obtained.

Issues

All respondents to a question about modal differences in benefits and concerns agreed that all modes would pose the same concerns and/or advantages. Only the regulatory structures would be different, not the response to an incident.

Benefits

While the third emergency responder organization was not in favor of eliminating paper copies of shipping papers, other response organizations saw improved response times and more accurate information from ESP.

A representative of the fourth emergency responder organization believed that providing electronic shipping data on hazmat would be beneficial for emergency responders because in cases where the driver is incapacitated, an emergency responder sometimes cannot get close enough to the vehicle to read the shipping papers. ESP would provide the opportunity to learn about the quantity and type of material involved in the shipment from a more remote, safer location.

One respondent looked beyond the benefits of ESP for emergency response and cited improvements in the settlement of claims and mitigation of lawsuits arising from the incident as benefits also.

Concerns with ESP

The third emergency responder organization was concerned about inaccessibility to ESP due to the fact that not all responders have mobile capability to access the Internet. This could be due to budgetary restraints or to the incident occurring in an area without wireless signals.

The third national responder organization also feared system outage and failure at the most critical times should the network be overloaded. Should the system fail during the response to an incident, then the responder would be in a worse situation than having to rely on paper copies of shipping papers and other visual clues. Additionally, there is a fear that the system would not keep the information current.

The respondent from the second emergency responder organization saw no concerns, while the first national emergency response organization cited the possibility of security problems.

The third emergency responder organization expressed concern that if both hard copy and electronic forms of shipping papers were available, the information might not match. If the information did not match, then there would be further

delays in the incident mitigation due to the fact that the verification process would take additional time.

The other two respondents saw no special concerns.

Information Needed to Determine which Type of Shipping Paper Was in Use

The third emergency responder organization wanted to retain use of the hard copy or shipping paper; therefore, no additional information needed to be determined as to what format the shipping paper should be in.

One respondent did not answer this question, and the other would like to see a system in which the hazmat vehicles are monitored electronically from a distance. If no information comes up, then follow-up measures would be taken to gather the needed information.

Communication Equipment Available in the Field

The third emergency responder organization stated that communications equipment availability and access to needed databases varies by jurisdiction and department. They restated their position of not endorsing the use of ESP in place of the paper form.

The respondent from the second emergency responder organization stated that a laptop is all that a responder would need to access ESP and that emergency responders typically have wireless connectivity.

The respondent from the first emergency responder organization stated that laptops are broadly available, but with limited connectivity from police systems, so there will be obstacles to overcome should the information be computer-based only.

The respondent from the first emergency responder organization was the only one to address cell phones and PDAs. He stated that most agencies will have access to cell phones but not PDAs. He further stated that at least one person at the scene of every incident is equipped with a cell phone.

The respondent from the first emergency responder organization commented that, while all emergency response agencies (including the police and fire departments) have radios, most do not communicate well with one another.

Preferences for Receiving Electronic Information

The third emergency responder organization wanted paper copies. However, the second emergency responder organization wanted the information via the web on a computer. The first emergency responder organization wanted electronic tagging of the vehicle in order to pull relevant information through scanning.

Conclusions

All respondents agreed that, at the scene of an incident, it is important to have the ability to identify the hazmat present through various means, including shipping papers, placards, labels, and containers. In addition to the basic information required by regulation, it is also important to be able to identify the transporter and have the ability to contact either the shipper or transporter for more information.

The third emergency responder organization was adamant in its response to the question of ESP potential. Its representative expressed grave concern over a carrier having the ability to choose electronics over paper. While the organization had no problem with a carrier having both, they nevertheless felt that this could lead to confusion should there be variances in the information contained on the hard copy shipping paper versus the electronic information.

The other respondents were very much in favor of ESP for a number of reasons, including ease of obtaining information, accuracy, the ability to expedite mitigation of the incident, and resolution of disputes and claims. It was expressed that lives and property could be saved due to this perceived increase in speed.

The third emergency responder organization stated that not all jurisdictions have access to electronic technology. This could be due to budgetary constraints or merely to the fact that no broadband connectivity is available, such as in remote areas. This again pointed to the third emergency responder organization's reluctance to endorse the use of ESP in lieu of paper shipping papers.

The other respondents did not express this concern. In fact, they felt that ESP would pose no problems at all and that most have some type of connectivity through the use of cell phones and computers. The computer would be more limited due to constraints imposed by the jurisdiction and/or agency.

It was apparent that there was a divide in opinion between the third emergency responder organization and the other respondents. The third emergency responder organization definitely opposed the allowance of ESP as the only means of hazmat documentation, while the other two respondents clearly supported migration to electronic identification of hazmat shipments.

C-1.6 Roadside Enforcement Officers

Current Practice

A roadside enforcement/inspection organization that was interviewed stated that it currently depends on the presence of hard copy shipping papers to enforce provisions of the HMR since that is the only method allowed today. However, they have been involved in a number of studies geared toward the use of electronic data exchange, including the following:

- Northrop-Grumman: Hazardous materials emergency preparedness study, in conjunction with Volvo and the Spill Center;
- FMCSA/Battelle: Hazardous materials safety and security operational test;
- DOE/University of Nevada–Las Vegas: Radioactive materials truck tracking study;
- VOHMA's (IVODGA's) EDI project; and
- PHMSA's ESP forum (i.e., HM-ACCESS).

While active in this area, the members of this roadside enforcement/inspection organization had not developed a formal position on the use of ESP.

Benefits

The main benefit for enforcement, should ESP be allowed, is that the accessibility aspect of the regulations would virtually disappear. Roadside enforcement would not have to rely on the driver providing the paperwork since it would be available online.

Concerns with ESP

There were several concerns, including:

- Data quality: The information received by the roadside inspector is only as good as the data entered. Also, there is a question as to the timeliness of the data at point of inspection or incident, especially in the LTL segment of the motor carrier industry.
- Accessibility: There is concern that, should the system be down, the information would be inaccessible for a time. This was a real concern due to the nature of computers and electronics in general. Additionally, in some areas, connectivity is either limited or nonexistent. In those areas, inspectors would be at a loss to verify shipment information. Another concern was related to how an inspector would determine which vehicles are using ESP and which are using hard copy shipping papers.
- Data format: Whatever the format, it needs to be consistent across the board, and it needs to be secure.

Issues

The roadside enforcement/inspection organization stated several issues:

- Safety and security: While no real concerns were seen regarding inspector safety, there was a concern over the security of the information, especially when transporting security-sensitive hazmat. It was thought that "if law enforcement can gain access to the information, so too can those who should not have access." Fear of the system being hacked to gain this information for nefarious purposes is real.
- Incident mitigation: This could be affected either positively or negatively, depending on whether an inspector or emergency responder has a means to identify whether the transporter uses ESP. Otherwise, if a driver of a motor vehicle, for example, is unconscious or otherwise unable to provide information to the responder, then the responder is left in the dark as to whether to look for hard copy shipping papers or attempt to obtain electronic versions. This step could cost valuable time in the overall response to and mitigation of the incident.
- Emergency response preparedness: Inspectors of this roadside enforcement/inspection organization believed that there would be no impact from ESP on emergency response preparedness due to the fact that hazmat shipment pre-notification is not required. (Nor did the roadside enforcement/inspection organization endorse implementation of this practice.) Incident mitigation, however, could be enhanced as long as the data were timely, standardized, accurate, and in compliance with the HMR.
- Impediments to implementation: Due to the cost of converting transporters' computer systems to supply the necessary data, members of the roadside enforcement/inspection organization felt that use of ESP would not be widespread. Also, concerns over the security of proprietary information has hindered past efforts (Operation Respond, for one) to get the motor carrier industry involved in electronic information sharing. They saw no change in that attitude from the trucking industry at this point.

There will also be implementation costs for states and localities to enable readers, scanners, and other devices necessary to identify users of ESP, and then to actually access that information. Many jurisdictions do not have the funds, especially in today's environment, to implement such systems.

Conclusions

1. This roadside enforcement/inspection organization did not have a formal policy at this time.
2. This roadside enforcement/inspection organization did not oppose use of ESP as a method of supplying shipment information.
3. Information standards and communication protocols must be standardized.
4. There needs to be a process for identifying carriers using ESP versus those that are using paper versions.
5. In areas of diminished or no connectivity, there needs to be means of access to shipment information.

6. No one mode of transportation poses any advantage or additional risk to inspectors should ESP be allowed in lieu of paper shipping papers.
7. Implementation and widespread use of ESP will be hampered by costs associated with the computer system and programming and due to the fear by carriers of loss of proprietary information to competitors or the criminal element.

C-2 Observations

C-2.1 Effective Practices

This section summarizes the best practices in implementing freight management systems. There are a number of good examples in use today.

Both Bolero and TradeNet are active global electronic supply chain management systems in widespread use throughout the world. Other more localized examples are the Columbus Electronic Freight Management system deployment test (U.S. Department of Transportation, Research and Innovative Technology Administration, Benefits Database Summary, Columbus Electronic Fright Management system benefits, http://www.itslessons.its.dot.gov/its/benecost.nsf/ID/E875B84CA305ECBD8525756A00675FEA?OpenDocument&Query=BOTM) and the Kansas City SmartPort Trade Data Exchange initiative (Kansas City SmartPort, http://www.kcsmartport.com/about/about.php).

IATA is the air transport industry's global trade association. With 230 members in more than 130 countries, IATA represents 93% of international scheduled traffic. IATA e-freight is an industry-wide program that aims to reduce the use of paper documents in the airfreight supply chain by moving to a simpler, paper-free, electronic environment. It involves airlines, shippers, freight forwarders, ground handling agents, and customs authorities, among others. The IATA e-freight initiative provides tools for accomplishing electronic data transactions and replacing paper documents with electronic messages.

The current EDI implementation on U.S. Class 1 railroads is a system that has been in place for many years; its electronic data sharing is providing benefits that are valued by those carriers, although other transportation modes find that rail uses a standard that does not enhance intermodal data sharing and operational efficiency. Certain segments of the ocean shipping industry also make extensive use of electronic data sharing, but not necessarily including all the information needed to support ESP. Hazmat data, though, are shared with terminals and regulatory agencies such as CBP and, for some materials, with the USCG.

Among these systems, there is not one that is universally recognized as having the attributes that could allow it to be currently embraced by the variety of stakeholders, with their differing needs, that are considering the utility of ESP as an alternative to hard copy shipping documents.

C-2.2 Benefits and Impediments

Benefits and impediments of ESP as an alternative to hard copy shipping papers are discussed specifically in Subsections 2.3.1.1 and 2.3.1.2, respectively.

APPENDIX D

Technology That Can Benefit Stand-Off Detection of ESP by Emergency Response and Regulatory Personnel

There is a technology that many emergency responders and carriers already have and that many others will obtain in the near future that could be capable of providing remote reading of ESP information. This technology could be incorporated into a concept for an initial system that would be designed to retrieve emergency response and regulatory compliance/enforcement information from hazmat vehicles from a distance. This could be possible even with vehicles owned by small operations with legacy equipment and relatively limited electronic commerce capabilities. A system based on this concept could provide benefits until such time as a more comprehensive program such as the U.S. DOT Dynamic Mobility Applications program attains functionally similar capability.

During the research, this technology development was noted to have potential for facilitating stand-off detection of hazmat contents in the near-term. It would capitalize on a wireless capability that industry is already advancing. The wireless technology is based on the IEEE 802.11n standard that is found in new electronic devices such as laptop computers, PDAs, and smartphones. Thus, it capitalizes on COTS hardware and software that many emergency response, regulatory compliance, and law enforcement officials already have. The concept can work for a shipment that changes vehicles, changes modes, and crosses international borders. The conceptual system is meant for surface modes of transportation. Its capability cannot be used for hazmat emergency response or regulatory compliance without further research and development.

This technology could be implemented through a solution that uses a data repository that would be much less resource-intensive than a central database. Its implementation could be limited to only the most dangerous types of hazmat, such as PIH/TIH. In this concept, a shipper initiating a placarded hazmat shipment for surface transportation would communicate with the initial carrier and enter into this data repository (i.e., temporarily store) the shipment's ESP and associated emergency response information linked to the transporting vehicle. Any of the three data intake methods discussed in Section 3.7 (scanned electronic copies, web portal, and electronic submission) could be used for ESP entry to the data repository, allowing basic legacy resources of small operations to be used as well as more sophisticated means. In the data repository, the shipment would be associated with the unique ID of a low-cost WiFi transponder affixed to the power unit (e.g., truck tractor, locomotive, tugboat) for the shipment. The WiFi transponder automatically and frequently (e.g., every 4 minutes) transmits its unique ID, which is the only information it would be capable of transmitting. The ESP information would thus be correlated with one and only one power unit ID that allows it to be quickly identified.

If the power unit transporting that hazmat shipment is involved in a serious accident or incident, its operator may be incapacitated and the vehicle may not be approachable due to conditions on the ground. Consequently, the hard copy shipping papers with emergency response information cannot be retrieved. The placard may not be visible even with binoculars due to darkness, fire, smoke, fog, brush, vehicle structural damage, or position. In that case, the unique ID transmitted by the power unit's WiFi transponder can be detected regardless of visibility or weather at a stand-off distance of up to 250 meters by an emergency PC, PDA, or smartphone. (It is recognized that the *Emergency Response Guidebook* calls for much greater isolation and/or protective action distances for spills of certain chemicals.) Emergency responders, using the unique ID of the hazmat shipment's power unit, could call up the ESP information for the shipment online and retrieve it from the data repository. The same information could be remotely accessed the same way for a regulatory compliance inspection or enforcement need.

No information on the contents of the hazmat shipment itself or proprietary information such as its origin, destination, or customer would be electronically available at the vehicle. Rather, ESP information on the shipment could only be accessed by emergency response, regulatory compliance, and law enforcement officials on an authorized, need-to-know

basis. When the shipment is located in the data repository, its ESP information could be downloaded and printed if a printer is available. In the event of a serious accident/incident, emergency responders would be able to know at a distance what hazmat substance they are dealing with. That awareness could buy them precious minutes of reaction time and enable them to make more informed decisions about what to do next (e.g., conduct a local evacuation) and other actions.

When an en route placarded hazmat shipment is transferred to another participating carrier, the second carrier would—on its own or through communication with the shipper—ensure that its ESP power unit ID association is entered into the data repository. The original carrier will either repurpose its power unit and re-enter the ID, now associated with new information (effectively deleting the previous power unit ID record), or, if not immediately reallocated, allow the ID association to time out and expire. This re-assignment could continue through a series of shipment transfers (including intermodal transfers) until the shipment is delivered to the consignee. When a new ESP power unit ID association is entered before the old one expires, the data repository would default to the new pairing and automatically delete the old one.

Potential top-level advantages include:

- More rapid access to hazmat shipping paper information for emergency responders during an incident;
- More efficient identification of shipping information by regulatory compliance/enforcement personnel on a need-to-know basis;
- Reduced injuries, fatalities, and property damage related to serious hazmat incidents; and
- Reduced carrier/shipper liability from an incident.

This conceptual system recognizes the special place held by emergency responders and motor carriers. The importance of emergency responders is clear in the HMCRP Project 05 SOW. The importance of motor carriers is implied by the large number of hazmat shipments transported by them, the relative geographic freedom within which those shipments move, and the much greater number of power units (tractors) for WiFi transponder placement than larger power units such as locomotives or tugboats. A motor carrier with 20 or fewer vehicles likely has only simple communication systems, but even small carriers should be able to work with the envisioned system.

This capability has the potential to help protect the health and safety of the responders and the public. It can help reduce the exposure of responders to unexpected releases of toxic materials as well as to boiling liquid expanding vapor explosions (BLEVEs) and other types of explosions by knowing what substance or combination of substances emergency responders are facing. With better information, emergency responders will also be able to more effectively conduct evacuations of at-risk populations in the vicinity of an incident. Although difficult to quantify, reductions in injuries and fatalities associated with more rapid and effective response to incidents could have tangible benefits for a number of stakeholders.

Finally, two of the three envisioned ESP data repository access methods envisioned could enable vehicle enforcement/compliance officials inspecting the contents of a hazmat vehicle to improve the accuracy and speed of their reporting. This could be accomplished by obtaining an electronic copy of the shipping papers for the vehicle being inspected and quickly entering this information in their report. This should also enable the vehicle operator to realize a time savings and consequent cost savings that would result from a shorter inspection period.

Abbreviations and acronyms used without definitions in TRB publications:

AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation