

Model Education Curricula and Toolkit for the Transportation of Hazardous Materials

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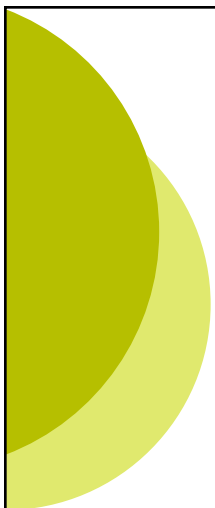
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HMCRP

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Model Education Curricula and Toolkit for the Transportation of Hazardous Materials

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ABSTRACT

The objective of this project was to develop model post-secondary education curricula that address the knowledge, skills, and abilities needed for the safe, secure, and efficient transportation of hazardous materials (hazmat). Over 170 existing hazmat-related education and training programs and other resources offered by industry and government were identified and evaluated, to assess the state of the art and to locate materials that might be used in the model curricula. Stakeholder groups who would benefit from hazmat transportation education were identified and defined, and draft materials were developed around a set of topics to meet stakeholder needs. The draft curricula were reviewed at a peer exchange workshop involving approximately fifty stakeholders, representing various interests in hazmat transportation. The final model curricula, presented in the form of a toolkit that can be adapted for different audiences and educational purposes, consist of PowerPoint presentations and supporting materials covering eight topics: introduction to hazmat transportation; hazmat logistics; legal and regulatory environment; mode and route selection; risk management; hazmat transportation incident management; security of hazmat transportation shipments; and workforce development issues. The report considers barriers to implementation of the model curricula, and proposes follow-up activities to help overcome them.

SUMMARY

Hazardous materials (hazmat) have a critical role in the nation's industry and commerce, and there is a need to ensure that hazmat transportation occurs safely, securely, and efficiently. Despite the importance of this activity, there has been little coverage of this topic in post-secondary education curricula in the United States. Hence the objective of this research was to develop model post-secondary education curricula that address the knowledge, skills, and abilities needed by the public and private sectors for the safe, secure, and efficient transportation of hazardous materials.

Over 170 existing hazmat-related education and training programs and other resources offered by industry and government were identified and evaluated, both to assess the state of the art, and to locate materials that might be used in the model curricula. The research found no organized hazmat transportation post secondary *education* curricula, and only a few courses devoted entirely to the subject. There is even a dearth of course modules on hazmat transportation. The most extensive educational resources related to hazmat transportation are for fire services and other emergency responders.

A large number of hazmat transportation *training* courses are available, largely focused on two topics: 1) regulatory compliance and 2) emergency response. There are also a large number of non-hazmat specific training courses, and some higher education courses, on emergency management, typically with an all-hazards approach. Large quantities of applicable training and research materials are available, from both public and private sources.

The topics that should be included in a comprehensive hazmat transportation curriculum may be organized into the following broad areas:

- Introduction—hazardous materials and societal needs
- Hazmat transportation logistics
- Hazmat laws and regulations
- Hazmat mode and route selection
- Hazmat risk management
- Hazmat transportation incident management
- Security of hazmat transportation shipments

A review was conducted of how well the available educational materials address these topics. It was found that the focus of much of the material is on the properties of the hazardous materials being packaged and shipped, regulatory requirements, and response to incidents. Lacking is general understanding of transport safety and security, including the considerations involved in mode and route selection. Even less understanding exists for the role of hazardous materials transport in society, the associated risks, and need for planning and transportation infrastructure considerations in moving these products throughout the distribution system.

More than a dozen stakeholder groups would benefit from formal study of hazmat transportation. These groups include shippers, carriers, other transportation and distribution workers, federal, state, and local officials, emergency responders, and others. The appropriate depth of coverage of

each topic for each stakeholder group, and by extension the related educational objectives, differ. The educational resources found in the review of current practice were used to develop draft curricula modules to meet the needs of these stakeholders, following the topical outline given above.

The draft model curricula for hazmat transportation post-secondary education were reviewed and evaluated at a one-day peer exchange workshop at the National Academies' Beckman Center in Irvine, California. Approximately fifty stakeholders, representing various interests in hazmat transportation, participated. The workshop participants were actively engaged and provided more than 80 pages of comments and suggestions. There was considerable support for revising and finalizing the curricula, and a directive to focus on the module content as the most valuable research product.

The curricula modules were extensively revised following guidance received from the peer exchange workshop. In addition an eighth module, on hazmat transportation workforce development issues, was prepared. The production of the final modules was guided by a strategy of designing the project output as a *toolkit* that could be used by educators to develop hazmat transportation content for a variety of courses and venues.

The revised curricula were prepared as separate instructional modules, organized in PowerPoint format. The PowerPoint slides for the final modules are available on the webpage for HMCRP Web-Only Document 2 (<http://www.trb.org/Main/Blurbs/169272.aspx>). See also Appendices E, F, G, and H for supplemental material.

In summary, this research produced a set of hazardous materials education curricula materials that are useful in a wide variety of educational settings. Peer review of the material was an essential element of achieving this result. The topics cover most of what educators and industry executives desire for educating current and future hazmat transportation employees.

There are, however, significant barriers to adoption of the hazmat transportation education toolkit, including lack of a permanent custodian and no recognized path to professional certification as part of an integrated education and professional development program. The following recommended further effort would help to overcome these barriers:

- Conduct a market analysis of prospective adopters.
- Promote the toolkit for hazmat transportation education to potential users.
- Organize a hazmat transportation education working group to facilitate curricula adoption and evolution, track curricula usage, and serve as the toolkit custodian and champion.
- Provide additional supporting materials for each module, such as student guide, exercises, examinations, etc.
- Support initial academic offerings at one or more universities.
- Produce and offer one or more executive education sessions.

The products of this research initiative will gradually become outdated and stale, absent an entity to serve as the “owner” of the curricula. The owner would provide leadership and technical support to update the toolkit content, facilitate course offerings, attract students, provide ongoing user support, and promote the success of the products. Identifying and perhaps funding someone to fill this “owner” role is the single largest obstacle to successful deployment.

CHAPTER 1

INTRODUCTION

The objective of this research was to develop model post-secondary education curricula that address the knowledge, skills, and abilities needed by the public and private sectors for the safe, secure, and efficient transportation of hazardous materials (hazmat).

Hazardous materials have a critical role in the nation’s industry and commerce, and there is a need to ensure that hazmat transportation occurs safely, securely, and efficiently. Despite the importance of this activity, there has been little coverage of this topic in post-secondary education curricula in the United States. The formal instruction that does exist is focused primarily on training shipper and transportation company operations personnel in how to conduct hazmat transport safely within the current regulations, and training emergency responders for incident management. Others with key responsibilities for hazmat transportation have access to less training and virtually no “education.” They include corporate managers; supply chain professionals; transportation officials in the public sector; and other public officials involved in planning, enforcement, and economic development. As a result, employees with responsibility for ensuring the safe, secure and efficient transportation of hazmat typically must learn the requirements through on-the-job training. Few higher education programs address proactive and sound management principles and strategies. Further, as the current cadre in industry and government with hazmat transportation expertise retires from active employment, a knowledge gap in the workforce must be addressed.

This report is organized around the six major stages of the research, as follows:

- Review literature and other sources to assess current industry and government practices and the availability of hazmat transportation education materials
- Develop draft curricula to meet the educational needs of the various hazmat transportation stakeholder groups
- Assess gaps and constraints for hazmat transportation education
- Obtain input from key stakeholders through a peer exchange workshop
- Develop of a set of educational materials organized in the form of a toolkit for hazardous materials transportation education
- Identify and analyze curricula implementation strategies

The results of completing these research tasks are presented in the ensuing chapters, and the final curricula materials accompany this report.

CHAPTER 2

CURRENT INDUSTRY AND GOVERNMENT PRACTICES

RESEARCH PROCESS

Existing education and training programs related to the safe, secure and efficient transportation of hazardous materials were identified and evaluated. A review of these programs provided a benchmark of the types and content of offerings that are available.

A key factor to this review was to understand the differences (and overlaps) between hazmat “education” and “training.” The latter provides trainees with the knowledge, skills, and abilities to perform fairly narrowly defined tasks, through application of proven and tested job performance methods. This—and rightly so—is the province of most of the programs that provide instruction in hazmat transportation and incident response. Education, on the other hand, provides program graduates with a deeper understanding of fundamentals that enables them to appreciate the reasoning and factors that lie behind current job methods, the strengths and weaknesses of current methods, and the latest research results that may produce future improvements. The *educated* hazmat transportation professional is able to promulgate programs that maximize safety, security and efficiency and minimize operational risk; lead and manage the use of human and other resources for hazmat operations and incident response; and develop and implement improved hazmat transportation technologies and processes.

While the focus of this research initiative was on education, existing training programs were not ignored. As discussed below, a number of excellent training modules and approaches were identified and subsequently incorporated in the educational curricula.

Potential sources of information were identified through internet and literature sources. Promising leads were followed up via e-mail and telephone contact. Information was also gathered at the 2012 Annual Meeting of the Transportation Research Board, and at meetings with the Tennessee Emergency Management Agency, and the Executive Board of the Intermodal Freight Transportation Institute at the University of Memphis.

The search for relevant information was divided into the categories listed in Table 1. Overall, over 170 potential sources were reviewed, with the vast majority consider useful in some capacity. Of these, a documentation form was completed and entered it into an interactive database to facilitate subsequent analysis.

Table 1. Categories of Education Programs and Resources

<p>University Programs</p> <ul style="list-style-type: none">Engineering and Environmental ScienceBusiness, Law, and Emergency ManagementPublic Policy, Public Health, Community Colleges, and Other <p>Public Agencies</p> <ul style="list-style-type: none">U.S. Department of TransportationDepartment of DefenseDepartment of Homeland SecurityDepartment of EnergyEnvironmental Protection AgencyState-Supported Training for Emergency Responders <p>Private Sector</p> <ul style="list-style-type: none">Trade Association Educational ProgramsPrivate Companies <p>TRB Cooperative Research Programs and TRID</p>

RESEARCH RESULTS

The education and training resources found in each search area are discussed in the following sections. The sources that were reviewed are listed in Appendix A; references to potentially useful materials are provided in Appendix B.

University Programs: Engineering and Environmental Science

Contacts were initiated with twenty-five universities identified as potentially having course offerings that covered hazardous materials transportation topics. The only full courses devoted entirely to hazmat transportation were found at the University of New Mexico (UNM) and the University of Nevada, Las Vegas (UNLV). The UNM course, CE 584, Transportation of Hazardous Materials, was formerly taught in the Civil Engineering Department. Topics covered included accident analysis, routing, risk assessment, community preparedness, and emergency response. However, the course was last taught in 2005, and the professor is now retired. A similar course, CEE 766, Analysis of Hazardous Materials Transportation was offered at UNLV, but the professor who taught it relocated to another institution and has not offered the course at his new location. The brochure for a new Master of Science in Transportation degree at South Carolina State University lists an elective course, TRP 634, Hazardous Material Transportation and Risk Management, but no further details are available, as this is likely a planned course yet to be taught.

The Arizona State University Environmental Technology and Management Program teaches ETM 401, Hazardous Waste Management. The course is focused on the regulatory requirements and prudent management practices for managing hazardous waste. Course topics include: RCRA and DOT definitions of hazardous waste and materials; modes of transportation; transportation incidents; DOT and EPA regulations; packaging; DOT Hazardous Materials Table; labeling, placarding and marking of hazardous waste and materials; shipping papers; reportable quantities; and hazardous waste discharges. This content is essentially an academic version of the regulatory compliance training that is widely available (as will be seen in a later section below). The program also teaches a course on Chemistry of Hazardous Materials.

The Michigan State University School of Packaging offers PKG 477, Hazardous Materials Packaging. The course objective is to develop an understanding of hazardous materials packaging from the package developer point of view. Topics include Title 49 of the U.S. Code of Federal Regulations, product classes, use of regulations, exceptions, authorized packaging, and the performance testing program.

The George Mason University Department of Civil, Environmental, and Infrastructure Engineering offers CEIE 686, Transportation System Security and Safety. Several lectures in the course are devoted to hazmat transportation topics, including security of truck, rail, and pipeline shipments, and an overview of hazmat transportation safety and regulatory compliance. Somewhat surprisingly, no other similar course modules were found at other universities, although it is likely that a few others do exist.

The Department of Environmental Health Sciences at the University of South Carolina offers two 3-credit graduate courses, ENHS 788,789, Concepts of Hazardous Materials Management I, II. Topics covered include: chemical and physical properties of hazardous materials; environmental effects; statutes and regulations; classification; use and storage; disposal options; transportation requirements; site safety considerations; and management systems involving hazardous materials. Some other graduate programs in environmental science likely have similar courses, but this material is not as applicable for this research project as that from other sources, so little effort was expended to find other examples.

University Programs: Business, Law, and Emergency Management

Twelve graduate business education programs at universities known to have an excellent reputation for their courses in the transportation field were contacted to elicit information on current courses, course modules, or executive education offerings with hazmat transportation content. Not a single positive response was received. Apparently business schools, even those with a strong transportation and logistics bent, do not offer education on hazmat transport. While not much content was expected, it was somewhat surprising to find absolutely nothing in the way of existing business school coursework.

A bit more success was found in the area of legal studies. Penn State University offers Business Law 425, Business and Environmental Regulation, which includes a course module on regulating the transportation and storage of hazardous materials. The St. John's University School of Law teaches Environmental Law 1010, Environmental Regulation of Toxic and Hazardous Substances, which includes a topic on hazardous waste transportation and management. It is likely that law courses at other universities have similar content.

The American Public University System, comprising American Public University (APU) and American Military University (AMU), offers online hazmat courses used in undergraduate and graduate degree programs in transportation and logistics, reverse logistics, emergency and disaster management, and fire science management, as well as various undergraduate and graduate certificate programs. Five APU/AMU courses that seem potentially useful are described in Table 2. Links are provided in the table for more information about each course, and copies of syllabi from previous semesters are available for four of the five courses. EDMG 330, Managerial Issues in Hazardous Materials, appears to use the National Fire Academy FESHE-approved curriculum.

The Federal Emergency Management Agency (FEMA) has compiled a list of 465 higher education programs in the general area of emergency management. As of May 2013, this list included 257 Emergency Management programs, 131 US Homeland Security/Defense and Terrorism programs, 16 US International Disaster Relief/Humanitarian Assistance Programs, 31 Public Health, Medical and Related Programs, and 30 other related programs (Appendix C provides some additional details). The vast majority of these programs do not feature education in hazmat transportation. The emergency management programs at North Dakota State University and Oklahoma State University are typical. They focus on disaster planning and recovery and terrorism, but do not have courses devoted to hazmat transportation. Some exceptions were found, however, as noted below.

Table 2. Selected APU/AMU Courses Offered by American Public University

Course	Description	Links
TLMT 318 Hazardous Materials Transportation	A study of the preparation, transportation, packaging, delivery and training required to prepare hazardous materials. Course topics include container, vehicular, storage, mode, onload/offload, and other considerations associated with hazardous materials transportation.	http://www.apu.apus.edu/academic/schedule/course/tlmt318 Archived syllabus available
TLMT 381 Hazardous Materials Management	Covers the requirements and regulations associated with packaging, handling, storage, transport, and incident response at the operational level for all forms of Hazardous Material. The emphasis will be on the federal regulations and their often-competing goals and contradictory provisions.	http://www.apu.apus.edu/academic/schedule/course/tlmt381 Archived syllabus available
RLMT 655 Reverse Logistics and Hazardous Materials	Studies the handling of hazardous materials in reverse logistics operations. The study designs a forward and reverse logistics chain to identify and analyze the point where the product becomes hazardous to workers in recycling, returns, and waste movement. The student examines the regulatory issues that govern the legal and illegal activities of returns through case studies.	http://www.amu.apus.edu/academic/schedule/course/rlmt655
EDMG 330 Managerial Issues in Hazardous Materials	Examines regulatory issues, hazard analysis, multi-agency contingency planning, response personnel, multi-agency response resources, agency policies, procedures and implementation, public education and emergency information systems, health and safety, command post dynamics, strategic and tactical considerations, recovery and termination procedures, and program evaluation.	http://www.amu.apus.edu/academic/schedule/course/edmg330 Archived syllabus available
EDMG 240 Chemistry of Hazardous Materials	Covers the science associated with hazardous materials, including those used in human terrorism and the most common hazardous materials in general use. This course is designed to provide the non-scientist student with the chemical bases for the characterization of hazardous materials and resultant handling and storage considerations, as well as the interactions between materials and appropriate segregation and incident response considerations. This course does not require any prior chemistry knowledge.	http://www.amu.apus.edu/academic/schedule/course/edmg240 Archived syllabus available

The Eastern Iowa Community Colleges, Health, Safety and Environmental Technology Program offers HSE-230, Transportation of Hazardous Materials. This course focuses on the U.S. Department of Transportation Hazardous Materials Regulations, and also covers certain Environmental Protection Agency regulations. Students learn how a hazardous materials or an environmental health and safety technician may support professional personnel responsible for compliance with the environmental regulations for transportation of hazardous materials.

Another course with an environmental regulations focus is EADP 4000, Hazardous Materials Planning and Management, at the University of North Texas, Department of Public Administration, in their B.S. degree program in Emergency Administration and Planning. This course is the study of contingency planning and management for hazardous materials. Particular attention is given to environmental regulations as they relate to hazardous materials, particularly those administered by OSHA and EPA. Topics include the role of the Awareness Level First Responder; the roles of the Local Emergency Planning Committee (LEPC) and the State Emergency Response Commission (SERC); and incident management procedures.

The Public Safety Administration B.S. degree program at Eastern Michigan University offers HSEM 434, Hazardous Materials, that examines hazardous material incidents from the perspective of the public safety officer or manager. Topics include identifying hazardous materials, assessing hazardous material accidents, and planning and tactics for addressing hazardous material problems. The intent is to enable students to recognize, identify and understand the materials that they might be confronted within a hazardous material incident. Points of emphasis include analysis of hazardous materials incidents and dispersion patterns of different materials.

Western Nebraska Community College teaches SFTX-1220, Transportation and Shipping of Hazardous Materials. A somewhat unusual aspect is that this course is designed for health care employees who handle dangerous goods. Specialized topics covered that are not often included in other hazmat courses include select agents and toxins, sending dangerous goods by mail, biological products, medical or clinical wastes, Category A infectious substances, shipping with dry ice, and shipping with overpacks.

The search for emergency management higher education programs with hazmat content uncovered several that are apparently no longer active. For example, the Environmental Technology Management Program at Arizona State University routinely taught for many years ETM 524, Emergency Preparedness, Response and Planning for Hazardous Materials. Apparently the course was last taught in 2001, and the course number has been transferred to a different title. Defunct courses were also identified at Gwinnett Technical College in Georgia, Metropolitan Community College in Omaha and the University of Cincinnati.

While not a course, a useful resource was found in the form of a guidebook produced by the Texas Transportation Institute at Texas A&M University. Their 2009 report, *Public Guidance for Managing Hazardous Material Transportation in Texas*, strives to answer common but critical questions concisely, and present facts and examples of management strategies. It also provides references for further information, to help sub-state level transportation planners become informed

and equipped to make better decisions regarding the transport of hazardous materials as prescribed by local conditions.

University Programs: Public Policy, Public Health, Community Colleges, and Other

Public Policy

Programs reviewed included:

- Georgetown Public Policy Institute
- Gerald R. Ford School of Public Policy, University of Michigan
- Kennedy School of Government – Regulatory Policy Program and Belfer Center for Science and International Affairs, Harvard University
- Richard and Rhoda Goldman School of Public Policy, UC Berkley
- Udall Center for Studies in Public Policy, University of Arizona
- Indiana University School of Public and Environmental Affairs
- University of Maryland, School of Public Policy
- The Bush School of Government and Public Service, Texas A & M University

In these programs, little was found related to a dedicated course or curricula focused on hazardous materials transport. However, some have programs where hazmat transport could be introduced, including the Master of Public Policy Programs at Georgetown Public Policy Institute, in their tracks for both environmental and regulatory policy and homeland security.

The Kennedy School of Government, in collaboration with Stanford, has put together a related course with extensive annotation that is available to the public. Indiana University's School of Public and Environmental Affairs offers a course in hazardous materials (E542) that provides a general overview of hazardous materials management with some focus on handling and transport.

The Bush School of Government and Public Service at Texas A&M University offers several courses focused on emergency response and hazardous materials management, but not covering hazardous materials transportation. However, nestled within these courses are case studies of train derailments, transportation considerations, and risk management.

Public Health

Much like public policy programs, little education surrounding hazardous materials transport was found within public health programs. For many universities with public health programs, the focus for hazmat transportation seems almost entirely centered around biological and chemical waste materials from laboratories or shipping of reagents/materials to and from the laboratories. As an example, the University of Illinois at Urbana-Champaign has documentation and offers training on the transportation of biological materials through the Division of Safety Research, but it primarily focuses on meeting DOT regulations. Many offer Hazardous Waste Operations and Emergency Response (HAZWOPER) training and some offer IATA or other similar train-

ing, examples of which are the University of Utah’s School of Medicine and the University of Minnesota’s School of Public Health through continuing education courses.

Community Colleges

Many community colleges offer training through continuing education initiatives for local fire and emergency responders, including hazmat training. Otherwise, except for Oakland Community College’s Hazardous Materials Transportation Program, community colleges seem to focus on courses for HAZWOPER certification, OSHA standards, and DOT regulations. Given that community colleges are numerous, a representative sample was chosen for examination based upon their offering of hazmat-related courses. These included the following:

- Oakland Community College (Michigan) provides a Hazardous Materials Transportation Program that covers policy, shipping of hazmat, emergency contacts, preparation of shipping documents, placarding, emergency response and spill response procedures. While this is still very much a training course, it is the most in-depth course found related to transportation of hazardous materials.
- Barton Community College (Kansas) provides both a hazardous materials management program for the general public and a vocational-technical training program for military soldiers, including courses on HAZWOPER, DOT regulations, OSHA standards, IATA Regulations and characterization of hazardous materials. A unique feature of the Barton HSE 230 Transportation of Hazardous Materials course is that it requires students presented with an actual hazmat accident to outline the reporting procedures as a practice activity and includes coverage of radioactive material packages.
- Cuyahoga Community College’s Regional Transportation Institute (Ohio) offers a Hazardous Materials program with certificates of completion for 49 CFR, IATA, and IMDG. The program is primarily focused on regulations with discussion on specific job function requirements, packaging, marking, and transportation of dangerous goods.
- The University of South Alabama’s School of Continuing Education and Special Programs offers HAZWOPER courses, DOT hazardous materials regulations, technical rescue training at two levels, and industrial safety and health (OSHA) training.

Other

The Environmental Resource Center at Cary, North Carolina, offers several seminars focused on hazardous material training, including classification, DOT, EPA, IATA, IMDG, HAZWOPER, and OSHA. The Southern California Education and Research Center at UCLA and UC Irvine offers a continuing education and outreach course titled “Certified Hazardous Materials Practitioner Exam Preparation” which is promoted as offering hands-on solutions to real world problems, including components on environmental protection, safety and public health, emergency response, transportation, storage and handling, and homeland security.

U.S. Department of Transportation (USDOT)

All USDOT agencies were reviewed. The agencies provide a wealth of information about hazardous materials considered useful for developing model curricula content.

Several complete regulatory compliance training programs were identified. Agencies providing these include:

- Pipeline and Hazardous Materials Safety Administration (PHMSA)
- Federal Motor Carrier Safety Administration (FMCSA)
- Federal Aviation Administration (FAA)
- Transportation Safety Institute (TSI)

The contents of the basic hazmat general awareness training courses offered through these agencies were quite similar. The PHMSA training is typical, and includes the following content:

- Introduction module
- Module 1 (Hazardous Materials Table: HMT)
- Module 2 (Shipping Papers)
- Module 3 (Marking and Labeling)
- Module 4 (Placarding)
- Module 5 (Packaging)
- Module 6a (Highway)
- Module 6b (Air)
- Module 6c (Rail)
- Module 6d (Water)

The complete training package, available for download, includes the lecture slides, and instructor and student guides for each module.

Due to their area of responsibility, some agencies provide specialized training appropriate to their modal focus. For example, the FAA offers the following courses designed specifically for air transport regulatory enforcement personnel:

- Advanced Radioactive Material (RAM) Training
- Hazardous Materials Investigations
- Aviation Hazmat Portals Train-the-Trainer Course
- Aviation Hazmat Portals (AHP) 2.0
- Air Transportation of Dangerous Goods - Basic
- Air Transportation of Dangerous Goods Basic - International

The Transportation Safety Institute (TSI), located within RITA, offers a broad array of training courses, including the following:

- Air Transportation of Hazardous Materials
- Cargo Tank Regulatory Compliance
- Infectious Substance Transportation
- Instructor Training: HM Transportation Modules
- International Maritime Dangerous Goods (IMDG)
- Military Airlift of Hazardous Materials
- Performance-Oriented Packaging
- Specialized Hazardous Materials; Cylinders
- Specialized Hazardous Materials; Explosives
- Specialized Hazardous Materials; Hazardous Waste and Substance
- Specialized Hazardous Materials; Radioactive Materials

- Transportation of Hazardous Materials
- Transportation of Hazardous Materials (Recurrent)

Since TSI is a fee-for-service agency, it is not clear as of this writing if their course materials will be made available for this project.

PHMSA co-sponsors the National Hazardous Materials Fusion Center with the International Association of Fire Chiefs, which makes training available at no charge to emergency responders. Training packages available for download include:

- Biodiesel
- Carbon Monoxide
- Chlorine
- Ethanol
- Hydrochloric Acid
- 2008 Emergency Response Guidebook
- Hydrogen Generator
- Methanol Institute Training Materials
- Guidance Concerning FEMA Missions Affected by BP Oil Spill

The Fusion Center also provides links to websites for a number of other training organizations. The Maritime Administration provides information about and links to the U.S. Merchant Marine Academy (USMMA) and the six state maritime academies. Both the USMMA and the Maine Maritime Academy provide nearly identical undergraduate courses on tanker operations, which are designed to satisfy the cargo training requirement for Tankerman and for Persons in Charge of Transfers of Dangerous Liquids and Liquefied Gases, and to meet the requirements for specialized training of personnel serving on oil and chemical tankers. A few advanced and related courses are also offered. While not reviewed, it is safe to assume that the other state academies provide similar courses. These are the only university-level courses that were found through the U.S. Department of Transportation agencies, and even these courses have considerable training content.

Again, while no other formal training resources were identified, the agencies do provide a rich array of reports and web documents on hazmat transportation topics, such as truck crashes involving hazmat, hazardous material commodity flow data, building model state inspection and compliance programs, emergency response to incidents, best practices for incident prevention, traffic management during hazmat incident clearance, cargo tank safety, research findings, and a myriad of other topics. These materials are in the public domain, and constituted a principal source of content for the model curricula.

Department of Defense (DOD)

It appears that the primary responsibility for DOD hazmat training is centered at the Army Defense Ammunition Center (DAC) at McAlester, Oklahoma, although both the Navy Supply Corps School (Newport, RI) and the 345th Aviation Training Squadron (Ft. Lee, VA) also provide hazmat training.

The search for relevant sources of information and training materials focused on DAC and three other DOD sources:

- Army Logistics University
- Defense Logistics Agency (DLA)
- U.S. Army Corps of Engineers (USACE)

The DAC Training Directorate is one of four main divisions, and their mission is “to provide ammunition-related training and knowledge management services for Department of Defense (DOD) military and civilian personnel.” DAC training is delivered at their facility, at other military bases and DOD facilities, and through distance learning. The following courses appear to be most applicable to this research project:

- Ammo-37 General Transportation of Hazardous Materials
- Ammo-43 Intermodal Dry Cargo Container/ CSC Reinspection
- Ammo-51 Naval Motor Vehicle and Railcar Inspection (MV/RC)
- Ammo-51-MV-DL Naval Motor Vehicle Inspection
- Ammo-51-RC-DL Naval Railcar Inspection
- Ammo-62 Technical Transportation of Hazardous Materials
- Ammo-66-1-DL Radiation Safety
- Ammo-67-DL HAZMAT Familiarization and Safety in Transportation
- Ammo-86-DL Transportation of Radioactive Materials
- Ammo-92 Transportation Physical Security
- PACK-1A-DL Military Preservation and Packaging for Storage and Shipment (Phase 1)
- PACK-1B Military Preservation and Packaging for Storage and Shipment (Phase 2)

Some of these courses, especially, “Ammo 62”, are taught by DAC employees at numerous military bases in the U.S. and abroad. Other courses are primarily for DAC interns and students in the Ammunition Manager Course and the Quality Assurance Specialists (QASAS) program. Several of the course descriptions refer to compliance with the federal regulations that govern hazmat transportation regardless of whether the shipper is civilian or military. Eastern Oklahoma State College has developed a program to allow certain DAC students to pursue an Associate degree in Ammunition Management and Safety, but the program is currently inactive.

A review of courses offered at the Army Logistics University (which replaced separate schools for quartermaster, ordnance, and transportation personnel) at Ft. Lee, Virginia, identified a single course entitled Defense Hazardous Materials/Waste Handling. The course description includes the following:

(The course) provides the attendees with fundamental information to handle hazardous waste as required by the RCRA regulations (40 CFR 260-265), by appropriate state and local requirements, and DOD and Army policy. This course fulfills the general training requirements initially required for hazardous waste handlers by RCRA regulations (40 CFR 264.16 and 265.16), The Hazard Communication Program (29 CFR 1910.1200), and DOT Hazardous Material Training (49 CFR 172.704).

The Defense Logistics Agency (DLA) offers a set of training courses that are comparable to the compliance-based course offered by many civilian sources. The DLA course titles are:

- First Responder: Awareness Level
- First Responder: Awareness Level (IVT Version)
- First Responder: Operations Level
- Hazard Communication (HAZCOM) Standard
- HAZWOPER Refresher
- Transportation of Hazardous Material/Hazardous Waste (HM/HW) for DOD
- Transportation of Hazardous Material/Hazardous Waste (HM/HW) for DOD Recurrent Training

Finally, a review of the U.S. Army Corps of Engineers' *Managers and Supervisors Training Handbook* (the "Purple Book") identified two courses, both compliance based:

- HW Manifest/DOT Certification
- Radioactive Waste Transport/DOT Recertification

The web site for USACE Environmental and Munitions Center of Expertise (EM CX) provides information and links to sources that could be useful in developing and delivering hazmat transportation curricula. "Compliance Fact Sheets" summarize various federal regulations pertaining to hazardous materials, each with suggested USACE points of contact for clarification.

The DOD regulations on hazmat transportation were found at the U.S. Transportation Command (USTRANSCOM) website, as part of *Defense Transportation Regulations, Cargo Movement 4500.9-R-Part II, June 2008*. Chapter 204 of those regulations covers hazardous materials, and training is covered in subsection D.

Department of Homeland Security

A number of hazmat-related training resources are available from the Department of Homeland Security, primarily through the Federal Emergency Management Agency (FEMA) and the U.S. Fire Administration (USFA).

The FEMA Emergency Management Institute (EMI), headquartered at the National Emergency Training Center in Emmetsburg, Maryland, offers a number of courses related to hazmat transportation. Some of the EMI courses that might be useful are described in Table 3. The first listed course, *An Introduction to Hazardous Materials (IS-5.A)*, seems to offer the most potential for adaptation as part of hazmat transportation introductory material. The "MERRTT" course (IS 302), developed by the Department of Energy, will be useful for content that focuses on radiological hazards. Other listed courses could be helpful for a module on incident management.

All but one of the listed courses are designed for "self study," and students can complete an online exam and receive continuing education unit (CEU) credit. Course material, including manuals and training modules, can be downloaded for all of the self-study courses.

The FEMA EMI also offers a suite of independent study courses that explain the fundamentals and components of emergency management from a federal perspective. These could be helpful

to the extent that the hazmat transportation curricula include an overview of emergency management:

- IS-230.b Fundamentals of Emergency Management
- IS-800.b National Response Framework, An Introduction
- IS-700.a National Incident Management System (NIMS) An Introduction
- IS-100.b Introduction to Incident Command System
- IS-821 Critical Infrastructure and Key Resources Support Annex
- IS-801 ESF #1 Transportation
- IS-803 ESF #3 Public Works and Engineering
- IS-810 ESF #10 Oil and Hazardous Materials Resources

The EMI established the Emergency Management Higher Education program in 1994 “with the aim of promoting college-based emergency management education for future emergency managers and other interested personnel.” According to the EMI website:

A goal of FEMA is to encourage and support the dissemination of hazard, disaster, and emergency management-related information in colleges and universities across the U.S. We believe that in the future more and more emergency managers in government as well as in business and industry will come to the job with college education that includes a degree in emergency management. We also believe that in order to build disaster resistant and resilient communities, a broad range of college students and professionals need courses that introduce them to hazards, risk, vulnerability, disasters, and what to do about them.

A number of resources reviewed can be accessed at FEMA’s Higher Education program website (<http://www.training.fema.gov/emiweb/edu/>).

Information about other emergency management training courses is provided by the FEMA National Training and Education Division, through a catalog that includes the courses provided by the EMI, but also courses offered by other federal, state and local organizations. A hard copy of the course catalog can be downloaded and a searchable On-line Course Catalog (OCC) is also available. A review of the catalog identified the non-EMI courses shown in Table 4 as potentially relevant to the research project objectives, although several are very specialized.

The first course shown in Table 4 (Port and Vessel Security for Public Safety and Maritime Personnel) is also available in a “self-paced, web-based” version. Although the course does not focus on hazmat, it does offer relevant information about maritime operations.

The FEMA Center for Domestic Preparedness (CDP) also provides hazmat training, including field exercises, at a state-of-the-art facility in Anniston, Alabama. The CDP describes itself as “DHS’s only federally chartered Weapons of Mass Destruction (WMD) training center.”

The DHS’s U.S. Fire Administration (USFA) also offers training resources, including resident courses at the National Fire Training Academy (NFA), also located at the Emmetsburg campus. Table 5 shows the NFA’s resident hazardous materials courses.

Table 3. Selected EMI Courses Related to Hazardous Materials Transportation

FEMA Course Number	Course Title	Description
IS-5.a	An Introduction to Hazardous Materials	Course is intended to provide a general introduction to hazardous materials that can serve as a foundation for more specific studies in the future.
IS-340	Hazardous Materials Prevention	The Emergency Management Institute (EMI) has designed this course to assist States, Tribes and local communities to better prepare for and respond to hazardous materials incidents.
IS-346	An Orientation to Hazardous Materials for Medical Personnel	Hospital emergency department personnel face many risks and difficult tasks when dealing with patients involved in hazardous materials incidents. Therefore, it is essential that all personnel who come in contact with patients have a general awareness of the issues and concerns when dealing with hazardous materials incidents. This course is designed to prepare hospital personnel to analyze hazardous materials situations, take the necessary steps to assure medical provider safety, and identify appropriate resources for decontamination and medical care.
IS-302	Modular Emergency Radiological Response Transportation Training	This course includes the following topics: radiological basics, biological effects, hazard recognition (markings, labels, and placards), initial response actions, radioactive material shipping packages, on-scene patient handling, radiological terminology and units, assessing package integrity, radiation detection instrumentation, and radiological decontamination.
E920	IEMC: Hazardous Materials Preparedness and Response	This “Integrated Emergency Management Course” focuses on preparing for and responding to a major hazardous materials incident. This exercise-based course is conducted with a “generic” audience. The participants represent communities from throughout the country. The IEMC places public officials and other key community leaders in a disaster simulation. The course methodologies of classroom instruction, planning sessions, and exercises, allow for structured decision making in a learning, yet realistic, environment.

Table 4. Courses Identified Through the NTED Catalog

Course No.	Title	Source
AWR-144	Port and Vessel Security for Public Safety and Maritime Personnel	Rural Domestic Preparedness Consortium
AWR-147	Rail Car Incident Response	Rural Domestic Preparedness Consortium
PER-212	Operational Level Response to HazMat/WMD Incidents	Texas Engineering Extension Service
PER-241	Radiological/Nuclear Course for Hazardous Material (HazMat) Technicians	Nevada Test Site
PER-250	Emergency Response to Terrorism: Operations	International Association of Fire Fighters
PER-261	Hazardous Materials Technician for CBRNE Incidents	Center for Domestic Preparedness
PER-292	Leadership and Management of Surface Transportation Incidents	Transportation Technology Center, Inc.

Table 5. NFA Resident Courses Related to Hazardous Materials

Course	Delivery
Advanced Life Support Response to Hazardous Materials Incidents (R247)	10-Day On-Campus
Hazardous Materials Operating Site Practices (R229)	10-Day On-Campus
Chemistry for Emergency Response (R233)	10-Day On-Campus
Hazardous Materials Incident Management (R243)	6-Day On-Campus
Special Operations Program Management (R254)	6-Day On-Campus

The USFA also sponsors a higher education program—the Fire and Emergency Services Higher Education (FESHE) program. A section of their website, entitled “Model Curriculum”, offers details under these headings:

- Associate’s Curriculum
- Baccalaureate Curriculum
- Emergency Medical Services Associate’s/Bachelor’s Curriculum
- Discipline-Specific Concentrations: Courses and Activities
- Seeking Curriculum Approval
- National System for Fire-Related Higher Education

Courses are available through a network of colleges and universities. Details about a course entitled *Managerial Issues in Hazardous Materials* can be found at:

<http://www.usfa.fema.gov/downloads/pdf/nfa/higher-ed/ba-courses/mihm.pdf> .

The U.S. Coast Guard (USCG) Yorktown Training Center offers sets of courses on contingency preparedness and port operations. The latter courses train Coast Guard members on the applicable regulations regarding marine transfer facilities, explosives handling, and pollution response, with more emphasis on oil than other hazmat.

Department of Energy (DOE)

The Environmental Management component in the Department of Energy operates the Transportation Emergency Preparedness Program (TEPP). According to its website, the TEPP mission is to “ensure that federal, state, tribal, and local responders have access to the plans, training, and technical assistance necessary to safely, efficiently, and effectively respond to transportation accidents involving DOE-owned radioactive materials.”

One course in the program is Modular Emergency Response Radiological Transportation Training (MERRTT). DOE delivers this course in two versions, a full 16-hour offering, and a one-day 8-hour version for radiological monitoring only. The course provides an understanding of basic radiological response hazards and safety, and teaches the responders to safely monitor for radiation. There is also a train-the-trainer version. TEPP includes other resources that might be useful. The MERRTT course is also available through the FEMA Emergency Management Institute’s Independent Study program as IS-302.

Oak Ridge National Laboratory (ORNL) offers several in-house training courses for employees who are involved in shipping hazardous materials. One of these is the “Hazardous Materials Transportation Training Program”, which is essentially identical to the same course offered by the Transportation Safety Institute. Other applicable training topics include modules on cargo and portable tanks, federal motor carrier safety regulations, and transportation security plans. ORNL made its training materials available to this research project.

Environmental Protection Agency (EPA)

The Environmental Protection Agency (EPA) is responsible for protecting both human health and the environment from hazardous material releases through various guidelines and

regulations. The EPA gathers health, safety and exposure data, requires necessary testing, and controls human and environmental exposures for numerous chemical substances and mixtures including hazardous materials such as hazardous waste. The EPA website, including the pages on the Emergency Planning and Community Right-to-Know Act (Sections 302-304) and the Pollution Prevention Act, provides volumes of information about reporting of chemicals being produced and shipped, incident and chemical releases, and other information to protect the public from adverse exposure to chemicals (included hazardous materials).

EPA offers some training through the Hazmat Hazardous Materials Training and Research Institute and also online. Online courses include the Toxic Release Inventory (TRI) BASIC CONCEPTS Online Training Module and the Toxic Release Inventory ADVANCED CONCEPTS Online Training Module. Both of these modules are focused on making release calculations, reporting requirements and appropriate form use, and overviews of the TRI program and processes. Another option, again with a training focus, is the Waste Treatment, Transportation and Disposal training course offered through The Training Exchange Website (TRAINEX) (<http://www.trainex.org/offeringslist.cfm?courseid=46&all=yes>) which focuses on treatment, transportation, and disposal of waste possibly including hazardous materials. The course is offered free of charge and often presented by a private consultant on behalf of the EPA. This is likely the only course that has components specifically focused on transportation of waste, but the extent to which hazardous materials are included is not known. Other similar courses are offered that may have relevance to hazardous materials but not transportation, such as the Wastes, Pesticides and Toxics Training or the Pesticides: Safety Training. Again, the focus of these courses is on training, not education. Some components of these courses may offer benefit to development of post-secondary hazmat transportation curricula.

State-Supported Training for Emergency Responders

Emergency responder training for hazmat transportation is provided by state emergency management agency's (EMAs), fire services training academies, and other state-supported organizations. In large cities, many local EMAs and fire services academies also provide such training. In many states, colleges and universities offer degrees and certificate programs in fire services, emergency management and homeland security, and some universities operate statewide extension programs for fire and other emergency services.

Most of the state EMAs are the designated authorities within their respective state governments for hazmat preparedness and response to the most significant hazmat incidents, in addition to being the state agency responsible for overall emergency management. Most of the training provided by State EMAs appears to be parallel and closely coordinated with training offered by FEMA, with adaptations made to address unique needs within the respective states. In most of the agencies, training is managed in combination with exercises. A scan of EMA websites indicates that most of the training is compliance focused, with some adjustments to address unique priorities.

To illustrate, the following excerpts are from the Tennessee Emergency Management Agency (TEMA) website:

TEMA Hazardous Materials Awareness Level Course

This 4-hour resident course covers the basic skills to recognize, detect, and identify the presence of hazardous materials during an emergency. Students will learn how to define and describe how hazardous materials are classified; understand the risks associated with them and proper notification procedures. Other topics of instruction include: understanding the importance of initiating command and control activities during a hazardous materials incident, surveying a hazardous material incident and identifying the containment systems and materials involved, and use of the Emergency Response Guidebook. Students who successfully complete this course will have met the standards under OSHA 29 CFR 1910.120 and NFPA 472 (2008).

TEMA Hazardous Materials Operations Level Course

This 40-hour resident course covers the basic operating procedures for first responder that teaches a systematic response to hazardous material incidents. The curriculum defines hazardous materials, and describes the roles, responsibilities and risks associated with an incident. It also describes the types, uses and sources of information needed to identify hazards, as well as the basic options, requirements and limitations of methods used to control, contain or confine a hazmat incident. Students who successfully complete this course will have met the standards under OSHA 29 CFR 1910.120 and NFPA 472 (2008).

Hazardous Materials Team Operations Course (Technician Level)

In this 80-hour course, the student is trained to operate in an offensive mode when responding to a hazardous materials incident. It is also designed to prepare team members to operate safely and as a unit in dealing with hazardous materials incidents. Emphasis is on teamwork and the use and limitations of existing team equipment. Content includes personal protection, safety procedures, basic physical and chemical properties, container characteristics, basic tactics and guidelines for team policies, procedures and operations.

MERRTT: Modular Emergency Response Radiological Transportation Training

TEMA works with the Department of Energy and delivers this course, which was described above.

FCRR: Fundamentals Course for Radiological Response

This 3-day course covers the concepts of radiation protection, radiation detection instruments, radiological monitoring techniques, radiological hazards and protective actions, team building, and basic procedures to support planning and response for emergency and recovery activities in the event of a radiological incident. The course covers all types of radiological hazards from fixed facility to transportation to WMD.

The last two courses reflect the presence of the Oak Ridge National Laboratory in Tennessee.

Perhaps the most extensive state program for emergency management training is the California Specialized Training Institute (CSTI), operated by the California EMA “for the training of firefighters, police officers and emergency management personnel.” The CSTI course catalog lists the following Hazardous Materials Section courses:

- Assistant Safety Officer
- CAMEO: Computer Aided Management of Emergency Operations

- First Responder Operations
- First Responder Operations Decontamination
- First Responder Operations/Awareness – WMD
- First Receiver Awareness and Decontamination for Health Care
- First Receiver Operations and Decontamination for Health Care
- Incident Commander
- Incident Commander- WMD
- Instructor Certification
- Instructor Certification for Trainers
- Instructor Recertification
- Investigations
- Advanced Environmental Crimes Training Program
- Rail Car Safety
- Specialist, Levels F-G
- Technician, Levels A-D
- Technician for Bomb Technician
- Technician for Coroner Response
- Technician for Private Industry
- Technician/Specialist Refresher
- Technical Reference Specialist
- WMD Terrorism for the Technician or Specialist

Most of the reviewed websites for state and local fire services academies did not provide much detail about hazmat training, but an extensive array of hazmat training materials for the fire services are provided by the International Fire Service Training Association (IFSTA). Available materials include text books, manuals, study-guides, and CDs. IFSTA also offers some training through “eLearning,” and three hazmat classes are available for a fee: Hazmat Awareness, Hazmat Operations, and Hazmat Technician.

A textbook from another source, *Firefighters Handbook: Essentials of Firefighting and Emergency Response* (Delmar), has a total of thirty chapters, five of which address aspects of hazardous materials:

- Hazardous Materials: Laws, Regulations and Standards
- Hazardous Materials: Recognition and Identification
- Hazardous Materials: Information Resources
- Protection from Hazardous Materials
- Hazardous Materials: Protective Actions

Another textbook, *Hazardous Materials: Managing the Incident*, does not focus exclusively on transportation incidents, but provides more than 600 pages of relevant information. The book has been “validated” by IFSTA and is used in the USFA-sponsored course on Managerial Issues in Hazardous Materials. A multi-faceted “Hazmat Learning System” is available from the publisher.

Several state universities provide fire services training as part of statewide extension programs. Most of these programs also provide consulting, research and other services. Most have expanded their scopes to include emergency management and homeland security. Four examples are described below:

LSU Fire and Emergency Training Institute, Louisiana State University

The stated mission of the Institute is “is to provide training and education to fire and emergency response providers in order to protect life, property, and the environment.” One distinguishing feature of the LSU program is a set of marine fire fighting courses.

MU Fire and Rescue Training Institute (MU FRTI), University of Missouri

This Institute “offers continuing professional education to more than 25,000 career and volunteer firefighters who serve nearly 900 local fire departments and fire protection districts, in addition to allied emergency service personnel, and private sector and institutional emergency brigade members, as they strive to meet public protection challenges.”

Maryland Fire and Rescue Institute (MFRI), University of Maryland

The MFRI “is the state’s comprehensive training and education system for emergency services. The Institute plans, researches, develops and delivers quality programs to enhance the ability of emergency service providers to protect life, the environment and property.” A searchable course catalog is available.

Fire Services Training, Oklahoma State University (OSU)

OSU operates the Oklahoma Fire Service Training (OFST) program as “an extension/outreach unit” of the university’s College of Engineering, Architecture and Technology (CEAT). A list of FST courses (including “Hazmat/Terrorism” courses) with links to course descriptions is available.

A degree program is also available through the ABET-accredited Fire Protection and Safety Technology (FPST) program in OSU’s College of Engineering, Architecture, and Technology. Another significant resource at OSU is the Department of Fire Protection Publications, host and partner for IFSTA. The International Fire Service Accreditation Congress is also housed at Oklahoma State.

Another training resource is provided by Michigan State University (MSU). An MSU sponsored website known as *SAFEREPONSE* (<http://www.saferesponse.com/>) offers free online training for three courses:

- Hazardous Materials Response - Awareness Level
- Incident Command System - Awareness Level
- Emergency Response Team Coordinator

The Association of Bay Area Governments also offers online hazmat courses, for a fee.

Trade Association Educational Programs

As a general rule, trade associations do not focus on providing general education related to hazardous materials transportation. Rather, an emphasis is placed on members receiving the appropriate training so as to be operating in compliance with the regulations. While in some instances training courses are offered directly by the association, more often these services are provided by outside third-parties. What follows is a brief description of those associations whose approach to hazardous materials education and training may offer information of potential use in developing hazardous materials transportation curricula.

- The Alliance of Hazardous Materials Professionals is geared towards preparation for becoming a Certified Hazardous Materials Manager (CHMM). Preparatory materials include: 1) Hazardous Materials Management Desk Reference, 2) software entitled CHMMprep V.4.0, and 3) a CD-ROM entitled CHMM Examination Study Guide.
- The American Chemistry Council (ACC) operates the Responsible Care program, designed to promote safe, responsible and sustainable management of chemicals through their entire life cycle, to which all its members have made CEO-level commitments to uphold by practicing the program's guiding principles. ACC sponsors two additional initiatives that help promote transportation safety: 1) CHEMTREC – an around-the-clock service available to emergency responders who need immediate information for incidents involving hazardous materials, and 2) TRANSCAER – a national outreach effort that promotes safe transportation and helps communities prepare for and respond to any transportation incident involving hazardous materials.
- The American Society of Transportation and Logistics offers certifications in transportation and logistics; professional designation in logistics and supply chain management; distinguished logistics professional; and global logistics associate. The organization has identified and provides a list of “blanket waiver schools” that automatically result in certification in transportation and logistics if the student graduates with an undergraduate degree, M.S. or Ph.D. in an industry related field.
- The Association of American Railroads (AAR) operates the Transportation Technology Center in Pueblo, CO, which has onsite the Security and Emergency Response Training Center (SERTC). A complete array of hazmat emergency response specialist courses is offered by SERTC. These courses might provide a good source of input to any curricula modules dealing with emergency response, if the course materials can be made available. The AAR Bureau of Explosives offers for sale selected hazmat publications that also provide good source material.
- The Commercial Vehicle Safety Alliance - Cooperative Hazardous Materials Enforcement Development (COHMED) is an intergovernmental/industry partnership that focuses on information sharing on hazardous materials transportation issues and delivery of services. COHMED uses education and training to provide state and local governments with information and resources to improve hazardous materials safety. It also provides advan-

aced hazardous materials training for regulatory and enforcement officers.

- The Council of Supply Chain Management Professionals offers the following workshops: 1) fundamentals of supply chain management, 2) challenges and solutions in transportation, 3) distribution center planning and operations, 4) growing your business with supply chain management, and 5) 21st century sales and operations planning. The organization also offers a variety of case studies designed for academic use.
- The Dangerous Goods Advisory Council focuses on safety and compliance. Training courses are offered that are geared towards meeting domestic and international regulations.
- The Institute of Hazardous Materials Management offers a Hazardous Materials Manager-in-Training program designed to introduce young professionals into the Certified Hazardous Materials Manager (CHMM) program. A textbook entitled Managing Hazardous Materials: A Definitive Text is utilized for this purpose.
- The International Association of Fire Chiefs offers a series of workshops and educational sessions at its annual conference.
- The National Conference of State Legislators has a standing hazardous materials transportation committee that helps states understand their role and voice their concerns with regard to regulating hazmat transportation.

Private Companies

Numerous private companies offer hazmat training and related products for a fee. The total number of such companies in the U.S. could not be determined, but the Transport Dangerous Goods Directorate (TDG) in Transport Canada has a database with more than 500 Canadian companies that provide such training.

The literature review found that a few private companies focus exclusively on hazmat transportation training, but most provide a wider range of services (e.g., consulting, packaging, even transport). Some offer a wider range of training (e.g., including aspects of hazardous material management other than just transportation, overall work place and operator safety, or logistics management). Virtually all of the hazmat transportation training provided by the private sector seems focused on regulatory compliance and certification—particularly compliance with USDOT, OSHA, IATA, and IMDG requirements.

Most of the firms deliver training in multiple ways—instructor-led classrooms (public or at the client’s site), web-based, CDs/DVDs, videos, and study guides. Many use training manuals or workbooks to supplement presentations. Some of the firms sell training manuals, software and other support material for use by other trainers, employers or individuals.

Table 6 highlights twelve firms that offer hazmat transportation training in the U.S. The table includes several relatively large firms (in terms of numbers of clients served and products/services offered) and several firms that are smaller. Three of the twelve (FedEx, UPS, and HazMat Environmental Services) are carriers. Several focus on packaging and provide training as part of an array of packaging services. Of the twelve firms listed, nine have trainers that are listed as members of the Dangerous Goods Trainers Association (DGTA).

The table includes links to key web pages and notes on unique features that might be useful in developing post-secondary curricula, delivery tools, and deployment strategies. While the table is considered representative, it is certainly not exhaustive. For instance, at least one manufacturer, DuPont, offers hazmat training, according to their website. One would expect that all major hazmat manufacturers have training programs, either using in-house or vendor-provided resources. Similarly, all major hazmat carriers would be expected to be actively involved in hazmat training for their employees, in part because such training is required by the federal hazardous materials regulations. Also, the National Labor College operates the Rail Workers Hazardous Materials Training Program, offering courses in hazardous materials/chemical emergency response, hazmat instructor training, and radiological transportation training. Many other hazardous materials courses and training materials are advertised on the Internet by individuals and small businesses throughout the U.S.

TRB Research Program and TRID

This literature review included all TRB research program initiatives (HMCRP, NCHRP, NCFRP, TCRP and ACRP) as well as documents cited in the Transportation Research International Documentation (TRID) database identified as potentially relevant to hazardous materials transportation based on use of appropriate keywords. TRID is a newly integrated database that combines the records from TRB's Transportation Research Information Services (TRIS) database and the OECD's Joint Transport Research Centre's International Transport Research Documentation (ITRD) database. TRID provides access to over 940,000 records of transportation research worldwide.

In general, it was found that whereas there is much useful material available to populate content in developing hazardous materials transportation curricula, this information has yet to be packaged in a form that constitutes an educational program. However, the quality of the information is such that it can significantly influence the manner in which hazardous materials transportation curricula are designed. Among the important considerations that were identified in performing this synthesis is the need to include the following topics:

- Characterization of freight transportation modes—truck (private, for-hire; tank, bulk, FTL, LTL), rail (mainline, regional and short line, spur), marine (brown, green, blue water), air, and pipeline, plus intermodal services
- Recognizing the differences in local distribution, intrastate and interstate transport
- Understanding the distinctions among and purposes of various vehicle configurations

Table 6. Twelve Companies Offering Training Related to Hazmat Transportation

Name of Company	Website(s)	Notes
ATP Training	http://www.alltranspack.com/Services/help.html http://www.alltranspack.com/Services/training.html	Focus on packaging services and related compliance training "IATA Accredited"
Currie Associates	http://www.currieassociates.com/ http://www.currieassociates.com/Training/Training.htm	Also provide staff for the Council on Safe Transportation of Hazardous Articles (COSTHA) and the International Vessel Operators Dangerous Goods Association (IVODGA)
DGI Training Center	http://dgitraining.com/	Syllabus info: http://dgitraining.com/pages/Syllabus-Info.html Examples of violations and resulting fines: http://dgitraining.com/pages/Oooops%21-%28Violations%29.html
FedEx	Website: <i>Shipping Dangerous Goods and Hazardous Materials With FedEx</i> ® : http://www.fedex.com/us/hazardous-materials/index.html	Seminars: http://www.fedex.com/us/service-guide/our-services/dangerous-goods-hazmat/index.html?qgroup=toggle-c1&qid=Dangerous Goods Seminars
HazMat Environmental Group	http://hazmatinc.com/ http://www.hazmatinc.com/training_consulting.php	Focus on transporting hazardous waste Course descriptions and schedules: http://www.hazmatinc.com/seminars.php
J.J. Keller and Associates	http://www.jjkeller.com/webapp/wcs/stores/servlet/topCategories_10151_-1_10551 http://www.jjkeller.com/webapp/wcs/stores/servlet/content_category_Hazardous_Materials_issues_Training_10151_-1_10551	Training on Demand: https://www.jjkellertraining.com/?action_code=49715 See also College/Campus, Academic Partnerships: http://www.jjkeller.com/webapp/wcs/stores/servlet/content_careers-campus
Labelmaster	http://www.labelmaster.com/	Training documents, training software, support materials and reference documents: http://www.labelmaster.com/Shop Annual Dangerous Goods Instructors' Symposium: http://www.myregs.com/airregs/conferences/

Lion Technology	http://www.lion.com/Home.aspx http://www.lion.com/Hazmat-Training	Sample video and workbook: http://www.lion.com/LionTechnology/media/Demo/HMT-Demo/player/playershell.swf?ext=.swf
Saf-T-Pak	http://www.saftpak.com/Training/training.aspx	Focus on infectious and biological substances Training demos : https://www.training.saftpak.com/ http://www.saftpak.com/Support/downloads.aspx
Transportation Compliance Associates	http://www.learnhazmat.com/ http://www.learnhazmat.com/training/	
Transportation Development Group	http://www.logisticstraining.com http://dgtraining.com/index.htm	Partnership with California State University, Long Beach, Center for International Trade and Transportation (CITT) http://www.ccpe.csulb.edu/citt/hazmat/programdescription.aspx?group_number=276&group_version=1 Demo: http://www.youtube.com/watch?v=73JRA_pSg2E&NR=1
UPS	Website: <i>UPS Guide for Shipping Ground and Air Hazardous Materials</i> http://www.ups.com/content/us/en/resources/ship/hazardous/index.html	Seminars: http://www.ups.com/content/us/en/resources/ship/hazardous/seminar.html http://upshazmatseminars.com/

This table considered to be representative of the companies that offer hazmat transportation training in the U.S. It is not intended to be an exhaustive list.

- Portraying hazmat commodity flow according to a variety of performance metrics (including tons, ton-miles, trip length and value)
- Introducing the concept of economic evaluation, particularly the use of benefit/cost analysis and life cycle assessment
- Enumerating the role of regulations/regulators at the local, state, tribal, federal and international levels
- Distinguishing tort liability (reasonably foreseeable risk) from regulatory compliance
- Describing the various forms of operator credentialing (e.g., TWIC, CDL, HME)
- Introducing the use of UN and NAICS codes
- Emphasizing the significance of emergency management agency coordination through NIMS/ICS guidelines and equipment interoperability
- Defining critical infrastructure in terms of tunnels, bridges, key routes, iconic structures and other valuable assets
- Introducing security assessments in terms of target attractiveness, attack scenarios, vulnerability and resilience
- Differentiating cyber security from physical attacks
- Recognizing the variety of factors that affect route selection, including accident/incident rates, traffic volume, trip length, facility geometry, physical condition, proximity to sensitive environments, population exposure, emergency response capability and availability of suitable diversion route
- Organizing accident root cause analysis according to the following parameters: 1) vehicle, 2) operator, 3) packaging, 4) infrastructure and 5) situational
- Acknowledging the availability of multiple accident data sources (e.g., MCMIS, FARS, HMIRS, TIFA, LTCCS, RAIRS, MISLE)
- Including consideration of both point source and non-point source environmental impacts
- Describing operations according to functional requirements, such as package integrity, equipment reliability, operator performance, hazmat commodity/vehicle/driver identification, communication, tracking, security and emergency response
- Including relevant case studies, covering such topics as:
 - Miamisburg, OH

- Waverly, TN
 - Texas City, TX
 - Yucca Mountain
 - Other NTSB incidents
 - Mode choice and routing applications
 - Emergency management plans
- Designing a module that covers risk management/assessment concepts and practices
 - Citing the role of industry safety programs, particularly Responsible Care, including related CHEMTREC and TRANSCAER initiatives
 - Including consideration of institutional issues, such as corporate governance; financial management; hiring, retention and workforce development; occupational health and safety; and customer service
 - Enumerating the type and role of various stakeholders, including shippers, carriers, customers, warehouse/terminal operators, international freight forwarders/carriers/brokers, regulators, the public, and media
 - Identifying emerging technologies and categorizing them according to their functional role (e.g., electronic documentation, monitoring and surveillance, alternative power generation, infrastructure integrated systems (such as positive train control))
 - Ensuring effective links between the Hazardous Materials Cooperative Research Program and the ongoing education of hazmat transportation professionals

CHAPTER 3

ELEMENTS OF THE MODEL CURRICULA

RESEARCH PROCESS

The focus of this stage of the research was to identify and describe the elements that should be included in model curricula for the transportation of hazardous materials for the post-secondary education community. The word “curricula” associated with this task suggests that hazmat education is needed in more than one discipline area. The project defined “curricula elements” to be the topics that should be included in each such program area. The crux of this task therefore became one of identifying and describing these curricula elements.

The outcome of this work essentially drove the rest of the project, as it specified both curricula content and intended audiences. The following activities were undertaken:

- Identify and describe hazmat topics
- Identify and describe the hazmat stakeholders who require education
- Specify the learning outcomes for each topic for each stakeholder group
- Prepare draft curricula materials for stakeholder review

The results achieved are discussed in the following sections.

HAZMAT TOPICS

A systematic review was conducted of the potential curricula topics defined in the original research proposal and the results of the aforementioned literature review. This led to revisions in the curricula topics, in both breadth and depth of coverage. The topic list was further refined as available educational materials were reviewed in detail. The resulting list of topics, given below, was used as the basis for both identifying gaps in the available materials and developing draft curricula content for subsequent stakeholder review.

1. Introduction to Hazmat Transportation
 - a. Hazardous materials and societal needs
 - b. Hazmat transportation logistics
 - c. Hazmat legal and regulatory environment
 - d. Risk management
 - e. Hazmat transportation incident management
 - f. Security of hazmat transportation shipments
2. Hazmat Transportation Logistics
 - a. U.S. freight transportation infrastructure, vehicles and equipment
 - b. Hazmat shipment classifications, modes and commodity flows
 - c. Hazmat shipment supply chain processes
 - d. Management and operational issues

3. Hazmat Legal and Regulatory Environment
 - a. Hazmat transportation regulatory context
 - b. Overview of legal and regulatory process
 - c. Hazmat legislation and regulations
 - d. USDOT and applicable international regulations
 - e. Compliance and enforcement
 - f. Other regulatory requirements, standards, and guidelines
 - g. Issues involving multiple/overlapping regulations
4. Hazmat Mode and Route Selection
 - a. Factors affecting mode choice
 - b. Route selection factors
 - c. Highway hazmat routing regulations
 - d. Railroad hazmat routing practices
 - e. Differences in highway and rail routing of hazmat
 - f. Different approaches in applying routing criteria
 - g. Community activism
5. Hazmat Risk Management
 - a. Hazmat transportation case study examples
 - b. Overview of hazmat transportation incident statistics
 - c. Overview of risk management techniques
 - d. Risk communication and management tools
 - e. Risk management for hazmat transportation
6. Hazmat Transportation Incident Management
 - a. Introduction and overview
 - b. National standards, guidelines, and resources
 - c. Incident response and stakeholder roles
 - d. Brief look at scene management
 - e. Reporting, after-action reviews, and recovery
 - f. Consequences of hazmat transportation incidents and incident management
7. Security of Hazmat Transportation Shipments
 - a. Transportation system security concepts
 - b. Regulatory requirements for hazmat shipment security
 - c. Motor carrier security
 - d. Rail security
 - e. Maritime security
 - f. Air cargo security
 - g. Pipeline security
 - h. Security related to international trade

HAZMAT STAKEHOLDERS

It is important to consider the various constituencies, or prospective students, who could benefit from exposure to the curricula topics. Hence a companion research activity was to identify these groups. The research team used the information sources gathered in the literature review to formulate a comprehensive list of hazmat transportation stakeholders. They are listed in Table 7 and are defined as follows:

- *Shippers* – Suppliers, recipients and users of raw materials and/or finished products that contain hazardous materials; participants in the packaging, loading and unloading of hazardous materials for shipment.
- *Carriers* – Transporters of hazardous materials from the shipment origin to its destination. Includes truck, rail, marine, pipeline and air movements.
- *Distributor/warehouse/terminal operator* – Stakeholders involved in the storage or transfer of a hazardous materials shipment.
- *International freight forwarder/carrier/broker* – Coordinate the import and export of shipments that contain hazardous materials as defined by various countries and international organizations.
- *Policymakers (elected/appointed officials)* – Persons with the authority to address public issues and establish policies that govern hazardous materials transportation practices.
- *Infrastructure providers and operators* – Agencies that have the responsibility for constructing, maintaining, and managing the freight transportation network utilized to haul hazardous material cargo.
- *Regulators* – Transform policies into standards that dictate how industry sectors involved with hazardous materials must manage and operate.
- *Transportation security* – Ensure that hazardous materials shipments are sufficiently protected from harm during the transport operation.
- *Compliance and enforcement* – Ensure that hazardous materials transportation operators are complying with appropriate rules and regulations.
- *Community planners/economic developers* – Developers and implementers of land use and infrastructure plans to support community growth and economic viability.
- *Emergency responders* – Provide emergency, on-the-scene response to a hazardous materials transportation incident.

Table 7. List of Hazmat Transportation Stakeholders

<p>Private Sector (Executives & Operations Managers)</p> <ol style="list-style-type: none">1. Shippers (raw materials and finished products)2. Carriers3. Distributor/warehouse/terminal operator4. International freight forwarder/carrier/broker <p>Public Sector (Federal, State & Local Officials)</p> <ol style="list-style-type: none">1. Policymakers (elected/appointed officials)2. Infrastructure providers and operators3. Regulators4. Transportation security5. Compliance and enforcement6. Community planners/economic developers7. Emergency responders8. Emergency managers <p>Other Stakeholders</p> <ol style="list-style-type: none">1. Educators2. Trainers3. Researchers4. Consultants5. Citizen groups6. Media

- *Emergency managers* – Develop and implement strategic plans and processes to prepare for, mitigate, respond to, and recover from hazardous materials transport incidents.
- *Educators* – Impart the knowledge, skills and experience to help students learn about the various aspects of hazardous materials transportation that will better prepare them for career development in a related field.
- *Trainers* – Provide formal instruction on how to conduct hazardous materials transport safely and respond to incidents within the current regulations and standards.
- *Researchers* – Pursue solutions to timely and critical problems that the industry is trying to better understand.
- *Consultants* – Offer guidance to organizations on how to improve the effectiveness of their hazardous materials transportation activities.
- *Citizen groups* – Organizations representing public interests and seeking a voice in how hazardous materials transportation activities are performed.
- *Media* – Disseminators of information through a variety of communication channels to inform the public or specific stakeholder groups.

The distinction in Table 7 between “public” and “private” is made to emphasize the important differences in perspective, but some overlap needs to be recognized. Certain public agencies are also shippers and even carriers of hazardous materials. Likewise, some private companies are responsible for aspects of infrastructure, security, economic development, emergency response and emergency management.

LEARNING OUTCOMES

An assessment of how much emphasis and depth of coverage each topic should receive for each of the stakeholder groups was compiled. The team considered what would be desirable depth of coverage for managers and executives already working in some aspect of hazmat transportation, and also what should be included in higher education programs designed to prepare students for those types of professional positions. The assessment focused on whether a particular audience should receive high, medium, or low level of subject matter exposure, respectively, of a curriculum topic. Statements of educational outcomes were subsequently developed that guided the preparation of the model curricula content.

DRAFT POST-SECONDARY EDUCATION CURRICULA

The objective of this effort was to produce a draft version of the proposed hazmat transportation post-secondary education curricula. The curricula were developed in sufficient detail to permit meaningful exposition and discussion at the peer exchange workshop discussed in chapter five.

Development of post-secondary education curricula that address the knowledge, skills, and abilities needed for transportation of hazardous materials must take into consideration existing knowledge of students, multiple types of learners, the level of knowledge sought for each key concept, and use of assessment techniques to evaluate learner understanding. The team's goal was to develop an active learning platform for the hazardous materials transportation curricula which includes various educational content levels and uses multiple formats to engage different learner types. The draft model curricula were to include both content and delivery mechanisms and aids.

The initial effort was to develop an instructional module for each of the seven main topics listed above, following the outline indicated by the subtopics. The instructional modules could then be packaged into several curricula, each with a syllabus. The content of each module was drawn primarily from the resource materials that were identified during the literature review. Module development was also informed by the gap analysis discussed in the next chapter. The draft material was developed at a depth deemed suitable for university-level instruction.

For each curricular module, the research team worked on developing the following draft items:

- Title
- Learning outcomes
- References
- PowerPoint slides
- Lecture notes describing further the information to be conveyed by each slide
- In-class exercises
- Out-of-class assignments
- Supporting materials (references, case studies)
- Proficiency tests (quizzes, examinations)

The project time schedule called for submittal of the draft curricula near the mid-point of the project timeline. This meant that priority was placed on developing curricular source materials and producing the learning outcomes, lesson plans and PowerPoint slides. The results of this effort constituted the draft version of the basic set of curricula materials.

CHAPTER 4

GAPS AND CONSTRAINTS IN CURRENT EDUCATION AND TRAINING

RESEARCH PROCESS

This activity involved the identification of gaps in current practices of education and training for the transportation of hazardous materials as well as potential constraints (e.g., aging workforce, reduced labor pool, availability of qualified instructors, and lack of an industry-recognized credential). The task had two interrelated objectives. The first was to identify and prioritize the gaps between current practices and resources, and what would be needed as subject matter in the model curricula to address the respective gap. The second objective was to identify the existing and potential constraints that should be addressed in formulating a plan for implementing the curricula, once complete.

The gap analysis was accomplished through an iterative process which involved members of the project team and project panel members. An important activity was mapping of available curricula and materials to the curricula topic areas identified in chapter three, plus three others that were of interest as potential additional modules or subtopics—transportation infrastructure, emerging trends, and special topics.

In comparing the existing education programs with the desired elements of the model curricula, it was important to identify both current best practices as well as gaps. The research team identified best practice syllabi and materials to be incorporated in the recommended model curricula. The principal output of this analysis was the team’s evaluation of the extent to which the existing education and training is covering all of the desired content.

Identification and evaluation of “constraints” was carried out in a parallel process. Whereas the *content* is the foundation of the recommended model curricula, effective *delivery* is essential to ensure that learning objectives are accomplished, and successful *deployment* enables programs to become available to those in need. Possible constraints related to content, delivery and deployment were identified and evaluated.

GAP ANALYSIS

The team analyzed the database of the current courses and materials evaluated in the literature review to produce distributions of audiences served, core topics and transportation modes covered, and learning outcomes. Figures 1 to 4 show the results of this analysis. It should be noted, that for many of these topics, multiple responses were allowed to be marked for one unit of curricula material under consideration and that the percentages are only representative of the materials evaluated and listed in Appendix B.

When considering the previously defined focus topics that were of interest, it became apparent that several areas were lacking in curriculum materials, including logistics, economics, and emerging trends. There appeared to be good coverage for regulations, mode-specific safety, and to the greatest degree, incident management (Figure 1). Regardless of the development of curricula by the project team, emerging trends may always fall low on a chart such as this because the topic is a “moving target” as new technology is developed, presenting difficulties in keeping educational materials current. Some areas with strong potential for improved representation in hazardous materials curriculum coverage include logistics and transportation infrastructure. In developing the model curricula, it was determined that these two areas would require significant effort to develop new curricula due to the present shortage of relevant materials.

Figure 2 represents the distribution of coverage of transportation modes. Much of the curricula evaluated covered many, if not all, modes. Routinely, hazardous materials education and training lessons were focused on all modes, excluding pipelines. This trend continues when considering mode-specific education and training, with minimal information available for the pipeline industry. Of the various modes, availability of educational materials was found to be greatest for highways, followed closely by rail. From Figure 2, there appeared to be a need for development of curricula related to hazardous material transport by pipeline and air, at least at the introductory level.

Another consideration was the current and intended recipients of hazardous materials education. Figures 3a and 3b indicate that hazmat transportation education and training is covering both the public and private sectors well, but with an apparent lack of focus on non-profit organizations. However, non-profit organizations may participate in courses offered to the public sector through universities or professional development programs. Private sector audiences were considered to be non-governmental and non-public colleges or universities. For the most part, hazardous materials education and training is offered to both public and private groups.

More specifically, the audiences being served are largely those of operations and emergency response, as shown in Figure 3b (over half of the material evaluated). To a lesser extent, it appears that approximately one-third of all material evaluated is serving both the management and regulatory communities. Those audiences with a significant need for exposure to hazardous materials transportation education included university students, planners, and equipment developers. Although no hard evidence exists, the last group likely shows up because the hazmat equipment industry does not appear to offer its own training, nor are they often listed as a target audience by other training providers. It is not surprising that university students are not being exposed to hazardous materials education considering that fulfilling this need was the main focus of this research project.

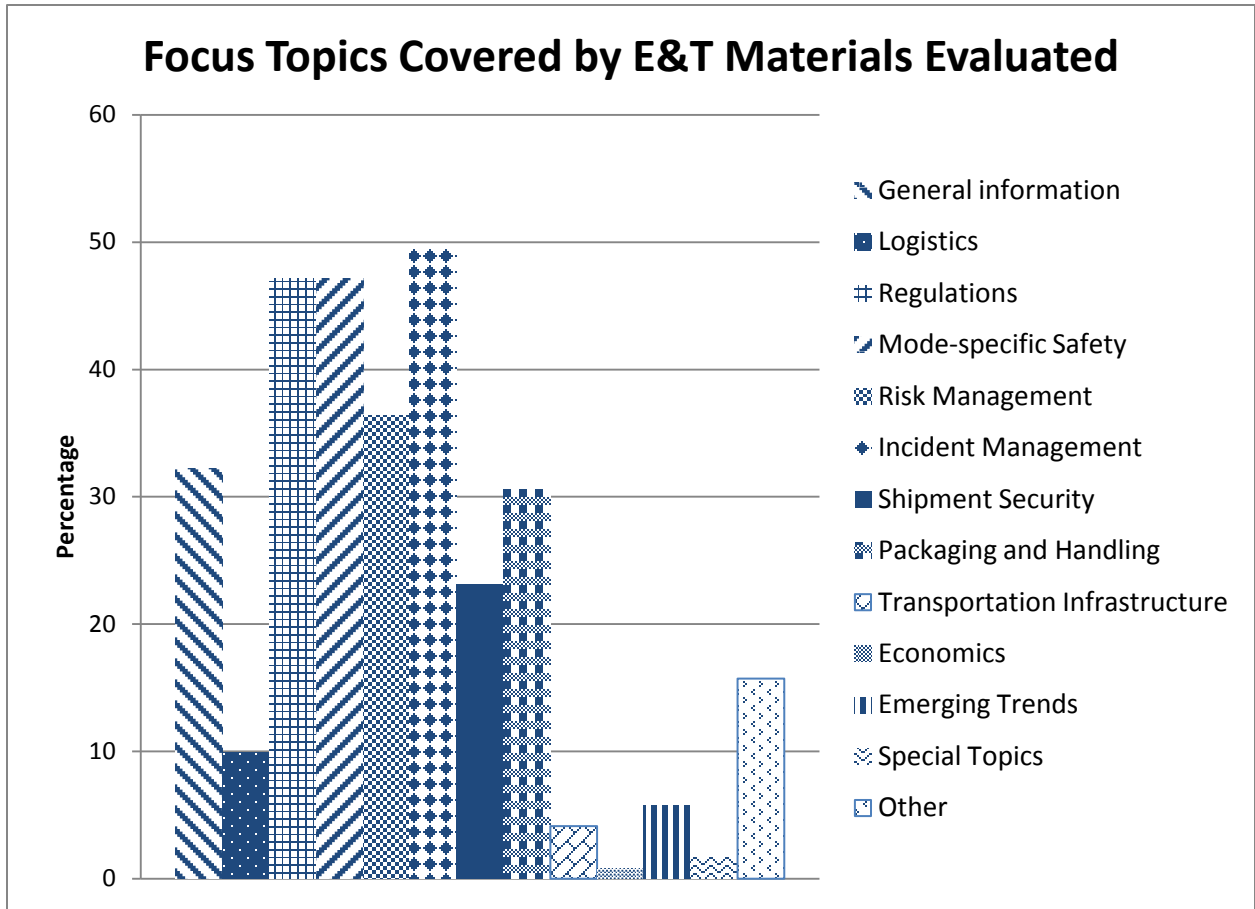


Figure 1. Focus Topic Summary

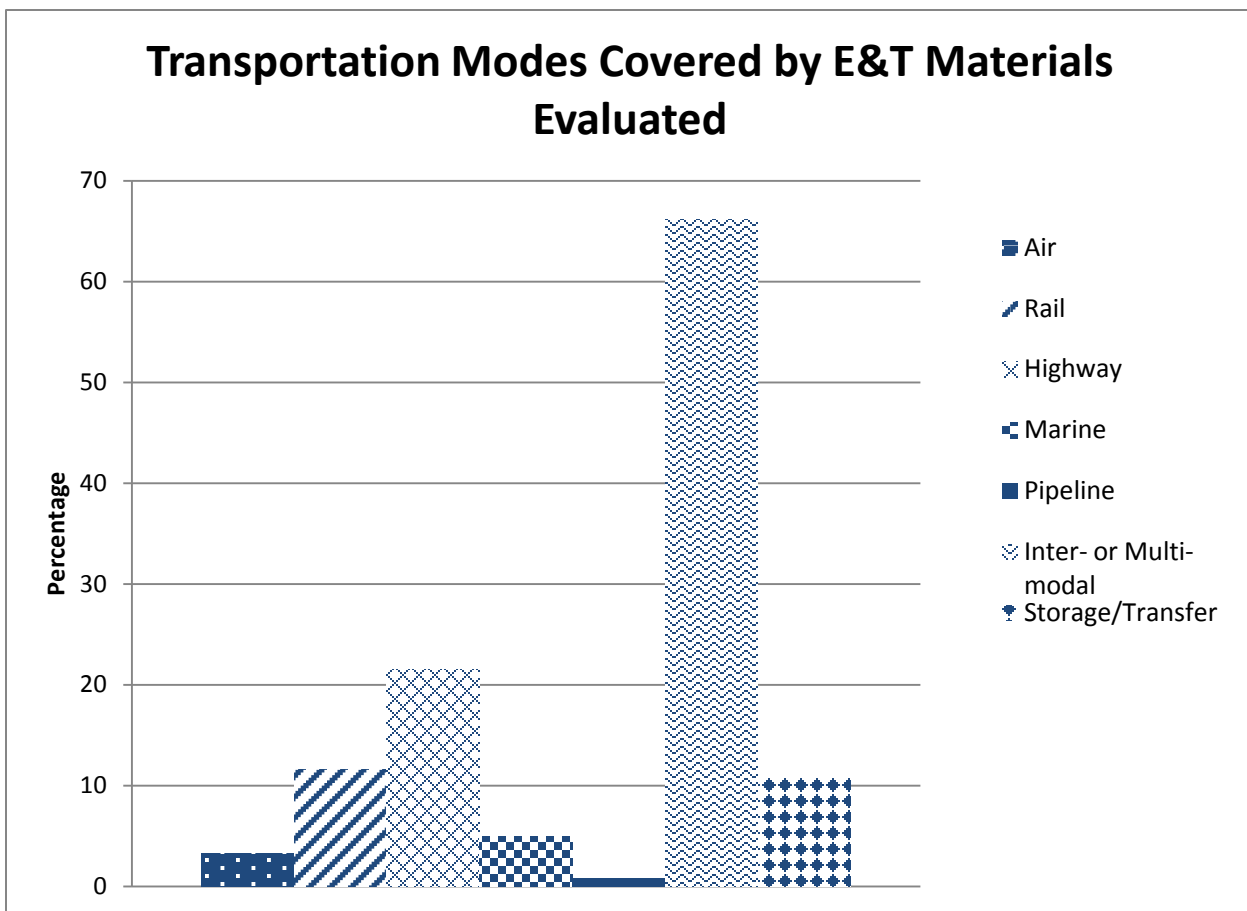


Figure 2. Transportation Mode Coverage

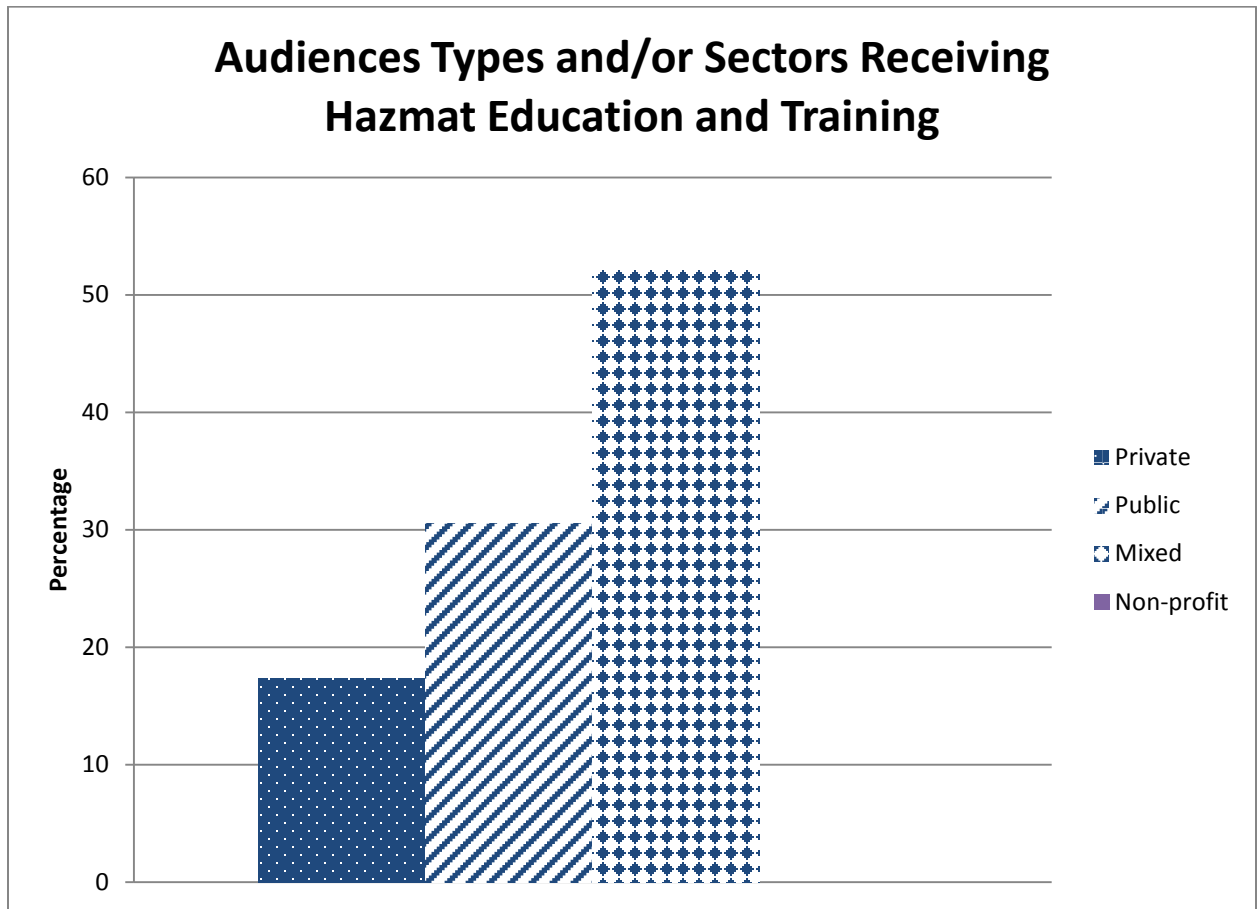


Figure 3a. Audiences Served (Type)

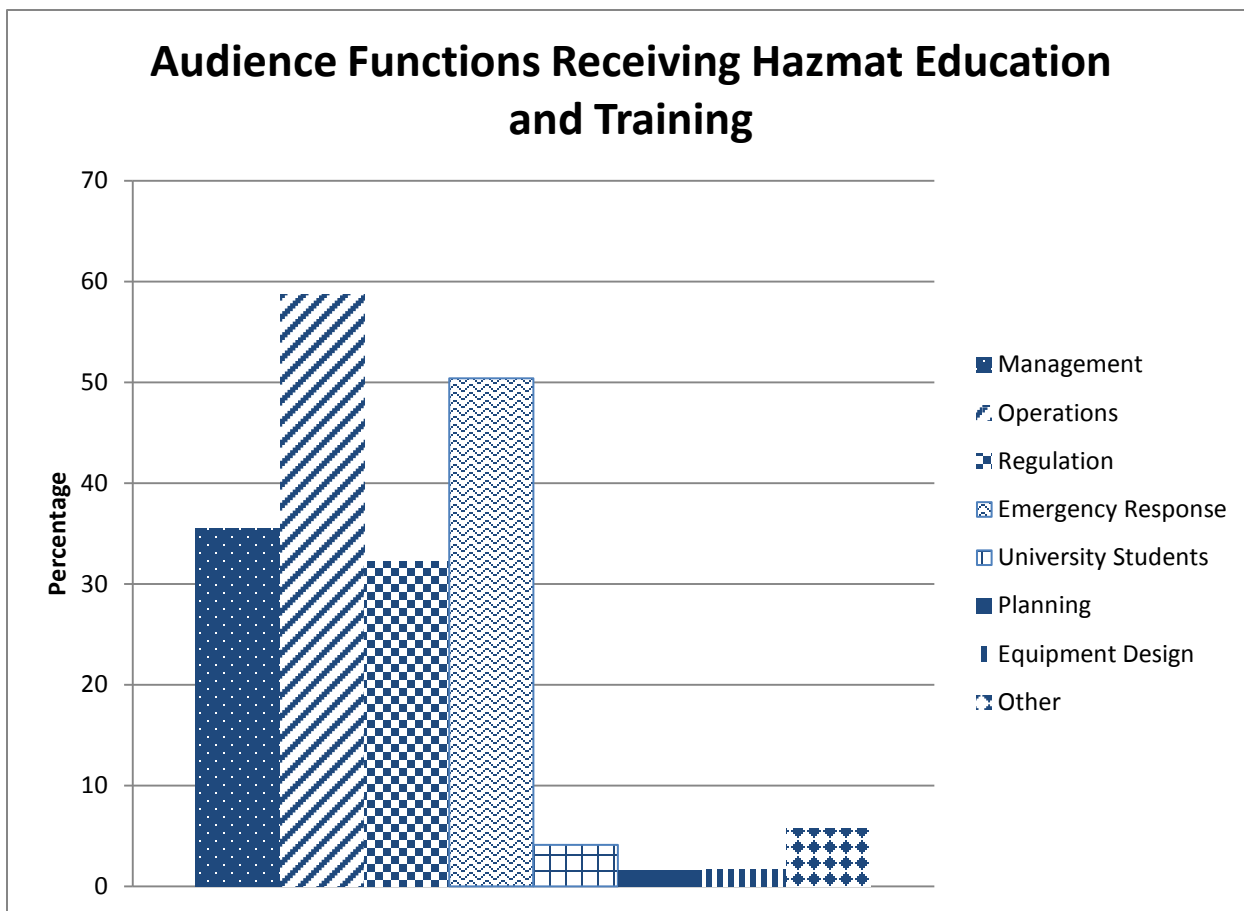


Figure 3b. Audiences Served (Function)

The extent to which the existing materials addressed the learning outcomes that were previously identified as having importance for hazardous materials education were also evaluated as part of the gap analysis (Figure 4). Among these, the most significant gap appeared to be for compliance and regulatory training, with safety and security and emergency response only represented in slightly higher percentages. Of the learning resources evaluated, there appears to be strong focus on material properties and hazards, accident/incident history, and the freight transportation system in general.

If the topics from Figure 1 are compared with the learning outcomes in Figure 4, one can surmise that much of the focus is on response to incidents and the properties of the hazardous materials being packaged and shipped. What appears to be lacking is general understanding of the safety and security of transport, including the logistics involved in mode and route selection and the general regulations surrounding hazardous materials transport. Even less understanding exists for the role of hazardous materials transport in society, the associated risks, and need for planning and transportation infrastructure considerations in moving these products throughout the U.S.

Table 8 provides a summary of the level of coverage of each primary topic area planned for inclusion in the model curricula. The column entries indicate the team’s assessment of the degree to which the materials reviewed are “curriculum-ready.” As noted above, the principal gap found was a lack of organized curricula materials for topics other than regulatory compliance and hazmat incident management.

CONSTRAINTS AND CHALLENGES

Making the curricula *available* will not necessarily result in their widespread *use* or *success*. This section discussed constraints and challenges considered to be the most significant obstacles for the curricula to reach intended audiences, accomplish learning objectives, and remain viable over time.

Some of the identified constraints and challenges are interrelated, but each is considered significant enough to warrant separate treatment. As much as possible, the discussion focuses on positive steps that can overcome the constraints and challenges.

Adapting to Audiences

The potential audiences for the hazmat transportation curricula vary in size and comprise diverse groups with different specialties. Perhaps the largest group of stakeholders comprises those who work for, or are studying to work for, trucking companies that move hazardous materials, with many thousands of companies carrying hazardous materials on an occasional basis or in small quantities. A much smaller number of companies specialize in hazmat transportation. The National Tank Truck Carriers (NTTC), for instance, is an organization of approximately 200 trucking companies—representing over 80% of bulk volume hauled in North America—and about 300 associated members.

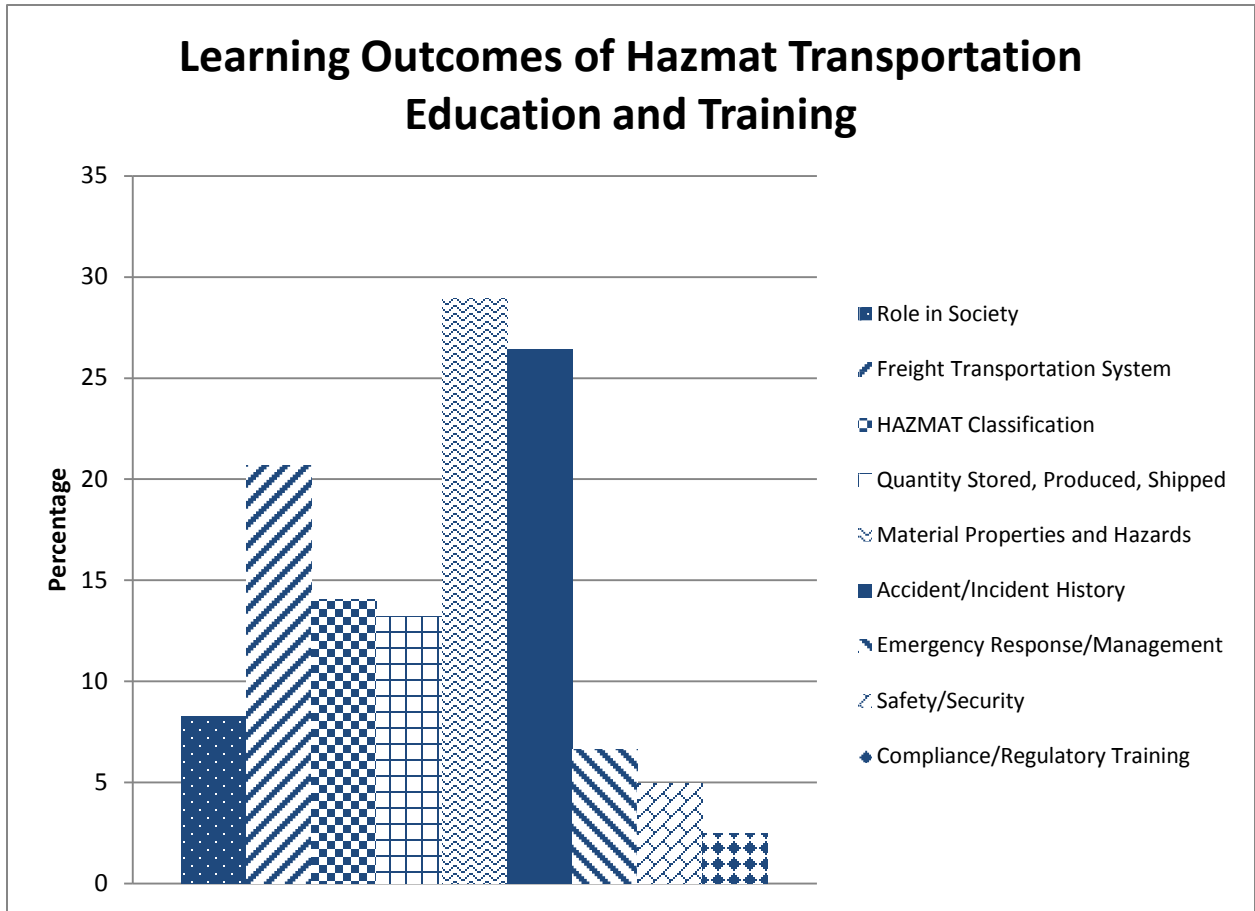


Figure 4. Coverage of Learning Outcomes

Table 8. Curricula Content Gap Assessment Summary

Curriculum Topic	Considerable information is available and is well organized for development of curricula topic	Considerable information is available and is NOT well organized for development of curricula topic	Some information is available for development of curricula topic, but is limited	No information is available for development of curricula topic
1 Introduction to hazmat transportation		X		
2 Freight transportation systems		X		
3 Hazmat transportation logistics			X	
4 Hazmat legal/regulatory	X			
5 Hazmat mode and route selection		X		
6 Hazmat risk management		X		
7 Hazmat emergency management and response	X			
8 Security of hazmat transportation shipments		X		
9 Emerging trends in hazmat			X	

Note: In chapter three topics 2 and 3 are combined, but during this part of the research they were being treated as separate topics.

The Alliance of Hazardous Materials Professionals has over 4,000 members in all fields of environmental, health, safety and security management. At another level, the Pipeline and Hazardous Materials Safety Administration (PHMSA) and the Federal Motor Carrier Safety Administration have a total of about 500 and 1,100 employees, respectively. At the smallest scale, the Dangerous Goods Trainers Association (DGTA), a relatively new organization, has fewer than 60 members. There are many groups of current practitioners who are specialists or already well-trained in a specific aspect or mode of hazardous materials transportation, but who could benefit from a more complete, broader level of professional development.

The challenge is to provide fundamental knowledge and skills that are useful for every audience, while recognizing that students will still have to rely on other resources to develop and maintain certain aspects of their respective expertise. Further, the curricula should lead to more holistic decision making and more effective interaction among the disciplines to help avoid inconsistency and redundancy.

Ideally, the curricula should be adaptable for all of the following circumstances:

- Entire curricula used for an undergraduate- or graduate-level course in an academic program for engineering, business, public policy, emergency management, or related field
- Modules used as part of a broader academic course in transportation, business, public policy, emergency management, fire and emergency services, law, environmental sciences, or related field
- Entire curricula condensed for use as an executive development course, with changes in emphasis depending on the focus of the audience (e.g., shippers, carriers, regulators, infrastructure providers, emergency managers, and emergency responders)
- Modules adapted for use in executive development courses (e.g., using discipline-specific material in leadership development courses for managers in the hazmat transportation industry)
- Modules adapted for use in training courses (e.g., to provide greater context and more information about emerging trends as part of compliance-based training)

The curricula will also need to be adaptable to both classroom situations and for distance-based learning. Once the basic course materials are adequately refined and validated, they will need to be supplemented and enhanced by audiovisuals, interactive tools, and other information technology applications.

Curricula Owner and Champions

The curricula content developed as part of this project will gradually become outdated and stale absent an entity to serve as the “owner” of the curricula. This organization would coordinate curricula updates to keep pace with changing regulations, technology, market forces, and other factors. The owner would also provide leadership and technical support to facilitate course offerings, attract students, provide ongoing user support, and promote the success of the products.

Efforts to deploy the curricula will also require additional stakeholders to serve as advocates or champions. In some cases, these stakeholders can themselves serve as course sponsors or organizers. They can also promote the importance of mastering the curricula in their hiring and promotion practices. Existing organizations that represent key hazmat transportation stakeholder groups are candidates to serve as champions.

Integration of Education and Professional Development

The curricula would be more likely to succeed if incorporated into an integrated system of education and professional development. Table 9 highlights the components of such systems for three selected professions—transportation engineers, logisticians, and emergency managers—and shows in comparison what is currently available to the hazmat transportation professional. In general it was found that hazmat transportation professionals as a group lack most of the attributes observed for the other groups.

For each of the three selected professions, accredited academic programs are available at numerous colleges and universities, with core and optional courses, proven textbooks, and networks linking students with potential employers. Professional journals describe the state of the practice and explore new concepts for both students and practitioners. Professional organizations facilitate exchange of information and continuing education through meetings, seminars, and conferences. Professional certifications set standards for experience and competency and require continuing education. Other incentives create both the demand for education and the resources to provide such education. Knowledge gained in the classroom is reinforced, expanded, and updated throughout the professional's career, and the classroom courses are updated to meet professional needs.

Although few components of such a system are in place for hazardous materials transportation professionals, the curricula developed in this project could be an important addition. Further, there may be opportunities to insert this product within the systems for these other, related professions. Curricula modules could become part of the courses taught to students in engineering, business, and emergency management. Other mechanisms include encouraging textbook authors to devote more attention to hazmat transportation, expanding the coverage of hazmat transportation subjects in technical journals, presenting the developed material to local chapters and at technical meetings, and advocating for hazmat transportation questions in exams for professional certification.

Field Testing and Refinement

The project scope of work provided for only two limited presentations of the curricula to help identify and correct any weaknesses. A more complete, systematic round of presentations would undoubtedly reveal additional opportunities for improvement, and increase the credibility and marketability of the curricula.

Table 9. Integrated Education and Professional Development for Selected Professionals

Feature	Transportation Engineers	Logisticians	Emergency Managers	Hazardous Materials Transportation Professionals
Recognized College/University Programs	Yes	Yes	Yes	No
Academic accreditation	Institutional (Regional) and Programmatic (ABET)	Institutional (Regional) and Programmatic (AACSB or ACBSP)	Institutional (Regional)	
Core curricula	Well defined	Well defined	Becoming well defined	HM-16 is first step
Widely used textbooks	Yes	Yes	A few, with more emerging	No
Discipline specific professional journal(s)	Yes	Yes	Yes	No
Discipline specific professional organizations	Institute of Transportation Engineers (ITE)	American Society of Transportation and Logistics (AST&L); International Society of Logistics (SOLE); Association for Operations Management (APICS); Council of Supply Chain Management Professionals (CSCMP); and others	International Association of Emergency Managers (IAEM)	No (1)
Approximate number of individual members; local chapters/sections	ITE has approx. 17,000 individual members; technical councils, districts, and sections; approx. 150 student chapters	AST&L has 1,000 members worldwide and chapters in seven metro areas in North America; SOLE has over 90 chapters in more than 50 countries; APICS has more than 200 local chapters and approx. 200 student chapters in North America; CSCMP has more than 8,500 members in more than 65 countries	IAEM has 5,000 individual members, including 1,500 students; national councils; student council and approx. 30 student chapters	

Table 9. Integrated Education and Professional Development for Selected Professionals (Continued)

Feature	Transportation Engineers	Logisticians	Emergency Managers	Hazardous Materials Transportation Professionals
Annual meeting(s)/ Technical conferences	Yes	Yes	Yes	
Professional Certifications	PTOE, PTP, TOPS, TSOS (2)	Multiple (3)	CEM, AEM (4)	No, other than regulatory compliance and broader hazmat professional (5)
Education and continuing education requirements	Yes	Yes	Yes	
Other motivation/support for education	Continuing education required for licensed Professional Engineers	Educational support through professional organizations and partnerships with business schools	IAEM Scholarship Program	Training required for regulatory compliance
Sources of research funding	NCHRP, RITA(UTCs), State DOTs	Businesses, associations, foundations	Limited	HMCRP
Federal agency technical support for higher education programs	No	No	Yes (FEMA Emergency Management Institute Higher Education Program)	No

Notes:

- (1) Related, but not transportation-specific professional organizations, include the Alliance of Hazardous Materials Professionals (AHMP) and the Institute of Hazardous Materials Management (IHMM).
- (2) Transportation Professional Certification Board, Inc.: Professional Transportation Operations Engineer (PTOE), Professional Transportation Planner (PTP), Traffic Operations Practitioner Specialist (TOPS), Traffic Signal Operations Specialist (TSOS)
- (3) AST&L, SOLE, APICS, CSCMP, and others (e.g., the Institute of Packaging Professionals (IOPP)) offer professional certification programs.
- (4) International Association of Emergency Managers: Certified Emergency Manager (CEM), Associate Emergency Manager (AEM)
- (5) The Institute of Hazardous Materials Management (IHMM) offers professional certification.

Adoption by Academic Institutions

Academic institutions have formal procedures for adding new programs and courses, or for making changes to existing courses. Many factors are considered, not the least of which are economic—will enough students be attracted to cover the costs, understanding that students may have an option to take another, already approved course to fulfill the same program requirement? Additional constraints can be circumstances where competing ideas for new course content are being proposed simultaneously or there is a lack of faculty teaching resources to support new offerings.

Advocates could try to use the curricula toolkit to accomplish one or more of the following within an academic institution:

1. Establish a new hazmat transportation program
2. Establish a new hazmat transportation concentration within an existing program
3. Add one or more hazmat transportation courses within an existing program
4. Add hazmat transportation content to existing courses

The most aggressive (#1) would require the approval of administrators, deans, department chairs, and faculty committees, and would require more compelling information than just the model curricula. Even the least aggressive (#4) might require approval from faculty committees, and would obviously require commitment by the faculty member or instructor responsible for the course.

At the undergraduate level, adding new courses in engineering can be especially difficult. Serious discussion is underway as to whether four years is enough time for a professional degree. In the meantime, accreditation for a civil engineering program, for example, now requires that students become proficient in mathematics and sciences, apply knowledge in four technical areas of civil engineering, perform experiments and analyze results, participate in a design project, and “explain basic concepts in management, business, public policy, and leadership.” The other engineering disciplines face similar requirements, so adding extra hours to an approved engineering program is not a reasonable option.

At the graduate level, universities are increasingly reliant on research funding to pay faculty salaries and provide student financial support. The HMCRRP, while a step in the right direction, is the only source of research funds focused exclusively on hazmat transportation and the recently enacted Federal transportation program reauthorization puts the future of this program in serious jeopardy. Consequently, university administrators may be skeptical that sufficient research funds would be available to offset an investment in a separate program or even a concentration in hazardous materials transportation.

Teach-the-Teacher

No resources or procedures are in place to provide instructors with background and supporting information, homework assignments, group activities, exam questions, or other materials that would enable them to bring a hazmat transportation course offering to fruition with minimal investment in time and effort. Beyond simply making the curricula materials available, the

modules could be used to introduce groups of educators to the subject of hazmat transportation, and train them in the use of the curricula.

Interdisciplinary Features

Hazmat transportation is an interdisciplinary field. When success stories are told, key ingredients almost always include effective coordination and communication among disciplines. Likewise, failures are typically caused by inadequate coordination and communication. Unfortunately, education and training is almost always delivered within the structure of a single discipline (academic school, company or government agency, professional organization, individuals with certain job/position responsibilities). Thus, it is especially important for the hazmat transportation curricula to address communication, cooperation, and interoperability in the course material, including case studies. Also, instructors should be encouraged to use techniques such as role playing, side-by-side comparisons, and perspective-based homework and research assignments.

Regulations

The curricula materials address regulatory processes, the basic themes of the various regulations that apply to hazmat transportation, and the relationships among the various regulations. The many details of the applicable regulations are more appropriately assimilated through training and operational experience. However, regulations are central to the transportation of hazardous materials. The curricula will therefore need to be updated frequently to reflect current regulations and those who teach the curricula will need to have knowledge and understanding of the management and operational implications of such regulations.

Case Studies

Most of the identified case studies focus on major incidents, providing details about the immediate causes and impacts. Less information is provided about the underlying business or operational decisions that contributed to the incident. Likewise, recovery efforts and longer term impacts on the community, shippers, carriers, and other stakeholders are not as well documented. Perhaps more important, case studies are not as readily available for the less dramatic but more frequent incidents that are caused by systemic problems and can have serious cumulative effects on shippers and carriers and other stakeholders. Instructors should be encouraged to assign the development of more insightful case studies as “group projects” that also helps create a repository of such studies for others to use.

CHAPTER 5

PEER EXCHANGE

ORGANIZATION AND CONDUCT OF THE PEER EXCHANGE WORKSHOP

The draft model curricula were reviewed and evaluated at a one-day peer exchange at the National Academies' Beckman Center in Irvine, California. Invited workshop participants represented a variety of stakeholder groups expected to benefit from having the curricula available, and considered knowledgeable about the educational needs of their constituents.

The stakeholder list appearing in Table 7 served as the starting point for identifying candidate workshop participants. Within the broad constituent groups in the table, potential candidates were identified from a number of sources, including:

- HMCRP Oversight Panel and project panels
- TRB Committee on Hazardous Materials Transportation
- Other relevant TRB committees
- USDOT University Transportation Centers and the Council of University Transportation Centers
- DHS Centers of Excellence
- Relevant industry associations
- Hazmat industry private companies, primarily shippers and carriers
- Individuals identified in the initial review of existing programs and resources
- Researcher individual contact networks in industry, government, and education

With guidance provided by the project panel, the list was reduced to a subset of individuals, who were each contacted to gain a better understanding of what they might be able to contribute to the workshop, as well as to ascertain their level of interest in participating. The final invitation list comprised 53 individuals with the following distributional representation:

9	Shippers and receivers (of raw materials and finished products)
14	Carriers
4	Distributor/warehouse/terminal operator
4	International freight forwarder/carrier/broker
4	Policymakers (elected/appointed officials)
4	Transportation infrastructure providers and operators
5	Regulators
2	Transportation security
2	Compliance and enforcement
1	Community planner/economic developer
2	Emergency responders
2	Emergency managers
8	Educators
13	Trainers

10 Researchers
7 Consultants

Note that because many invitees were considered as being associated with more than one stakeholder group the above list sums to well over 53. This overlap was considered advantageous in that these individuals would be able to review the model curricula from multiple perspectives.

Also, note that there is disproportionate representation across certain stakeholder groups. This was done purposely, to reflect that certain audiences are primarily potential curriculum users, while others are highly knowledgeable about existing hazmat education and training resources.

Appendix D provides some of the materials used at the workshop, including the agenda and the invitation roster. The shaded rows in the roster identify four invitees who were not able to attend. The last three columns of the roster indicate the breakout groups to which participants were assigned by the project team to help ensure balanced perspectives in each group.

The first plenary session included a brief summary of the project findings to that date, since most participants were not familiar with the background effort that led to the draft curricula. In the second plenary session project team members presented overviews of each module.

Participants were asked to provide feedback on the overall breadth and depth of the draft curricula, and to identify any missing topics. Other mechanisms were made available for providing detailed comments, as follows:

- Binders with hardcopy slides for markup were available throughout the day.
- Workshop folders included blank sheets for participant comments (signed or anonymous). The sheets were collected at the final session.
- Participants were encouraged to send email to the project's principal investigator
- Participants were invited to talk to research team members throughout the day.

At the end of the plenary session, electronic polling was used to obtain input on which modules the participants desired to discuss in depth during the breakout sessions to follow. Modules covering the topics of hazmat legal and regulatory environment, risk management, and hazmat transportation incident management were selected. As time permitted, the other modules were also discussed. Each breakout group was also asked to discuss any special topics that warranted coverage in an existing module or treatment as a separate curricula module.

In the first afternoon plenary session, reports from the morning breakout sessions were presented. At the end of the session participants used electronic polling to register their preferences on the proposed special topics. Two topics emerged as those of highest interest: (1) new technologies and (2) workforce issues and careers in hazmat transportation.

The afternoon breakout groups discussed curriculum deployment strategies and considerations, and performance measures. In all three groups the bulk of the discussion was on the first of these topics. The breakout group conclusions and recommendations were presented in the concluding plenary session. This was followed by a closing discussion on the totality of the workshop proceedings.

On the second day, the project panel, TRB staff, and research team met for several hours to discuss the workshop outcomes and remaining project work tasks.

PEER EXCHANGE RESULTS

Feedback from the workshop included a transcript of the handwritten notes that were taken to capture issues and questions raised during the various workshop sessions, and a compilation of specific participant comments submitted during and at the end of the workshop and some via e-mail. This feedback was used to in guiding the module revision process and developing the project final report. A summary of the overarching comments follows.

1. Considerable support for implementing the curricula was evident.
 - a. Product viewed as a “curriculum toolkit.”
 - b. Most valuable material is the vetted module content.
2. Clarify scope and target audience.
 - a. Focus on education recognizing multiple audiences (e.g., university students, professionals, etc.).
 - b. Teach student how to think about the problem (e.g., fewer lists, more synthesis).
 - c. Limit amount of “how to” information
3. Key points to consider in finalizing curricula
 - a. Use risk management as a unifying concept.
 - b. Include an international/global slant (e.g., “dangerous goods” as well as “hazardous materials”).
 - c. Include recognition of industry roles and initiatives.
 - d. Focus more on management processes, including the concept of risk versus reward.
 - e. Make sure that air, marine, pipeline, and nuclear transport are adequately covered.
 - f. Consider developing guidance on how the material may be utilized by different audiences.
 - i. Instructor guide or curricula guide as preface
 - ii. Notes throughout modules
4. Need to define “hazardous materials” and “dangerous goods,” and use these terms consistently through the modules
5. Make greater use of case studies
6. Consider social media channels to:
 - a. raise awareness
 - b. impart curriculum (in subjects such as risk communication and incident management)
 - c. use as a student assignment (e.g., truth digging associated with a past incident)
 - d. access and utilize You Tube videos and other relevant information.
7. Recommend a program of follow-up deployment activities involving stakeholders.

CHAPTER 6

REVISED CURRICULA AND IMPLEMENTATION STRATEGIES

RESEARCH PROCESS

The nature of this task changed somewhat as a result of discussions with the project panel at the conclusion of the peer exchange workshop. The clear directive from the panel (and workshop participants) was that the most important aspect of this task was revising the draft model curricula to incorporate the valuable feedback generated at the peer exchange workshop, with an emphasis on improving the coverage and quality of the slides and related materials. There was less interest in pursuing ancillary efforts such as developing detailed slide notes, student exercises, proficiency tests, and other student performance assessments. There was also a secondary desire for the team to do more work on outreach and exploration of methods to develop a mechanism for further updates, curricula dissemination, and related tasks.

In light of this directive, the research team performed the following subtasks:

- Revise and finalize the model curricula slide content and related materials
- Conduct trial presentations of selected curricula material
- Develop initial proposed implementation plans

The results achieved are described in the following sections.

REVISED MODEL CURRICULA: A TOOLKIT FOR HAZARDOUS MATERIALS TRANSPORTATION EDUCATION

The draft curricula modules were extensively revised following guidance received at the peer exchange workshop. Much of the revision implemented a strategy of designing the project output as a toolkit that could be used by educators to present hazmat transportation content in a variety of courses and venues. In fact, the entire set of material now has a suggested title of “Toolkit for Hazardous Materials Transportation Education.”

The most significant change was development of an entirely new module on hazmat transportation workforce issues, which was one of the primary recommendations that came out of the peer exchange workshop. Hence the final modules in the toolkit are:

1. Introduction to Hazmat Transportation
2. Hazmat Transportation Logistics
3. Hazmat Legal and Regulatory Environment
4. Hazmat Mode and Route Selection
5. Hazmat Risk Management
6. Hazmat Transportation Incident Management
7. Security of Hazmat Transportation Shipments
8. Hazmat Transportation Workforce Development Issues

During the revision process, considerable material was moved to the slide notes, and additional material was added, both on the slides and the notes. The revised modules are in PowerPoint format rather than PDF files. Users are urged to view the slide notes for additional relevant content.

Five other notable additions were also developed. As noted in the workshop the term “hazardous materials” has many possible definitions, so a handout document was developed (see Appendix E) to assist instructors and students in reviewing meaningful definitions for the purposes of their respective courses and practical applications. There also appeared to be a need for a glossary of terms corresponding to curricula nomenclature, so one was prepared (see Appendix F). Appendix G provides brief introductory notes for the benefit of instructors and a list of supplementary materials that could be useful for many courses. Suggestions are offered for student handouts (see Appendix H). Also in response to workshop feedback, incident reports, reviews, and case study materials were collected and referenced in several modules. These materials are listed in Appendix G and are available online.

TRIAL PRESENTATIONS OF SELECTED CURRICULA MATERIAL

While the project schedule did not permit time for extensive presentations of the draft model curricula, the team did arrange three presentations of portions of the material, as summarized below.

The principal investigator made two presentations as part of the TRB Annual Meeting in January 2013. At the meeting of the Committee on Transportation of Hazardous Materials, he gave an overview of the project, and previewed the content of four of the modules. Considerable discussion of the project outcomes ensued. In general there was broad acceptance of the research product, and several of the academicians present expressed a desire to use the materials as part of their transportation or logistics course offerings during the Spring 2013 semester. At this writing, it appears that at least two such endeavors occurred, including one where the instructor used parts of modules one and two in his supply chain management course.

The principal investigator also spoke as part of a session focused on workforce development in transportation. At that session he presented a brief project summary, spending more of the time previewing the workforce development module. Some of the themes of that module were also part of the presentations given by other session participants, from which good leads for sources of cooperation in advancing dissemination of the curricula were developed.

The third presentation was given by team member Dr. Martin Lipinski at the Freight Workforce Summit on February 5-6, 2013 in Memphis, Tennessee. That meeting was sponsored by the Intermodal Freight Transportation Institute (IFTI) at the University of Memphis, as a member of the National Center for Freight and Infrastructure Research and Education (CFIRE) who sponsored the summit. The Freight Workforce Summit provided an opportunity for private industry, public sector and academic institutions to discuss the growing workforce challenges facing this industry. Some of the specific discussion topics included what undergraduate students need to know to flourish in the working world; ways to continue educating current employees; and how to match the right students to the right jobs. As part of this program, Dr. Lipinski gave

an overview of the HMCRP HM-16 project to a group of fifteen representatives of academic institutions and industry. He presented the draft module that was developed focusing on Hazmat Transportation Workforce Development Issues. The group provided comments and feedback that was used to revise the content of this module.

All three of these presentations provide good examples of the kind of outreach that needs to occur if the model curricula are to find their way into academic and executive education offerings nationwide. These types of early offerings would both expose the curricula to potential adopters, and also garner feedback that can be used for content improvement.

IMPLEMENTATION STRATEGIES

Chapter four discusses some of the primary constraints on adoption and use of the model hazmat transportation education curricula. That material was used as the basis for the extensive discussion during the peer exchange workshop of how to implement and sustain the hazmat model curricula. One of the key recommendations of the workshop participants was to institute a program of follow-up deployment activities involving stakeholders. Some of the ideas discussed as to how to accomplish this are summarized below.

1. First step: estimate demand.
 - a. Consider industry and government needs.
 - b. Performing a market analysis (Who is the audience? What is the demand?) will drive identification of the most important audiences and delivery mechanisms.
 - c. One indicator of demand: there are about 7,500 Certified Hazardous Materials Managers, with about 450 new certificates issued each year
2. Tie the curricula to jobs, internships, etc.
 - a. Encourage use of the toolkit within the educational element of internships.
3. There is high potential for deployment of the curricula, as the modules could be used with a range of courses in areas such as engineering, business, environmental management, public health, emergency management, criminal justice, and others.
 - a. However, major restructuring would be required to mount a full academic program.
4. The toolkit is compatible with offerings in multiple venues and formats, including:
 - a. single university survey course or module, perhaps initially a “special topics” course
 - b. multiple courses
 - c. executive courses
 - d. offer continuing education units (CEUs), professional development hours (PDHs), etc., following International Association for Continuing Education and Training (IACET) standards
 - i. CEUs are more difficult to implement than PDHs
 - ii. Certified DG Professional may be an option for CEUs
 - e. community colleges, technical colleges
 - f. certificate programs
 - g. focus on colleges catering to adult learners
 - h. possible transitional course for career change and continuing education

- i. for-profit schools
5. Consider on-line curriculum delivery, both synchronous and asynchronous.
 - a. Webinars, e-conferencing, and similar venues would be good options, if appropriate sponsors can be found.
6. Pursue an analog to the EIT/PE model:
 - a. education to qualify for first-level exam
 - b. experiential component
 - c. second level exam for certification
7. International courses, programs, certificates offer another possible model to follow:
 - a. The European Union requires hazmat firms to employ a Dangerous Goods Safety Advisor (DGSA), a certification that is also available in the U.S.
 - b. Dangerous Goods Training Association (DGTA) offers certifications.
8. Organize a peer group of educators to use, support, and enhance the toolkit.
 - a. Encourage faculty sharing of lesson plans and feedback associated with using curriculum materials.
9. Support for deploying and enhancing the toolkit could come from industry trade associations, individual shippers or carriers, government agencies or non-profit groups, and educational institutions.
 - a. A large list of potential sponsoring organizations was drafted and reviewed at the workshop.
 - b. The peer exchange participants could be a resource for reviewing and editing this listing, to identify organizations, contacts, and champions.
10. Other specific deployment suggestions
 - a. Look at AREMA Course 24 as a model.
 - b. Identify organizations and agencies that may be interested in offering this for CEUs/PDHs.
 - c. Present at hazmat committee showcases.
 - d. Provide incentives to students (e.g., certificates).
 - e. Align assignments with the type of offering (i.e., What is a relevant student exercise for a full course versus a partial course?)
 - f. Make use of field trips, table top exhibits (touch and feel), and outside speakers.
 - g. Introduce hazmat as a topic for student presentations and competitions at national professional meetings.
 - h. Consider copyrights vs. open source site.
 - i. Target the segment of the work force that needs this education now.
 - j. Use social media to publicize the toolkit and various offerings.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

This research project produced a set of hazardous materials education curricula materials that are useful in a wide variety of educational settings. Peer review of the material was an essential element of achieving this result. The topics cover most of what educators and industry executives desire for educating current and future hazmat transportation employees.

That being said, it is clear that resource constraints did not allow producing a final set of course materials that are as polished and vetted as other recent Cooperative Research Program curricula efforts, such as Road Safety 101, *NCHRP Report 667*, or similar commercial products. The main shortcomings are complete slide notes, instructor and student guides, exercises, and proficiency tests. Hence, the resulting product is more correctly labeled a “toolkit for hazardous materials transportation education.” There also was not time for full semester-length trial offerings of the content, which would have the benefit of providing in-use feedback for a final round of curricula material improvement.

Deployment and ongoing support of the hazmat transportation education toolkit emerged as a challenge, but one in which there is considerable interest among those who have seen the developed material. The recommendations offered below principally address the issues of toolkit deployment and enhancement.

RECOMMENDATIONS

The following recommendations for further effort would considerably enhance the prospects for implementation of the hazmat transportation model curricula.

- Conduct market analysis of prospective adopters.
- Promote curricula to potential users.
- Organize a hazmat transportation education working group to facilitate curricula adoption and evolution, track curricula usage, and serve as the secretariat for a stated period. A similar model was followed by the Federal Highway Administration and TRB in supporting development of the Distance Learning Graduate Certificate Program in Transportation that is currently administered by the USDOT Regional University Transportation Centers.
- Provide additional supporting materials for each module, such as student guide, exercises, examinations, etc.
- Support initial academic offerings at one or more universities.

- Produce and offer one or more executive education sessions.

The products of this research initiative will gradually become outdated and stale, absent an entity to serve as the “owner” of the curricula. The owner would provide leadership and technical support to update the toolkit content, facilitate course offerings, attract students, provide ongoing user support, and promote the success of the products. Identifying and perhaps funding someone to fill this “owner” role is the single largest obstacle to successful deployment.

APPENDIX A

LIST OF SOURCES REVIEWED

University Programs: Engineering and Environmental Science

Arizona State University, Environmental Technology Management Program,
<https://technology.asu.edu/etm>.

George Mason University, <http://civil.gmu.edu>.

Michigan State University, School of Packaging, <http://www.packaging.msu.edu>.

Michigan Tech University, <http://www.mtu.edu/engineering>.

North Carolina State University, Department of Forestry and Environmental Resources,
<http://cnr.ncsu.edu/fer/index.html>.

North Dakota State University, <http://www.ndsu.edu/cea>.

Northwestern University, <http://www.mccormick.northwestern.edu>.

South Carolina State University, <http://utc.scsu.edu/education.htm>.

Texas A&M University, College of Architecture, Hazard Reduction and Recovery Center,
<http://archone.tamu.edu/hrrc>.

University of British Columbia, <http://www.engineering.ubc.ca>.

University of Carleton, <http://www.carleton.ca>.

University of Illinois, Railroad Engineering Program,
<http://ict.illinois.edu/railroad/cee/overview.asp>.

University of Kentucky, <http://www.engr.uky.edu>.

University of Manitoba, <http://www.cc.umanitoba.ca>.

University of Nevada, Las Vegas, <http://ce.egr.unlv.edu>.

University of South Carolina, Department of Environmental Health Sciences,
<http://www.sph.sc.edu/enhs/default.htm>.

University of Tennessee, Knoxville, <http://www.engr.utk.edu>.

University of Waterloo, <http://uwaterloo.ca>.

University Programs: Business, Law, and Emergency Management

American Public University System, <http://www.apus.edu>.

Arizona State University, Carey Business School, <http://wpcarey.asu.edu>.

Arizona State University, Environmental Technology Management Program, <https://technology.asu.edu/etm>.

Auburn University, Department of Aviation and Supply Chain Management, <http://business.auburn.edu/academicdepartments/aviation/undergrad/index.cfm>.

Eastern Iowa Community Colleges, Health, Safety, and Environmental Technology Program, <http://www.eicc.edu/highschool/programs/career/environmental/hset/index.html>.

Eastern Michigan University, Public Safety Administration Program, <http://catalog.emich.edu>.

Georgia Southern University, Management, Marketing and Logistics Department, <http://coba.georgiasouthern.edu/depts/mml>.

Gwinnett Technical College, Emergency Management Associate Degree Program, <http://www.gwinnettech.edu>.

Iowa State University, College of Business, <http://www.business.iastate.edu>.

Metropolitan Community College, Emergency Management Program, <http://www.mccneb.edu/careerprograms.asp>.

Michigan State University, Eli Broad Graduate School of Management, <http://broad.msu.edu>.

North Dakota State University, Department of Emergency Management, <http://www.ndsu.edu/emgt>.

Northwestern University, Kellogg School, <http://kellogg.northwestern.edu>.

Ohio State University, Fisher College of Business, <http://www.cob.ohio-state.edu>.

Oklahoma State University, Fire and Emergency Management Administration Program, <http://grad.okstate.edu/programs/fire/femp.htm>.

Pennsylvania State University, Smeal College of Business, <http://www.smeal.psu.edu>.

Rutgers University, Business School, <http://business.rutgers.edu>.

St. Johns University, School of Law, <http://www.stjohns.edu/academics/graduate/law>.

Texas A&M University, Texas Transportation Institute, <http://tti.tamu.edu>.

University of Arkansas, Sam M. Walton College of Business, <http://waltoncollege.uark.edu>.

University of Cincinnati, <http://www.uc.edu>.

University of North Florida, Coggin College of Business, <http://www.unf.edu/coggin>.

University of North Texas, Department of Public Administration, <http://pacs.unt.edu/public-administration>.

University of Tennessee, College of Business Administration, <http://bus.utk.edu/cba>.

Western Nebraska Community College, <http://www.wncc.net/hatc>.

University Programs: Public Policy, Public Health, Community Colleges, and Other

Public Policy

Georgetown Public Policy Institute, <http://gppi.georgetown.edu/>.

Gerald R. Ford School of Public Policy, University of Michigan, <http://www.fordschool.umich.edu>.

Indiana University, School of Public and Environmental Affairs (SEPA), http://www.indiana.edu/~spea/research/research_centers/index.shtml.

Kennedy School of Government, Regulatory Policy Program, and Belfer Center for Science and International Affairs, Harvard University, <http://www.hks.harvard.edu>.

Richard and Rhoda Goldman School of Public Policy, UC Berkeley, <http://gspp.berkeley.edu>.

U.S.-Mexico Border Environment Program, Udall Center for Studies in Public Policy, University of Arizona, <http://www.udallcenter.arizona.edu/programs/usmex>.

University of Maryland, School of Public Policy, <http://www.publicpolicy.umd.edu>.

Public Health

University of Findlay, All Hazards Training Center, <http://seem.findlay.edu>.

University of Illinois at Urbana-Champaign, Division of Safety Research, Transport of Biological Materials, <http://www.drs.illinois.edu/bss/programareas/transport>.

University of Minnesota, School of Public Health, <http://www.sph.umn.edu/ce/niehs>.

University of Utah, School of Medicine, Rocky Mountain Center for Occupational and Environmental Health, <http://medicine.utah.edu/rmcoeh>.

Community Colleges

Continuing Education Program, Wilkes Community College, NC,
<http://www.wilkescc.edu/default2.aspx?id=8118>.

Wilson Community College, Continuing Education Business and Industry Training,
<http://www.wilsoncc.edu/coned/busind.cfm>.

York Technical College, SC, <http://www.yorktech.com/ce/EECourses.php>.

Other

Bureau of Dangerous Goods, <http://www.bureaudg.com/training/49cfr-initial-training.asp>.

Flatline Response, Inc., <http://www.flatlineresponse.com>.

Gennaro Transport Training, <http://www.gennaro.ca/training/index.html>.

Justice Institute of British Columbia, Canada.

Montreal Polytechnic, Quebec

Richards Truck Driving School, <http://www.richardsdrivingschool.com>.

Ritchies Training Centre, University of Paisley, Scotland , David Ritchie, Dangerous Goods Trainer.

University of Birmingham, United Kingdom, Birmingham Centre for Railway Research and Education, <http://www.birmingham.ac.uk/index.aspx>.

University of Ottawa, Transportation of Dangerous Goods,
<http://www.uottawa.ca/services/ehss/tdg.htm>.

Women Exploring Trades & Technology Program, Yukon College,
<http://www.yukoncollege.yk.ca/programs/wett/index.php>.

U.S. Department of Transportation (USDOT)

Federal Aviation Administration, <http://www.faa.gov>.

Federal Highway Administration, <http://www.fhwa.dot.gov>.

National Highway Institute, <http://www.nhi.fhwa.dot.gov/default.aspx>.

Federal Motor Carrier Safety Administration, <http://www.fmcsa.dot.gov>.

Federal Railroad Administration, <http://www.fra.dot.gov>.

Maritime Administration, <http://www.marad.dot.gov>.

United States Merchant Marine Academy, <http://www.usmma.edu>.

Maine Maritime Academy, <http://www.mainemaritime.edu>.

National Highway Traffic Safety Administration, <http://www.nhtsa.gov>.

Pipeline and Hazardous Materials Safety Administration, <http://www.phmsa.dot.gov>.

Research and Innovative Technology Administration, <http://www.rita.dot.gov>.

Bureau of Transportation Statistics, <http://www.bts.gov>.

Transportation Safety Institute, <http://www.tsi.dot.gov>.

Saint Lawrence Seaway Development Corporation, <http://www.seaway.dot.gov>.

Surface Transportation Board, <http://www.stb.dot.gov/stb/index.html>.

Department of Defense (DOD)

Army Logistics University, <http://www.almc.army.mil/>.

Defense Ammunition Center, U.S. Army, <http://ammo.okstate.edu/>.

Defense Logistics Agency, <http://www.hr.dla.mil/downloads/trn/courses/environmental.pdf>.

Defense Technical Information Center, <http://www.dtic.mil/dtic/index.html>.

Eastern Oklahoma State College, <http://www.eosc.edu/academic/programs.html>.

U.S. Army Corps of Engineers. USACE Environmental and Munitions Center of Expertise, <http://www.environmental.usace.army.mil/>.

Department of Homeland Security (DHS)

Federal Emergency Management Agency, Center for Domestic Preparedness. <http://cdp.dhs.gov>.

Federal Emergency Management Agency, Emergency Management Institute Higher Education Program, <http://www.training.fema.gov/emiweb/edu>.

Federal Emergency Management Agency, U.S. Fire Administration, <http://www.usfa.fema.gov>.

U.S. Coast Guard, Hazardous Materials Division (CG-5215), <http://www.uscg.mil/hq/cg5/cg5215>.

U.S. Coast Guard, Training Center Yorktown, <http://www.uscg.mil/tcyorktown/default.asp>.

Department of Energy (DOE)

Oak Ridge National Laboratory, Transportation Management Organization, <http://www.ornl.gov/sci/tpm>.

U.S. Department of Energy, Transportation Emergency Preparedness Program, <http://www.em.doe.gov/TEPPPages/TEPPHome.aspx>.

Environmental Protection Agency (EPA)

Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation, <http://www.epa.gov/superfund/partners/osrti/index.htm>.

State-Supported Training for Emergency Responders

Association of Bay Area Governments, Hazmat School. <http://www.hazmatschool.com/HSCourses.html>.

California Emergency Management Agency, California Specialized Training Institute, <http://www.calema.ca.gov/CSTI/Pages/CSTI.aspx>.

California State University, Long Beach, Center for International Trade and Transportation, Hazmat Training Online program, http://www.ccpe.csulb.edu/citt/hazmat/programdescription.aspx?group_number=276&group_version=1.

International Association of Fire Fighters, HazMat/WMD Training, <http://www.iaff.org/et/hw/index.htm>.

International Fire Service Accreditation Congress, <http://www.ifsac.org>.

International Fire Service Training Association, <http://imis-ext.osufpp.org/imispublic>.

Louisiana State University, LSU Fire and Emergency Training Institute., <http://feti.lsu.edu>.

Michigan State University, SAFEREPOSE, <http://www.saferesponse.com>.

National Association of SARA Title III Program Officials, <http://www.nasttppo.com>.

Oklahoma State University, Fire Protection and Safety Technology Program, <http://fpst.okstate.edu>.

Oklahoma State University, Fire Services Training, <http://osufst.org/mission>.

Tennessee Emergency Management Agency, Tennessee Hazardous Materials Program, <http://www.tnema.org/ema/training/collectivetraining.html>.

Texas Engineering Extension Service, Fire Services, Emergency Services Training Institute. <http://teexweb.tamu.edu/teex.cfm?pageid=ESTIprog&area=ESTI&templateid=1415>.

Transport Canada, Transport Dangerous Goods Directorate, <http://wwwapps.tc.gc.ca/saf-sec-sur/3/train-form/search-eng.aspx>.

University of Maryland, Maryland Fire and Rescue Institute, <http://www.mfri.org> .

University of Memphis, University College, Fire Homepage, <http://www.memphis.edu/univcoll/firedegrees.php>.

University of Missouri, Fire and Rescue Training Institute, <http://mufrti.org/index.shtml>.

Trade Association Educational Programs

Air Transport Association (ATA), www.airlines.org.

Alliance of Hazardous Materials Professionals (AHMP), www.achmm.org.

American Association of Port Authorities (AAPA), www.aapa-ports.org/home.cfm.

American Chemistry Council (ACC), www.americanchemistry.com.

American Petroleum Institute (API), www.api.org.

American Society of Transportation and Logistics (AST&L), www.astl.org.

American Trucking Association (ATA), www.truckline.com.

American Waterway Operators (AWO), www.americanwaterways.com.

Association of American Railroads (AAR), www.aar.org.

Association of Insurance and Risk Managers (AIRMIC), www.airmic.com.

Cargo Tank Risk Management Committee (CTRMC), www.cargotanksafety.org.

Commercial Vehicle Safety Alliance (CVSA), Cooperative Hazardous Materials Enforcement Development (COHMED), www.cvsa.org/programs/cohmed.php.

Council of State Governments (CSG), www.csg.org.

Council of Supply Chain Management Professionals (CSCMP), www.cscmp.org.

Dangerous Goods Advisory Council (DGAC), www.dgac.org.

Freight Carriers Association of Canada/North American Transportation Council (FCA/NATC), www.fca-natc.org.

Freight Stakeholders Coalition (FSC), www.freightstakeholders.org.

Inland Rivers Ports and Terminals (IRPT), www.irpt.net.

Institute for Supply Management (ISM), www.ism.ws.

Institute of Hazardous Materials Management (IHMM), www.ihmm.org.

International Association of Emergency Managers (IAEM), www.iaem.com.

International Association of Fire Chiefs (IAFC), <http://www.iafc.org>.

National Conference of State Legislators (NCSL), www.ncsl.org.

National Defense Transportation Association (NDTA), www.ndtahq.com.

National Emergency Management Association (NEMA), www.nemaweb.org.

National Governors Association (NGA), www.nga.org.

National Industrial Transportation League (NITL), www.nitl.org.

National League of Cities (NLC), www.nlc.org.

National Private Truck Council (NPTC), www.nptc.org.

National Tank Truck Carriers (NTTC), www.tanktruck.org.

North American Hazardous Materials Management Association (NAHMMA), www.nahmma.org.

Supply Chain Risk Leadership Council (SCRLC), www.scrclc.com.

International Air Cargo Association (IACA), www.tiaca.org.

Transportation and Logistics Council (TLC), www.tlcouncil.org.

Transportation Research Forum (TRF), www.trforum.org.

Transportation Technology Center, Security and Emergency Response Training, <http://www.sertc.org>.

Trucking Association Executives Council (TAEC), www.truckline.com/Federation/taec/Pages/default.aspx.

Truckload Carriers Association, www.truckload.org.

Private Companies

ATP Training, <http://www.alltranspack.com/Services/help.html>.

Currie Associates, <http://www.currieassociates.com>.

CSX Transportation, Public Safety and Environment Department, <http://csxhazmat.kor-tx.com/catalog.php>.

DGI Training Center, <http://dgitraining.com>.

DuPont, Emergency Response Solutions, http://www.dupontert.com/course_catalog.htm.

FedEx, Shipping Dangerous Goods and Hazardous Materials with FedEx, <http://www.fedex.com/us/hazardous-materials/index.html>.

HazMat Environmental Group, <http://hazmatinc.com>.

J.J. Keller and Associates, http://www.jjkeller.com/webapp/wcs/stores/servlet/topCategories_10151_-1_10551.

Labelmaster, <http://www.labelmaster.com>.

Lion Technology, <http://www.lion.com/Home.aspx>.

National Labor College, Rail Workers Hazardous Materials Training Program, <http://www.georgemeany.org/~bcantrell/index.html>.

Rural Domestic Preparedness Consortium, <http://www.ruraltraining.org>.

Saf-T-Pak, <http://www.saftpak.com/Training/training.aspx>.

Transportation Compliance Associates, <http://www.learnhazmat.com>.

Transportation Development Group, <http://dgtraining.com/index.htm>.

Transportation Technology Center, <http://www.aar.com>.

UPS, Guide for Shipping Ground and Air Hazardous Materials, <http://www.ups.com/content/us/en/resources/ship/hazardous/index.html>.

West Star Industries, http://www.rmwest.com/pages/transportation_services.html.

TRB Cooperative Research Programs and TRID

Transportation Research Board, Cooperative Research Programs, <http://www.trb.org/Main/Home.aspx>

Highway (NCHRP)

Transit (TCRP)

Airport (ACRP)

Freight (NCFRP)

Hazardous Materials (HMCRP)

Transportation Research International Documentation (TRID) database, <http://trid.trb.org>

APPENDIX B

REFERENCES TO COURSES AND MATERIALS

University Programs: Engineering and Environmental Science

Brogan, James. 2005. *Transportation of Hazardous Materials*. CE 584, Course Syllabus. Albuquerque, NM: University of New Mexico, Department of Civil Engineering.

Bronzini, Michael. 2011. *Transportation System Security and Safety*. CEIE 686, Course Syllabus. Fairfax, VA: George Mason University, Department of Civil, Environmental, and Infrastructure Engineering.

Hristovski, Kiril. 2011. *Hazardous Waste Management*. ETM 401, Course Syllabus. Mesa, AZ: Arizona State University, Environmental Technology Management Program.

South Carolina State University. undated. *Master of Science Degree in Transportation*. Brochure. Orangeburg, SC: Department of Civil and Mechanical Engineering Technology and Nuclear Engineering, <http://www.utc.scsu.edu/docs/MSTBrochure.pdf> (accessed Feb 2012).

University of Nevada, Las Vegas. 2012. *Analysis of Hazardous Materials Transportation*. CEE 766, Course Description. Las Vegas, NV: Department of Civil and Environmental Engineering.

University of South Carolina. 2011. *Concepts of Hazardous Materials Management I,II*. ENHS 788, 789, Course Descriptions. Columbia, SC: Department of Environmental Health Sciences. <http://marine-science.sc.edu/academic/courses/785to899.html> (accessed Feb 2012).

Wang, K. 2011. *Practices and Technologies in Hazardous Materials Transportation and Security*. Report No. MBTC DHS 107. Fayetteville, AR: Mack-Blackwell Transportation Center, University of Arkansas.

Young, Dennis. 2011. *Hazardous Materials Packaging*. PKG 477, Course Syllabus. East Lansing, MI: Michigan State University, School of Packaging.

University Programs: Business, Law, and Emergency Management

Eastern Michigan University. 2011. *Hazardous Materials*. HSEM 434, Course Description. Ypsilanti, MI: Eastern Michigan University, 2011-2012 Undergraduate Catalog, <http://catalog.emich.edu> (accessed Feb 2012).

Majchrzak, Bob. 2012. *Transportation of Hazardous Materials*. HSE-230, Course Syllabus. Scott, IA: Eastern Iowa Community Colleges, Health, Safety and Environmental Technology Program.

McCormick, Karen. 2010. *Hazardous Materials Planning and Management*. EADP 4000, Course Syllabus. Denton, TX: University of North Texas, Department of Public Administration, https://faculty.unt.edu/syllabi/3312_2768_4000_001_syllabus.pdf (accessed Feb 2012).

Pennsylvania State University. 2012. *Business and Environmental Regulation*. B Law 425, Course Description. University Park, PA: University Bulletin, University Course Descriptions, http://bulletins.psu.edu/bulletins/bluebook/university_course_descriptions.cfm?letter=B&courseID=11252&courseID2=11252 (accessed Feb 2012).

St. John's University. 2012. *Environmental Regulation of Toxic and Hazardous Substances*. Environmental Law 1010, Course Description. Queens, NY: School of Law, <http://www.stjohns.edu/academics/graduate/law/academics/courses/E.stj> (accessed Feb 2012).

Warner, Jeffery E. 2009. *Public Guidance for Managing Hazardous Material Transportation in Texas*. FHWA/TX-09/0-5929-P1. College Station, TX: Texas A&M University, Texas Transportation Institute, 41 pp., <http://tti.tamu.edu/documents/0-5929-P1.pdf> (accessed Feb 2012).

Western Nebraska Community College. 2010. *Transportation and Shipping of Hazardous Materials*. SFTX-1220, Course Syllabus. Scottsbluff, NE: Business and Community Education.

University Programs: Public Policy, Public Health, Community Colleges, and Other

Aini, M.S., A. Fakhru'l-Razi, W.M.N. Ibrahim, S.K. Tangavelu, M. Daud. 2001. "Study on Emergency Response Preparedness of Hazardous Materials Transportation." *Disaster Prevention and Management*, Vol. 10, No. 3, pp. 183-188.

Carnes, Sam A. 1986. "Institutional Issues Affecting the Transport of Hazardous Materials in the United States: Anticipating Strategic Management Needs." *Journal of Hazardous Materials*, Vol. 13, pp. 257-277.

Clark, Renee M. and Mary E. Besterfield-Sacre. 2009. "A New Approach to Hazardous Materials Transportation Risk Analysis: Decision Modeling to Identify Critical Variables." *Risk Analysis*, Vol. 29, No. 3, pp. 344-354.

Clark, Shirley E., Robert Pitt, Steven M. Becker. 2005. *Hazmat Accident Education An Integrated Approach*. UTCA Report 02215. Tuscaloosa, AL: University Transportation Center for Alabama.

Erkut, Erhan, Stevanus A. Tjandra, Vedat Verter. 2007. "Chapter 9: Hazardous Materials Transportation." *Handbook on OR & MS*, Vol. 14, pp. 539-621.

Graziano, Kristen M. 2002. "Security Requirements for Offerors and Trainers of Hazardous Materials: HM-232 Proposal." *Environmental Quality Management*, Autumn 2002, pp. 65-74.

Kawprasert, Athaphon and Christopher P.L. Barkan. 2009. "Communication and Interpretation of Results of Route Risk Analyses of Hazardous Materials Transportation by Railroad." *Transportation Research Record: Journal of the Transportation Research Board*, No. 2097, pp. 125-135.

Kuncyte, Rolanda, Claire Laberge-Nadeau, Teodor Gabriel Crainic, John A. Read. 2003. "Organization of Truck-driver Training for the Transportation of Dangerous Goods in Europe and North America." *Accident Analysis and Prevention*, Vol. 35, pp. 191-200.

Samuel, C., N. Keren, M.C. Shelley, S.A. Freeman. 2009. "Frequency Analysis of Hazardous Material Transportation Incidents as a Function of Distance From Origin to Incident Location." *Journal of Loss Prevention in the Process Industries*, Vol. 22, pp. 783-790.

Schmidt, Michael. 2004. *Hazardous Materials Transportation Program*. Bloomfield Hills, MI: Oakland Community College, 32 pp.

Shoushtarian, Ali. 2011. *Transportation of Dangerous Goods Class 7 Guide*. Ottawa, ONT: University of Ottawa.

U.S. Congress, Office of Technology Assessment. 1986. *Transportation of Hazardous Materials*. OTASET.30LI. Washington, DC: U.S. Government Printing Office.

Warner, Jeffery E, A. Protopapas, D. Jasek, et. al. 2008. *Management of Hazardous Materials Transportation: Literature Summary*. College Station, TX: Texas Transportation Institute, 56 pp.

U.S. Department of Transportation (USDOT)

Bureau of Transportation Statistics. 2011. *National Transportation Statistics 2011*. Washington, DC: Bureau of Transportation Statistics.

Bureau of Transportation Statistics. 2010. *United States: 2007 – Hazardous Materials Transportation Commodity Flow Survey*. Washington, DC: Bureau of Transportation Statistics and U.S. Census Bureau.

Craft, Ralph. 2004. *Analysis Brief: Crashes Involving Trucks Carrying Hazardous Materials*. FMCSA-RI-04-024. Washington, D.C.: Federal Motor Carrier Safety Administration, U.S. Department of Transportation, 8 pp., <http://www.fmcsa.dot.gov/facts-research/research-technology/analysis/fmcsa-ri-04-024.pdf> (accessed Feb 2012).

Daniell, J. Neal. 2009. *Traffic Incident Management in Hazardous Materials Spills Incident Clearance*. Report No. FHWA-HOP-08-058. Washington, DC: Federal Highway Administration.

Duych, Ron, Chester Ford, and Hossain Sanjani. 2011. *Hazardous Materials Highlights – 2007 Commodity Flow Survey*. SR-026. Washington, DC: Bureau of Transportation Statistics, 6 pp.,

http://www.bts.gov/publications/special_reports_and_issue_briefs/special_report/2011_01_26/pdf/entire.pdf (accessed Feb 2012).

Federal Aviation Administration. 2003. *Air Transportation of Dangerous Goods - Basic*. FAA70401. Washington, DC: U.S. Department of Transportation, <https://www.academy.jccbi.gov/catalog/courseDetail.asp?CID=FAA70401&TYPE=COURSE> (accessed Feb 2012).

Federal Aviation Administration. Undated. *Security and Hazardous Materials Training Courses*. Washington, DC: U.S. Department of Transportation, <https://www.academy.jccbi.gov/catalog/course.asp?CHAP=ASH> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. 2004. *A Guide for Building a Model State Hazardous Materials Program*. Washington, DC: U.S. Department of Transportation, 21 pp, <http://www.fmcsa.dot.gov/documents/hazmat/state-hm-guidebook.pdf> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. 2004. *Hazardous Materials Emergency Response Guidebook*. Washington, DC: U.S. Department of Transportation, <http://www.fmcsa.dot.gov/safety-security/hazmat/2004-emergency-response-guidebook.htm> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. 1998. *Bilingual Hazardous Materials General Awareness Training*. Washington, DC: U.S. Department of Transportation, <http://www.fmcsa.dot.gov/documents/01-overview.pdf> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. 1995. *Hazardous Materials Incident Prevention Manual*. Washington, DC: U.S. Department of Transportation, <http://www.fmcsa.dot.gov/facts-research/research-technology/publications/accidenthm/hmpreventman.htm> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. Undated. *Hazardous Materials (HM) Cargo Tank Safety*. Washington, DC: U.S. Department of Transportation, <http://www.fmcsa.dot.gov/safety-security/hazmat/cargo-tank.htm> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. Undated. *Hazardous Materials Safety & Security Field Operational Test*. Washington, DC: U.S. Department of Transportation, <http://www.fmcsa.dot.gov/safety-security/hazmat/fot/index.htm> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. Undated. *How to Comply with Federal Hazardous Materials Regulations*. Washington, DC: U.S. Department of Transportation, <http://www.fmcsa.dot.gov/safety-security/hazmat/complyhmregs.htm> (accessed Feb 2012).

Federal Motor Carrier Safety Administration. Undated. *Motor Carrier Security*. Washington, DC: U.S. Department of Transportation, <http://www.fmcsa.dot.gov/safety-security/security/index.asp> (accessed Feb 2012).

Federal Railroad Administration. Undated. *FRA Hazmat Technical Reports*. Washington, DC: U.S. Department of Transportation, <http://www.fra.dot.gov/rpd/policy/419.shtml> (accessed Feb 2012).

International Association of Fire Chiefs. Undated. *National Hazardous Materials Fusion Center*. Fairfax, VA, <http://www.hazmatfc.com/Pages/Home.aspx> (accessed Feb 2012).

Maine Maritime Academy. 2011. *Tanker Operations*. NS210-A, Course Description, in Course Catalog. Castine, ME: Maine Maritime Academy, <https://sisportal.mma.edu/services/CourseCatalog/default.aspx?TERM=SPRING&YEAR=2011> (accessed Feb 2012).

National Hazardous Materials Fusion Center. 2008. *Chlorine Release Training Package*. Fairfax, VA: International Association of Fire Chiefs, <http://www.hazmatfc.com/training/trainingpackages/Pages/ChlorineTrainingPackage.aspx> (accessed Feb 2012).

Pipeline and Hazardous Materials Safety Administration. 2011. *Top Consequence Hazardous Materials by Commodities and Failure Mode: 2005-2009*. Washington, DC: U.S. Department of Transportation.

Pipeline and Hazardous Materials Safety Administration. 2010. *Hazardous Materials Incident Reporting*. Washington, DC: U.S. Department of Transportation.

Pipeline and Hazardous Materials Safety Administration. Undated. *Hazardous Materials Transportation Training Modules, Version 5.1*. Washington, DC: U.S. Department of Transportation, <http://www.phmsa.dot.gov/hazmat/training/publications/modules> (accessed Feb 2012).

Pipeline and Hazardous Materials Safety Administration. Undated. *Publications and Training Modules*. Washington, DC: U.S. Department of Transportation, <http://www.phmsa.dot.gov/hazmat/training/publications> (accessed Feb 2012).

Science Applications International Corporation. 2004. *Final Hazmat Safety and Security Field Operational Test: Public Sector Detailed Test Plans*. Report No. FHWA-JPO-04-058. Washington, DC: Federal Highway Administration.

Transportation Safety Institute. 2011. *Hazardous Materials/Motor Carrier Training*. Washington, DC: Research and Innovative Technology Administration, U.S. Department of Transportation, <http://www.tsi.dot.gov/hazmat.aspx> (accessed Feb 2012).

United States Merchant Marine Academy. 2011. *Tanker Operations*. DN240, Course Description, in Combined Catalog, p. 95. Kings Point, NY: U.S. Merchant Marine Academy, http://www.usmma.edu/admissions/PDFs/Combined_Catalog_28_Dec_2011.pdf (accessed Feb 2012).

Department of Defense (DOD)

Army Logistics University. *Alphabetical Listing of Courses*. Ft. Lee, VA: Department of Defense, <http://www.almc.army.mil/> (accessed Dec 2011).

Defense Ammunition Center, U.S. Army. *Course Catalog/Class Schedule*. McAlester, OK: http://ammo.okstate.edu/index.php?option=com_content&view=category&id=50&Itemid=76 (accessed Dec 2011).

Defense Ammunition Center, U.S. Army. *Welcome to DAC Training*. McAlester, OK: <http://ammo.okstate.edu/> (accessed Dec 2011).

Defense Logistics Agency. *Environmental Courses*. Washington, DC: Department of Defense, <http://www.hr.dla.mil/downloads/trn/courses/environmental.pdf> (accessed Jan 2012).

Eastern Oklahoma State College. *Academic Programs and Degrees*. Wilburton, OK: <http://www.eosc.edu/academic/programs.html> (accessed Dec 2011).

U.S. Army Corps of Engineers. 2011. *The Purple Book and PROSPECT Training Needs Survey FY2012*. Washington, DC: <http://ulc.usace.army.mil/downloads/purplebook2012.pdf> (accessed Jan 2012).

U.S. Department of Defense. 2012. *Defense Transportation Regulations, Cargo Movement 4500.9-R-Part II, June 2008*. Washington, DC: <http://www.transcom.mil/dtr/part-ii/index.cfm> (accessed Feb 2012).

United States Transportation Command. 2008. *Defense Transportation Regulations, Cargo Movement 4500.9-R-Part II, June 2008*. Washington, DC: <http://www.transcom.mil/dtr/part-ii/index.cfm> (accessed Feb 2012).

Department of Homeland Security (DHS)

Federal Emergency Management Agency. 2012. *2011 Body of Knowledge Report*. Washington, DC: <http://training.fema.gov/EMIWeb/edu> (accessed Feb 2012).

Federal Emergency Management Agency. 2011. *An Introduction to Hazardous Materials (IS-5.a)*. Washington, DC: <http://training.fema.gov/EMIWeb/IS/IS5.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *An Orientation to Hazardous Materials for Medical Personnel (IS-346)*. Washington, DC: <http://training.fema.gov/EMIWeb/IS/is346.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *Critical Infrastructure and Key Resources Support Annex (IS-821)*. Washington, DC: <http://www.training.fema.gov/EMIWeb/IS/IS821.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *Fundamentals of Emergency Management* (IS-230.b). Washington, DC: <http://www.training.fema.gov/EMIWeb/IS/is230b.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *Hazardous Materials Prevention* (IS-340). Washington, DC: <http://training.fema.gov/EMIWeb/IS/is340.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *Integrated Emergency Management Course: Hazardous Materials Preparedness and Response* (E920). Washington, DC: <http://www.training.fema.gov/EMICourses/crsdetail.asp?cid=E920&ctype=R> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *Introduction to Incident Command System* (IS-100.b). Washington, DC: <http://training.fema.gov/EMIWeb/IS/is100b.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *Modular Emergency Radiological Response Transportation Training* (IS-302). Washington, DC: <http://training.fema.gov/EMIWeb/IS/IS302.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2011. *National Incident Management System (NIMS), An Introduction* (IS-700.a). Washington, DC: <http://www.training.fema.gov/EMIWeb/IS/is700a.asp> (accessed Jan 2012).

Federal Emergency Management Agency. 2006. *Hazardous Materials Tabletop Exercises Manual*. Washington, DC: Federal Emergency Management Agency.

Federal Emergency Management Agency. Undated. *EMI Academic Emergency Management and Related Courses for the Higher Education Program*. Washington, DC: <http://training.fema.gov/EMIWeb/edu/collegecrsbooks.asp> (accessed Jan 2012).

Federal Emergency Management Agency. Undated. *Emergency Management Institute (EMI) Higher Education Program*. Washington, DC: <http://www.training.fema.gov/emiweb/edu/> (accessed Jan 2012).

Federal Emergency Management Agency. Undated. *ESF #1 Transportation* (IS-801). Washington, DC: http://training.fema.gov/occ/courseDetailsView.do?courseNumber=IS-801&actionName=COURSE_DETAILS_BY_COURSE_ID (accessed Jan 2012).

Federal Emergency Management Agency. Undated. *ESF #3 Public Works and Engineering* (IS-803). Washington, DC: http://training.fema.gov/occ/courseDetailsView.do?courseNumber=is-803&actionName=COURSE_DETAILS_BY_COURSE_ID (accessed Jan 2012).

Federal Emergency Management Agency. Undated. *ESF #10 Oil and Hazardous Materials Resources* (IS-810). Washington, DC: http://training.fema.gov/occ/courseDetailsView.do?courseNumber=IS-810&actionName=COURSE_DETAILS_BY_COURSE_ID (accessed Jan 2012).

Federal Emergency Management Agency. Undated. *National Preparedness Directorate Searchable Online Course Catalog (OCC)*. Washington, DC: <http://training.fema.gov/occ/> (accessed Jan 2012).

Federal Emergency Management Agency. Undated. *National Response Framework, An Introduction (IS-800.b.)* Washington, DC: http://training.fema.gov/occ/courseDetailsView.do?courseNumber=IS-800.b&actionName=COURSE_DETAILS_BY_COURSE_ID (accessed Jan 2012).

Federal Emergency Management Agency, U.S. Fire Administration. Undated. *Fire and Emergency Services Higher Education (FESHE) Program*. Washington, DC: http://www.usfa.fema.gov/nfa/higher_ed/index.shtm (accessed Feb 2012).

Federal Emergency Management Agency, U.S. Fire Administration. Undated. *National Fire Academy Courses, Schedules and Instructors*. Washington, DC: <http://apps.usfa.fema.gov/nfacourses/main/home> (accessed Feb 2012).

Federal Emergency Management Agency, U.S. Fire Administration. Undated. *Managerial Issues in Hazardous Materials*. Washington, DC: <http://www.usfa.fema.gov/downloads/pdf/nfa/higher-ed/ba-courses/mihm.pdf>. (accessed Feb 2012).

National Fire Academy. 2011. *U.S. Fire Administration, 2011-2012 Course Catalog*. Washington, DC: http://www.usfa.fema.gov/downloads/pdf/publications/1112_nfa_catalog.pdf (accessed Feb 2012).

National Fire Academy. Undated. *Managerial Issues in Hazardous Materials: Course Description*. Washington, DC: <http://www.usfa.fema.gov/downloads/pdf/nfa/higher-ed/ba-courses/mihm.pdf> (accessed Feb 2012).

U.S. Coast Guard. 2006. *U.S. Coast Guard Incident Management Handbook (COMDTPUB P3120.17a)*. Washington, DC: Department of Homeland Security, <http://www.uscg.mil/hq/nsfweb/docs/FinalIMH18AUG2006.pdf> (accessed Feb 2012).

U.S. Coast Guard, Training Center Yorktown. Undated. *Contingency Preparedness and Response Management School*. Yorktown, VA: Department of Homeland Security, <http://www.uscg.mil/tcyorktown/mSchools/CPS/default.asp> (accessed Feb 2012).

U.S. Coast Guard, Training Center Yorktown. Undated. *Port Operations School*. Yorktown, VA: Department of Homeland Security, <http://www.uscg.mil/tcyorktown/mSchools/MPO/default.asp> (accessed Feb 2012).

Department of Energy (DOE)

U.S. Department of Energy. *Transportation Emergency Preparedness Program*. Washington, DC: <http://www.em.doe.gov/TEPPPages/TEPPHome.aspx> (accessed Jan 2012).

U.S. Department of Energy. *Transportation Emergency Preparedness Program, How To Videos*. Washington, DC: <http://www.teppinfo.com/merrtt/videos/how-to> (accessed Feb 2012).

Environmental Protection Agency (EPA)

Environmental Protection Agency, Office of Superfund Remediation and Technology Innovation. *Waste Treatment, Transportation, and Disposal*. Washington, DC: <http://www.trainex.org/offeringlist.cfm?courseid=46&all=yes> (accessed Aug 2012).

State-Supported Training for Emergency Responders

Association of Bay Area Governments. *Hazmat School*. Oakland, CA: <http://www.hazmatschool.com/HSCourses.html> (accessed Feb 2012).

California Emergency Management Agency. California Specialized Training Institute. Undated. *Hazardous Materials Outreach Program*. San Luis Obispo, CA: [http://www.calema.ca.gov/CSTI/Pages/Hazardous Materials Outreach.aspx](http://www.calema.ca.gov/CSTI/Pages/Hazardous%20Materials%20Outreach.aspx) (accessed Jan 2012).

Delmar. 2008. *Firefighter's Handbook: Essentials of Firefighting and Emergency Response*. Albany, NY: Delmar, Thomson Learning.

Hand, Bill. 2007. *Highway Cargo Tank Trucks*. [http://www.livoniafirefighters.com/docs/ Containers - Highway Cargo.pdf](http://www.livoniafirefighters.com/docs/Containers-Highway%20Cargo.pdf) (accessed Jan 2012).

International Fire Service Training Association. Undated. *ELEARNING*. Stillwater, OK: [http://imis-ext.osufpp.org/imispublic/Product Search/core/orders/category.aspx?catid=28](http://imis-ext.osufpp.org/imispublic/Product_Search/core/orders/category.aspx?catid=28) (accessed Feb 2012).

Louisiana State University. *LSU Fire and Emergency Training Institute*. Baton Rouge, LA: <http://feti.lsu.edu/> (accessed Feb 2012).

Michigan State University (MSU). *SAFERESPONSE*. East Lansing, MI: <http://www.saferesponse.com/> (accessed Feb 2012).

National Fire Protection Association. 2008. *NFPA 472: Standard for Competence Of Responders To Hazardous Materials/Weapons Of Mass Destruction Incidents*. Quincy, MA: <http://www.nfpa.org/aboutthecodes/aboutthecodes.asp?docnum=472> (accessed Feb 2012).

National Fire Protection Association. 2008. *NFPA 473: Standard for Competencies for EMS Personnel Responding to Hazardous Materials/Weapons of Mass Destruction Incidents*. Quincy, MA: <http://www.nfpa.org/aboutthecodes/aboutthecodes.asp?docnum=473> (accessed Feb 2012).

National Fire Protection Association. 2002. *NFPA 471: Recommended Practice for Responding to Hazardous Materials Incidents*. <http://www.nfpa.org/aboutthecodes/aboutthecodes.asp?docnum=471> (accessed Feb 2012).

Noll, Gregory G. Undated. *Competency-Based HazMat/WMD Training: Facts, Fictions and Realities*. <http://www.livoniafirefighters.com/docs/Competency- Based HazMat WMD Training.pdf> (accessed Jan 2012).

Noll, Gregory G., Michael S. Hildebrand, and James Yvorra. 2005. *Hazardous Materials: Managing the Incident* (3rd ed.). Maryland: Red Hat Publishing Company.

Oklahoma State University. Undated. *Fire Protection and Safety Technology (FPST) Program*, Stillwater, OK: College of Engineering, Architecture, and Technology, <http://fpst.okstate.edu/> (accessed Feb 2012).

Oklahoma State University. Undated. *Fire Services Training*. Stillwater, OK: <http://osufst.org/mission> (accessed Feb 2012).

Tennessee Emergency Management Agency. *Tennessee Hazardous Materials Program*. Nashville, TN: <http://www.tnema.org/ema/training/collectivetraining.html> (accessed Jan 2012).

University of Maryland. Undated. *Maryland Fire and Rescue Institute (MFRI)*. College Park, MD: <http://www.mfri.org/> (accessed Feb 2012).

University of Missouri. Undated. *Fire and Rescue Training Institute*. Columbia, MO: <http://mufrti.org/index.shtml> (accessed Feb 2012).

Trade Association Educational Programs

Alliance of Hazardous Materials Professionals (AHMP). Undated. www.achmm.org (accessed Feb 2012).

American Chemistry Council (ACC). Undated. www.americanchemistry.com (accessed Feb 2012).

American Petroleum Institute (API). Undated. www.api.org (accessed Feb 2012).

American Society of Transportation and Logistics (AST&L). Undated. www.astl.org (accessed Feb 2012).

Association of American Railroads. 2012. *Bureau of Explosives Publications*. Sewickley, PA: http://www.boepublications.com/images/PDFs/BOE_Pubs_Brochure.pdf (accessed Feb 2012).

Commercial Vehicle Safety Alliance (CVSA), Cooperative Hazardous Materials Enforcement Development (COHMED). Undated. www.cvsa.org/programs/cohmed.php (accessed Feb 2012).

Council of Supply Chain Management Professionals (CSCMP). Undated. www.cscmp.org (accessed Feb 2012).

Dangerous Goods Advisory Council (DGAC). Undated. www.dgac.org (accessed Feb 2012).

Institute of Hazardous Materials Management (IHMM). Undated. www.ihmm.org (accessed Feb 2012).

International Association of Fire Chiefs (IAFC). Undated. Fairfax, VA: <http://www.iafc.org/> (accessed Feb 2012).

National Conference of State Legislatures (NCSL). Undated. Washington, DC: <http://www.ncsl.org/> (accessed Feb 2012).

Transportation Technology Center. Undated. *Security and Emergency Response Training*. Pueblo, CO: <http://www.sertc.org> (accessed Jan 2012).

Private Companies

DuPont. Undated. *Emergency Response Solutions, Course Catalog*. Belle, WV: http://www.dupontert.com/course_catalog.htm (accessed Jan 2012).

FedEx. Undated. *Shipping Dangerous Goods and Hazardous Materials with FedEx*. Memphis, TN: <http://www.fedex.com/us/hazardous-materials/index.html> (accessed Feb 2012).

Fialdini, Leonard. 2010. "Intermodal Hazmat Shipping: Challenges and Opportunities." *National Defense Transportation Association 2010 Forum, Washington D.C., September 18-22*. <http://www.ndtahq.com/documents/Hazmat.pdf> (accessed Jan 2012).

National Labor College. 2010. *Welcome to the Rail Workers Hazardous Materials Training Program's Web Site*. Silver Spring, MD: <http://www.nlc.edu/~bcantrell/index.html> (accessed Feb 2012).

Transport Canada. Transport Dangerous Goods Directorate (TDG). Undated. *Organizations Providing Dangerous Goods Training*. Ottawa, ONT: <http://www.wapps.tc.gc.ca/saf-sec-sur/3/train-form/search-eng.aspx> (accessed Jan 2012).

UPS. Undated. *UPS Guide for Shipping Ground and Air Hazardous Materials*. <http://www.ups.com/content/us/en/resources/ship/hazardous/index.html> (accessed Feb 2012).

TRB Research Program and TRID

Ranous, R. 2012. *Improving Local Community Recovery from Disastrous Hazardous Materials Transportation Incidents*. Preliminary draft final report, HMCRRP HM-11. Arlington, VA.

Pape, D., S.R. Fredman, D. Murray, M. Lueck, M. Abkowitz, and J. Fleming. 2012. *Role of Human Factors in Preventing Cargo Tank Truck Rollovers*, preliminary draft final report, HMCRP HM-13. Columbus, OH.

Murphy, M. and T. McSweeney. 2012. *Technical Assessment of Dry Ice Limits on Aircraft*, HMCRP HM-09, abstract. Columbus, OH.

Battelle Memorial Institute. 2010. *HMCRP Report 1: Hazardous Materials Transportation Incident Data for Root Cause Analysis*. Transportation Research Board of the National Academies. Washington, DC.

Battelle Memorial Institute. 2010. *HMCRP Report 5: A Guide for Assessing Emergency Response Needs and Capabilities for Hazardous Materials Releases*. Transportation Research Board of the National Academies. Washington, DC.

Tate, W. and M. Abkowitz. 2010. *HMCRP Report 4: Emerging Technologies Applicable to Hazardous Materials Transportation Safety and Security*. Transportation Research Board of the National Academies. Washington, DC.

Tate, W., S.R. Fredman, A. Greenberg, T. McSweeney, T. Timcho, D. Murray, and S. Keppler. 2012. *Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments*. Preliminary draft final report. HMCRP HM-05. Columbus, OH.

Daum, P., C. Barkan, M. Saat, and L. Ghosh. 2012. *Accident Performance Data of Bulk Packages Used for Hazardous Materials Transportation*. HMCRP HM-07, abstract. Aurora, IL.

Lewis, R. and Z. He. 2010. *HMCRP Report 2: Assessing Soil and Groundwater Impacts of Chemical Mixture Releases from Hazardous Materials Transportation Incidents*. Transportation Research Board of the National Academies. Washington, DC.

Huddleston, N. and B. Jones. 2007. "Going the Distance: The Safe Transport of Spent Nuclear Fuel and High-Level Radioactive Waste in the United States." *TR News*, No. 248, pp. 25-28.

Jeong, D.Y. 2009. "Probabilistic Approach to Conditional Probability of Release of Hazardous Materials from Railroad Tank Cars During Accidents." *Proceedings of the ASME International Mechanical Engineering Congress and Exposition*. Report No. IMECE2009-10872. New York, NY: American Society of Mechanical Engineers.

Organisation for Economic Cooperation and Development. 2001. *Safety in Tunnels: Transport of Dangerous Goods Through Road Tunnels – Highlights*. Paris, France: Organisation for Economic Cooperation and Development.

Bierling, D., G. Rogers, D. Jasek, A. Protopapas, J. Warner, and L. Olson. 2010. *HMCRP Report 3: Hazardous Materials Commodity Flow Data and Analysis*. Transportation Research Board of the National Academies. Washington, DC.

Kruse, C.J., A. Protopapas, L. Olson, M. Donelan, and N. Hutson. 2012. *Marine Highway Transport of Toxic Inhalation Hazard (TIH) Materials*. NCFRP 17(01). Houston, TX

Marinik, A., D. Bowman, R. Pethtel, and T. Trimble. 2011. *HMCRP Report 6: Consolidated Security Credential for Persons Who Transport Hazardous Materials*, Transportation Research Board of the National Academies. Washington, DC.

Visual Risk Technologies, Inc. 2012. *Hazardous Materials Transportation Risk Assessment: State of the Practice*, HMCRP HM-12, abstract. Arlington, VA

Visual Risk Technologies, Inc. 2012. *Current Hazardous Materials Transportation Research and Future Needs*, HMCRP HM-10, abstract. Arlington, VA

APPENDIX C

COLLEGES, UNIVERSITIES AND INSTITUTIONS OFFERING EMERGENCY MANAGEMENT COURSES

The Emergency Management Institute of the Federal Emergency management Agency (FEMA) maintains an online directory, known as “The College List,” with links to numerous programs that offer courses related to emergency management. FEMA does not necessarily recommend any of the listed programs or offer comments on the relative merits.

As of May 2013, the programs were categorized as follows:

Emergency Management Programs

[Doctoral Level](#)

[Masters Level](#)

[Masters Certificate, Specialization, Concentration, Track](#)

[Bachelor Degrees](#)

[Bachelor-Level Concentrations, Minors](#)

[Associate Level](#)

[Stand Alone Certificate Programs](#)

[One or More Courses](#)

Homeland Security Programs

[Doctoral](#)

[Masters Level](#)

[Masters Certificate, Specialization, Concentration, Track](#)

[Bachelor Degrees](#)

[Bachelor Level Concentrations, Minors](#)

[Associate](#)

[Certificates/Diplomas](#)

Public Health, Medical, and Related Programs

International Disaster Relief/Humanitarian Assistance

Emergency and Disaster Management Programs in Other Countries

Related Programs

[Graduate](#)

[Bachelor](#)

[Bachelor Level Concentrations, Minors](#)

[Associate
Certificate](#)

[*Distance Learning*](#)

[*Programs Being Investigated/Proposed*](#)

Source: <http://www.training.fema.gov/emiweb/edu/collegelist> (accessed May 2013)

APPENDIX D

PEER EXCHANGE WORKSHOP MATERIALS

The HM-16 draft curricula were reviewed and evaluated at a one-day peer exchange at the National Academies Beckman Center in Irvine, California on October 4th, 2012. Included herein are the following workshop materials:

- workshop agenda
- participant roster
- handout describing various curriculum deployment strategies and considerations.

HMCRP HM-16 Peer Workshop Agenda

The Beckman Center
Irvine, CA
October 4, 2012

- 7:00 a.m. **Registration and Continental Breakfast**
- 8:00 a.m. **Project Overview (plenary)**
- *Welcome and introduction*
- *Project objectives, tasks, and deliverables*
- *Summary of interim findings*
- *Workshop schedule and objectives*
- 8:30 a.m. **Content of Model Curriculum (plenary)**
- *Presentation of curriculum content, followed by facilitated discussion*
- *Selection of curriculum content for review using electronic polling*
- 10:15 a.m. **Break**
- 10:45 a.m. **In-Depth Curriculum Review (breakout)**
- *Concurrent small group sessions involving presentation and subsequent discussion of curriculum modules. Attendees will be assigned to one group.*
- *Discuss suggested special topics*
- 12:15 p.m. **Lunch**
- 1:15 p.m. **Overview of In-Depth Curriculum Findings and Discussion of Special Topics (plenary)**
- *Summary of findings and recommendations from each breakout group, followed by facilitated discussion*
- *Discuss suggested special topics*
- *Assessment/prioritization of special topics using electronic polling*
- 2:45 p.m. **Break**
- 3:00 p.m. **Curriculum Delivery, Evaluation Methods, and Implementation Issues (breakout)**
- *Concurrent small group sessions involving facilitated discussion to identify:*
 1. *Potential methods and deployment strategies for delivering content to specific audiences*
 2. *Performance measures to evaluate curriculum effectiveness*
- 4:15 p.m. **Break**

4:45 p.m.

Closing Session (plenary)

-Summary of recommended curriculum delivery methods, deployment strategies and performance measures from each breakout group, followed by facilitated discussion

-Assessment/prioritization of recommendations using electronic polling

-Concluding remarks

5:30 pm

Reception and Dinner

HM-16 Peer Exchange Participant List

Name	Company / Organization	Title
Teresa Adams	University of Wisconsin	Director, Transportation Center
John Allen	Battelle	Consultant
Shawn Allen	IOPP, 3M Package Engineering	Manager - Packaging Regulatory Affairs
Joyce Beerbower	Safety & Compliance Services, Inc	Principal
David Bierling	Texas Transportation Institute	Associate Research Scientist
Denise A. Branch	Port Authority of New York & New Jersey	Manager, Environmental Services Kennedy International Airport
Ruby E. Brunelle	UPS	Manager, UPS Hazardous Materials
Cherry Burke	Dow Chemical Company	Global Trans Safety and Risk Mgt Leader
Ed Chapman	BNSF Railway	Director - Hazardous Materials
Samrat Chatterjee	University of Southern California	Postdoctoral Research Associate
John Conley	National Tank Truck Carriers	President
George Cummings	Port Authority of Los Angeles	Director of Policy and Administration
Philip Daum	Engineering Systems, Inc.	Sr. Managing Consultant
Kimberly Q. Davis	Project Performance Corporation	Principal Analyst
William J. DeWitt, III	Maine Maritime Academy	Assoc Dean, Prof of Logistics, & Dir Grad Studies Loeb-Sullivan School of Intl. Business & Logistics
Dr. Shannon B. Fox	DHS	Senior Research Scientist
Robert Fronczak	Association of American Railroads	Assistant VP - Environment and Hazmat
Jeffrey Greenwald	Institute of Hazardous Materials Management	Executive Director
John Haney	American Airlines	Environmental Manager
John Hardridge	Federal Motor Carrier Safety Administration	Lead Transportation Specialist Hazardous Materials Division
Dan Hoglund	Visionary Solutions, LLC	Director of Training

Kelly Horn	Illinois Emergency Management Agency	Health Physicist
Kiril Hristovski	Arizona State University, College of Technology and Innovation	Assistant Prof Dept. of Applied Sciences and Mathematics
James (Jim) Kruse	Texas Transportation Institute	Director, Center for Ports and Waterways
Gary Lanthrum	NAC International	VP Consulting
Mark Lepofsky	Visual Risk Technologies, Inc.	Vice President
Paul Little	Logistics Safety Solutions, Inc.	President
Don Loftis	Olin Corporation	Principal Software Engineer
Randolph Martin	DuPont Corporation	Senior Hazardous Materials Consultant
Donna McLean	Transport Canada	Chief, Inspector Education and Public Awareness
Adolfo R. Negron	DHS-CSAC	Deputy Director CSAC
Steve Niswander	Groendyke Transport	Vice President of Safety Policy and Regulations
Craig Philip	Ingram Barge Company	CEO
Gary Pike	AAR	Manager-CIRG
James (Jim) Reed	National Conference of State Legislatures	Transportation Program Director
William Reese	Commercial Vehicle Safety Alliance	COHMED National Chairman
Dr. M. Rapik Saat	University of Illinois at Urbana-Champaign	Research Assistant Professor
Danny Simpson	Canadian National	Assistant VP - Safety and Environment
Lucia Spears	Oak Ridge National Laboratory	Transportation Safety Compliance Manager
Robert Waters	Sandia National Laboratories	Distinguished Technical Staff
Carrie Wayne	Honeywell	Corporate Manager of Transportation Safety and Regulatory Compliance
Jack Whitley	PHMSA	Hazardous Materials Safety Assistance Team Member for the Western Region
Jeanne Zmich	Labelmaster	Vice President, R & D

Panel Members

John A. Bergendahl	Worcester Polytechnic Institute Department of Civil & Environmental Engineering	Associate Professor
Darren J. Gross	The Dow Chemical Company	Director, Supply Chain
Robert D. Jaffin	International Association of Emergency Managers	Educator/Consultant
Kathleen T. Kovach	Port Authority of New York & New Jersey, Tunnels, Bridges and Terminals Department	Environmental Manager
Diana L. Long	Rahall Transportation Institute, Marshall University	Director, Workforce Development
Shashi Nambisan	Iowa State University	Professor of Civil Engineering & Director of Transportation
Theodore J. Turner, III	PHMSA	Hazardous Materials Investigator
Melissa Williams	General Engineer	Federal Motor Carrier Safety Administration
Stephan A. Parker	Transportation Research Board Cooperative Research Programs (Div. D)	Senior Program Officer
William C. Rogers	Transportation Research Board Hazardous Materials Cooperative Research Programs (Div. D)	Senior Program Officer

HM-16 Project Team

Michael Bronzini	Principal	3 Sigma Consultants, LLC
Mark Abkowitz	Principal	3 Sigma Consultants, LLC
Malcolm Baird	Principal	3 Sigma Consultants, LLC
Janey Camp	Principal	Camp Construction and Engineering, LLC
Martin Lipinski	Consultant	
Tom Corsi	Consultant	

Shading indicates
"could not attend"

Curriculum Deployment Strategies and Considerations

1. Packaged Content

- a. Full academic program – Degree or certificate programs offered by engineering, business, public policy, emergency management or related field
- b. Full academic course offering - Entire curricula used for a graduate or undergraduate course in engineering, business, public policy, emergency management or related field
- c. Partial academic course offering - Individual modules integrated as part of a broader academic course in transportation, business, public policy, emergency management, fire and emergency services, law, environmental sciences or related field
- d. Full executive development offering - Entire curricula condensed for use as an executive development course, with changes in emphasis depending on the focus of the audience (e.g., shippers, carriers, regulators, infrastructure providers, emergency managers, emergency responders)
- e. Partial executive development offering - Select modules adapted for use in executive development courses (e.g., using discipline-specific material in leadership development courses for managers in the hazmat transportation industry)
- f. Training supplement - Select modules adapted for use in training courses focused on regulatory compliance and emergency management

Note: Any of these options can be considered as part of an accredited academic or certificate program

2. Curriculum Management and Maintenance Considerations: Who will sponsor/host the hazmat transportation education curricula?

- a. Organize offerings of courses and workshops.
- b. Coordinate updates to keep pace with changing regulations, technology, market forces and other factors.
- c. Provide ongoing user support.
- d. Track and monitor use of the materials for follow-up and performance monitoring for future modifications/versions.
- e. Foster integration of education and professional development
 - i. Professional society or subgroup(s)
 - ii. Professional certification
 - iii. Academic program oversight/accreditation
 - iv. Continuing education
 - v. Research journals

3. Information Dissemination

- a. Announce availability of curriculum materials at professional meetings, through print media and at TRB web site
- b. Make materials available for download from TRB and/or other web sites
- c. Conduct “teach the teacher” workshops to train potential future users of the materials

APPENDIX E

DEFINITIONS OF HAZARDOUS MATERIALS

Some relatively concise definitions of “hazardous materials” are shown in Table 1 for comparison. As noted in the table, the term “hazardous materials” is used primarily in the United States. Internationally, the common term is “dangerous goods.” The two terms “hazardous materials” and “dangerous goods” are essentially interchangeable, but as discussed on subsequent pages the terms used in practice must follow specific regulatory definitions.

Table E-1. Four Definitions of Hazardous Materials

Source	Definition
Institute of Hazardous Material Management (IHMM) http://www.ihmm.org/index.php?option=com_content&view=article&id=61&Itemid=161	A hazardous material is any item or agent (biological, chemical, physical) which has the potential to cause harm to humans, animals, or the environment, either by itself or through interaction with other factors.
National Fire Protection Association (NFPA) <i>NFPA 472, Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents (2013)</i>	Hazardous material. Matter (solid, liquid or gas—or energy) that when released is capable of creating harm to people, the environment, and property. This includes Weapons of Mass Destruction (WMD), as defined in 18 US Code Section 2332A, as well as any other criminal use of hazardous materials, such as illicit labs, environmental crimes, or industrial sabotage.
Merriam-Webster (Web) http://www.merriam-webster.com/dictionary/hazmat	HAZMAT: a material (as flammable or poisonous material) that would be a danger to life or to the environment if released without precautions.
Wikipedia (a Wikipedia search for “hazardous materials” was redirected to “dangerous goods”) http://en.wikipedia.org/wiki/Hazardous_materials	Dangerous goods are solids, liquids, or gases that can harm people, other living organisms, property, or the environment. They are often subject to chemical regulations. In the United States and sometimes in Canada dangerous goods are more commonly known as hazardous materials (abbreviated as HAZMAT or HazMat).

REGULATORY DEFINITIONS

The following overview of regulatory definitions is from the Institute of Hazardous Materials Management (IHMM):

Hazardous materials are defined and regulated in the United States primarily by laws and regulations administered by the U.S. Environmental Protection Agency (**EPA**), the U.S.

Occupational Safety and Health Administration (**OSHA**), the U.S. Department of Transportation (**DOT**), and the U.S. Nuclear Regulatory Commission (**NRC**). Each has its own definition of a “hazardous material.”

OSHA’s definition includes any substance or chemical which is a “health hazard” or “physical hazard,” including: chemicals which are carcinogens, toxic agents, irritants, corrosives, sensitizers; agents which act on the hematopoietic system; agents which damage the lungs, skin, eyes, or mucous membranes; chemicals which are combustible, explosive, flammable, oxidizers, pyrophorics, unstable-reactive or water-reactive; and chemicals which in the course of normal handling, use, or storage may produce or release dusts, gases, fumes, vapors, mists or smoke which may have any of the previously mentioned characteristics. [Full definitions can be found at 29 Code of Federal Regulations (CFR) 1910.1200.]

EPA incorporates the OSHA definition, and adds any item or chemical which can cause harm to people, plants, or animals when released by spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping or disposing into the environment. (40 CFR 355 contains a list of over 350 hazardous and extremely hazardous substances.)

DOT defines a hazardous material as any item or chemical which, when being transported or moved, is a risk to public safety or the environment, and is regulated as such under the: Hazardous Materials Regulations (49 CFR 100-180); International Maritime Dangerous Goods Code; Dangerous Goods Regulations of the International Air Transport Association; Technical Instructions of the International Civil Aviation Organization; U.S. Air Force Joint Manual, Preparing Hazardous Materials for Military Air Shipments.

The **NRC** regulates items or chemicals which are “special nuclear source” or by-product materials or radioactive substances. (See 10 CFR 20).

http://www.ihmm.org/index.php?option=com_content&view=article&id=61&Itemid=161

From a transportation perspective, the definitions used by the U.S. DOT are based on the Hazardous Materials Transportation Act of 1975 (HMTA) which empowered the Secretary of Transportation to designate material as hazardous “when the Secretary determines that transporting the material in commerce in a particular amount and form may pose an unreasonable risk to health and safety or property. “

U.S. DOT regulations contain this definition:

Hazardous material means a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and has designated as hazardous under section 5103 of Federal hazardous materials transportation law (49 U.S.C. 5103). The term includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials

designated as hazardous in the Hazardous Materials Table (see 49 CFR 172.101), and materials that meet the defining criteria for hazard classes and divisions in part 173 of subchapter C of this chapter. (49 CFR 105.15)

It is also important to note that the HMTA and U.S. DOT regulations define “transports” or “transportation” to mean “the movement of property and loading, unloading, or storage incidental to the movement.” Thus, “transportation” for the purpose of DOT hazmat regulations includes the actual movement by highway, rail, air, waterway, or pipeline as well as the loading, unloading, intermodal transfer, and “incidental” storage.

FEDERAL STANDARD 313D (U.S. GENERAL SERVICES ADMINISTRATION)

The U.S. General Services Administration (GSA) defines hazardous materials in a standard that “establishes requirements for the preparation and submission of Material Safety Data Sheets (MSDS) by contractors who provide hazardous materials to government activities.” *Federal Standard, Material Safety Data, Transportation Data, And Disposal Data for Hazardous Materials Furnished to Government Activities (FED-STD-313D)* includes the following definition, which incorporates many of the regulations described above:

3.2 Hazardous material.

3.2.1 Any item or chemical which is a “health hazard” or “physical hazard” as defined by OSHA in 29 CFR 1910.1200, which includes the following:

- chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes;

- chemicals which are combustible liquids, compressed gases, explosives, flammable liquids, flammable solids, organic peroxides, oxidizers, pyrophorics, unstable (reactive) or water-reactive;

- chemicals which in the course of normal handling, use, or storage operations may produce or release dusts, gases, fumes, vapors, mists or smoke which have any of the above characteristics.

3.2.2 Any item or chemical which is reportable or potentially reportable or notifiable as inventory under the reporting requirements of the Hazardous Chemical Reporting (40 CFR Part 370), or as an environmental release under the reporting requirements of the Toxic Chemical Release Reporting: Community Right to Know (40 CFR Part 372), which includes the following:

- chemicals with special characteristics which in the opinion of the manufacturer can cause harm to people, plants, or animals when released by spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or

disposing into the environment (including the abandonment or discarding of barrels, containers, and other receptacles).

3.2.3 Any item or chemical which, when being transported or moved, is a risk to public safety or an environmental hazard and is regulated as such by one or more of the following:

- Department of Transportation Hazardous Materials Regulations (49 CFR 100-180);
- International Maritime Dangerous Goods Code of the International Maritime Organization (IMO);
- Dangerous Goods Regulations of the International Air Transport Association (IATA);
- Technical Instructions of the International Civil Aviation Organization (ICAO);
- US Air Force Joint Manual, Preparing Hazardous Materials for Military Air Shipments (AFJW 24-204).

3.2.4 The item or chemical is a special nuclear source, or by-product material as defined in 10 CFR or is regulated or referred to as radioactive under one or more of the referenced documents in paragraph 2 above.

GLOBAL HARMONIZATION

The Global Harmonized System (GHS) of Classification and Labeling of Chemicals (GHS) is an international system developed by the United Nations, designed to replace various classification and labeling standards used in different countries such that consistent criteria for classification and labeling can be accomplished on a global level. The United States was an active participant in the development of the GHS, and is a member of the UN bodies established to maintain and coordinate implementation of the system.

The GHS includes these two elements:

- Harmonized criteria for classifying substances and mixtures according to their physical, health, environmental hazards
- Harmonized hazard communication elements, including requirements for labeling and safety data sheets

Federal agencies in the United States, including the U.S. DOT (PHMSA), the Occupational Safety and Health Administration (OSHA), and the Environmental Protection Agency (EPA) have amended, or plan to amend, hazmat transportation and related regulations to be consistent with the GHS. Other federal agencies with interests in the GHS include the Consumer Product Safety Commission (CPSC), Department of Commerce, Food and Drug Administration (FDA), Office of the U.S. Trade Representative, Department of Agriculture, and National Institute of Environmental Health Sciences.

The GHS does not offer specific definitions for “hazardous materials” or “dangerous goods,” but GHS is the international standard for defining and classifying the physical, health, and

environmental hazards associated with specific chemicals and for specifying the information that should be included on labels and safety data sheets.

The UN document *Globally Harmonized System of Classification and Labeling of Chemicals (GHS) (Third Revised Edition, 2009)*, known as “The Purple Book,” can be viewed in PDF format at: <http://www.unece.org/?id=3636>.

More insight can be gained from *A Guide to the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)* which is available from OSHA at: <http://www.osha.gov/dsg/hazcom/ghs.html#2.4>.

APPENDIX F

HAZMAT TRANSPORTATION GLOSSARY OF TERMS AND ACRONYMS

AA – anhydrous ammonia

AAR – Association of American Railroads. An industry trade association that includes Amtrak, the major Class I railroads of the United States, Canada and Mexico, and smaller non-Class I and commuter railroads.

Accident – Used to describe events that happen unintentionally. Vehicular crash is a term often considered synonymous with accident.

AHMP – Alliance of Hazardous Materials Professionals. An association devoted to the professional advancement of individuals in the hazardous materials management field.

Barrel (BBL) – Unit of volume for some hazardous materials liquids, equal to 42 U.S. gallons at 60 degrees Fahrenheit.

Blue water – The deep waters of open oceans, often considered a subdivision of the marine transport mode.

Boiling point – The temperature at which a liquid changes to a vapor state at a given pressure. The boiling point is usually expressed in degrees Fahrenheit at sea level pressure (760 mm Hg, or one atmosphere).

Broker – An entity who, for compensation, arranges for transportation of cargo belonging to others.

Brown water – Rivers and other navigable bodies that make up the inland waterway system, often considered a subdivision of the marine transport mode.

BTS – Bureau of Transportation Statistics. An organization, presently housed within the USDOT Research and Innovative Technology Administration, created as a federal entity to administer data collection, analysis, and reporting of transportation activity.

Bulk packaging – Packaging, other than a vessel, or a barge, including a transport vehicle or freight container, in which hazardous materials are loaded with no intermediate form of containment and which has a maximum capacity greater than 450 liters (119 gallons) as a receptacle for a liquid; a maximum net mass greater than 400 kilograms (882 pounds) or a maximum capacity greater than 450 liters (119 gallons) as a receptacle for a solid; or a water capacity greater than 454 kilograms (1,000 pounds) as a receptacle for a gas as defined in Sec. 173.115 of 49 CFR.

Cargo – Product, including its packaging.

Cargo tank – A bulk packaging which: 1) is a tank intended primarily for the carriage of liquids or gases and includes appurtenances, reinforcements, fittings, and closures; 2) is permanently attached to or forms a part of a motor vehicle, or is not permanently attached to a motor vehicle but which, by reason of its size, construction or attachment to a motor vehicle is loaded or unloaded without being removed from the motor vehicle; and 3) is not fabricated under a specification for cylinders, portable tanks, tank cars, or multi-unit tank car tanks.

Carrier – An entity engaged in the transportation of passengers or property by land or water as a common, contract, or private carrier, or civil aircraft.

CHEMNET[®] – A network of for-hire contractors (primarily in the U.S.) for CHEMTREC[®] registrants who may need the services of an emergency response contractor at the scene of an incident involving their product.

CHEMTREC[®] – Chemical Transportation Emergency Center. A national center established to relay pertinent emergency information concerning specific chemicals on requests from individuals and response agencies. CHEMTREC has a 24 hour toll free telephone number (800-424-9300) to help agencies who respond to chemical transportation emergencies.

Code of Federal Regulations (CFR) – A compilation of the general and permanent rules of the executive departments and agencies of the federal government as published in the Federal Register. The code is divided into 50 titles that represent broad areas subject to federal regulation.

COFC – Container-on-flatcar, an arrangement that allows a container to be transported on a railroad flat-car.

COHMED – Cooperative Hazardous Materials Enforcement Development. An outreach activity of the Commercial Vehicle Safety Alliance to foster coordination, cooperation and communication between federal, state and local agencies having regulatory and enforcement responsibility for the safe transportation of hazardous materials and the hazmat industry.

Commercial driver's license (CDL) – A license issued by a State or other jurisdiction, in accordance with the standards contained in 49 CFR 383, to an individual which authorizes the individual to operate a class of a commercial motor vehicle.

Commercial Vehicle Safety Alliance (CVSA) – A non-profit organization of local, state, provincial, territorial and federal motor carrier safety officials and industry representatives from the United States, Canada and Mexico. CVSA's mission is to promote commercial motor vehicle safety and security by providing leadership to enforcement, industry and policy makers.

Commodity flow – The amount of cargo being transported between two points.

Consignee – A person or company to whom commodities are shipped.

Consignor – A person or company shown on the bill of lading as the shipper.

Consist – A group of railcars or barges and other fleet equipment that form a single shipment.

Corrosive substance – A material that causes visible destruction of or irreversible alterations by chemical action at the site of contact.

Dangerous goods – International term for hazardous materials.

DHS – U.S. Department of Homeland Security

DOD – U.S. Department of Defense

DOE – U.S. Department of Energy

Dose – The amount of a given material or chemical that enters the body of an exposed organism in a specific period of time. The time can be as short as a few seconds (e.g., injection) or as long as a lifetime (e.g., chronic exposure).

DOT – U.S. Department of Transportation

EMA – Emergency management agency

EMS – Emergency medical services

Emergency Response Guidebook (ERG) – Reference that provides first responders with information to help deal with hazmat accidents during the critical first 30 minutes.

EOC – Emergency operations center.

EPA – U.S. Environmental Protection Agency.

EPCRA – Emergency Planning and Community Right-to-Know Act. EPCRA was created to help communities plan for emergencies involving hazardous substances, by establishing requirements for federal, state and local governments, Indian tribes, and industry regarding reporting on hazardous and toxic chemicals.

ESCM – Electronic supply chain manifest. Its intent is to create a secure cargo manifest that allows for automated data transfer across transportation modes and political jurisdictions.

Event tree – A graphical representation of the logic used to identify and quantify the possible outcomes following an initiating event.

Exemption – Specific DOT-written relief from certain a hazmat regulation, for shippers, carriers or manufacturers

Extremely hazardous substance – A chemical determined by the U.S. Environmental Protection Agency to be extremely hazardous to a community during an emergency spill or release due to its material toxicity and physical/ chemical properties.

FAA – Federal Aviation Administration, U.S. Department of Transportation

Fault tree – A technique by which factors and conditions that might contribute to a specified event are identified, organized and quantified, represented in a graphical manner.

FEMA – Federal Emergency Management Agency, U.S. Department of Homeland Security

FHWA – Federal Highway Administration, U.S. Department of Transportation

Flash point – The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

FMCSA – Federal Motor Carrier Safety Administration, U.S. Department of Transportation

FMCSR – Federal Motor Carrier Safety Regulations

FRA – Federal Railroad Administration, U.S. Department of Transportation

Freight Analysis Framework (FAF) – A system that integrates data from a variety of sources to create a comprehensive picture of freight movement among states and major metropolitan areas by all modes of transportation.

Freight container – A reusable box having a volume of 64 cubic feet or more, designed and constructed to permit being lifted with its contents intact and intended primarily for containment of packages (in unit form) during transportation.

Fuel tank – A tank, other than a cargo tank, used to transport flammable or combustible liquid or compressed gas for the purpose of supplying fuel for propulsion of the transport vehicle to which it is attached, or for the operation of other equipment on the transport vehicle.

GHG – Greenhouse gas, defined as a gas in the atmosphere that absorbs or emits radiation within the thermal infrared range.

GIS – Geographic information system, a set of technologies designed to capture, store, manipulate, analyze, manage and present different types of geographical data in a compatible spatial format.

Global Harmonized System (GHS) of Classification and Labeling of Chemicals – an international system, developed by the United Nations, designed to replace various classification and labeling standards used in different countries such that consistent criteria for classification and labeling can be accomplished on a global level.

GPS – Global positioning system, a system of satellites, computers and receivers that is able to determine the latitude and longitude of a receiver on Earth.

Green water – Intracoastal waters, often considered a subdivision of the marine transport mode.

Gross weight – The weight of a packaging plus its contents.

Hazard – The inherent characteristic of a material, condition or activity that has the potential to cause harm to people, property or the environment.

Hazard class – A group of hazardous materials that share similar dangerous characteristics. The category of hazard is assigned to a hazardous material under the definitional criteria of Part 173 and the provisions of the Sec. 172.101 Table. A material may meet the defining criteria for more than one hazard class, but is assigned to only one of them.

Hazard communication standard – A regulation, contained in 29 CFR 1910.1200 and administered by the Occupational Safety & Health Administration, requiring an organization that produces/uses hazardous materials to provide its employees with information and training on the proper handling and use of these materials.

Hazard division – A means of sub-dividing similar hazardous materials which require different hazard communications.

Hazardous material – According to DOT regulations, a substance or material that the Secretary of Transportation has determined is capable of posing an unreasonable risk to health, safety, and property when transported in commerce. This includes hazardous substances, hazardous wastes, marine pollutants, elevated temperature materials, materials designated as hazardous in the Hazardous Materials Table, and any other materials that meet the defining criteria for hazard classes and divisions as described in the Code of Federal Regulations.

Hazardous materials permit – a safety permit issued to carriers that is required when transporting certain types and various amounts of hazardous materials.

Hazardous materials regulations (HMR) – Issued by the Pipeline and Hazardous Materials Safety Administration and govern the transportation of hazardous materials by highway, rail, vessel and air. The HMR address hazardous materials classification, packaging, hazard communication, emergency response information and training.

Hazardous Materials Table (HMT) – Issued by the Pipeline and Hazardous Materials Safety Administration, the HMT provides key information that governs the transportation of hazardous materials by various modes. For each material listed in the table, it identifies the corresponding hazard class, proper shipping name, and requirements pertaining to labeling, packaging, quantity limits aboard aircraft, and stowage of hazardous materials aboard vessels.

Hazardous substance – A material listed in Appendix A to § 172.101 and the quantity in one package equals or exceeds the reportable quantity (RQ).

Hazardous waste – Any material that is subject to the Hazardous Waste Manifest Requirements of the U.S. Environmental Protection Agency specified in 40 CFR Part 262.

Hazardous waste manifest – A shipping document required by the USDOT and the EPA for hazardous waste shipments; also referred to as the Uniform Hazardous Waste Manifest (UHW). If all USDOT requirements are entered on the UHW, the manifest may also be used as a shipping paper.

Hazmat – Hazardous material.

Hazmat employee – An employee who has a direct responsibility for the safe transport of a hazardous material. This includes anyone who operates a vehicle used to transport hazardous materials; individuals who load, unload or handle hazmat; those who test, recondition, repair, modify, mark, or otherwise represent packaging as qualified for use in the transportation of hazmat; or anyone who prepares hazmat for transportation.

Hazmat employer – A person whose employees transport hazardous materials in commerce; cause hazmat to be transported or shipped in commerce; or represent, mark, certify, sell, offer, recondition, test, repair, or modify packaging as qualified for use in the transportation of hazmat. It also includes any department, agency, or instrumentality of the United States, a state, a political subdivision of a state, or an Indian tribe engaged in offering or transporting hazmat in commerce.

Heat map – A two-dimensional graphical representation of risk using event likelihood on one axis and consequence (should the event occur) on the other axis.

IAFC – International Association of Fire Chiefs. A trade association representing firefighters and emergency responders worldwide.

ICAO – International Civil Aviation Organization. An agency of the United Nations, created to promote the safe and orderly development of international civil aviation through development of standards and regulations.

ICS – Incident Command System. A national, scalable system for organizing and managing on-scene emergency response operations.

IMDG – International Maritime Dangerous Goods code. A code administered by the International Maritime Organization, a United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships.

Incidents – Onerous events associated with a hazardous materials shipment, whether in transit or during loading, unloading or in storage, some of which may result in a release.

Infrastructure – All relevant elements of the environment in which a transportation system operates.

Institute of Hazardous Materials Management (IHMM) – a non-profit organization that offers the accredited Certified Hazardous Materials Manager (CHMM) credential and administers a Certified Hazardous Materials Practitioner (CHMP) credential and a Hazardous Materials Manager-in-Training (HMMT) program.

Intermediate bulk container (IBC) – A rigid or flexible portable packaging, other than a cylinder or portable tank, which is designed for mechanical handling.

Intermodal – Movements of cargo interchangeably between transport modes.

Interstate commerce – A shipment whose trip origin and destination are located in different states.

Intrastate commerce – A shipment whose trip origin and destination are located in the same state, and is completed without crossing state lines.

ISO – International Standards Organization. An entity that develops voluntary international standards for products, services and good practice, to help facilitate international trade.

Label – Hazard class identifier required on hazardous materials packaging.

Less-than-truckload (LTL) – A quantity of freight less than that required for the application of a truckload rate. Usually less than 10,000 pounds and generally involves the use of terminal facilities to break and consolidate shipments.

Key route – A designation by the Association of American Railroads (AAR) corresponding to routes that carry a certain annual load threshold of specified hazardous materials.

Key train – A train that carries a specified number of car loads of certain hazardous materials.

LEPC – Local emergency planning committee, established in response to the Emergency Planning and Community Right-to-Know Act (EPCRA).

Limited quantity – The maximum amount of a hazardous material for which there may be specific labeling or packaging exception.

Logistics – Management and operation of resources utilized to obtain, store and move cargo to the locations where they are required.

MARAD – Maritime Administration, U.S. Department of Transportation.

Marine pollutant – Hazardous material which is listed in Appendix B to Section 172.101 of 49 CFR and, when in a solution or mixture of one or more marine pollutants, is packaged in a concentration which equals or exceeds: 1) 10% by weight of the solution or mixture, or 2) 1% by weight of the solution or mixture for materials that are identified as severe marine pollutants.

Marking – Information required to be placed on the outside of the shipping container, which may include proper shipping name, identification number; UN standard packaging marks, and instructions/caution.

Material Safety Data Sheet (MSDS) – The written information on a specific chemical compound that expresses such items as physical hazards, signs and symptoms of exposure, toxicology information and other pertinent data. Will be referred to as “Safety Data Sheets” under OSHA’s revisions to the Hazard Communication Standard (HCS) to conform with the United Nations’ Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

Mixture – A material composed of more than one chemical compound or element.

Mitigation – Activities taken to avoid or reduce the severity or consequences of an emergency.

Mutual aid – An agreement among state and/or local governments to lend assistance across jurisdictional boundaries.

National Fire Protection Association (NFPA) – An international non-profit organization that develops, publishes and disseminates consensus codes and standards intended to minimize the possibility and effects of fire and other risks.

National Highway System – A transportation network comprising Interstate highways as well as other roads important to the nation’s economy, defense and mobility.

National Incident Management System (NIMS) – provides the national template for the management of incidents.

National Response Center (NRC) – The sole federal point of contact for reporting significant oil or chemical spill, or other environment-related accident that has occurred.

National Response Framework (NRF) – Provides structure and mechanisms for national-level policy for incident management.

NGO – Non-governmental organization

NLRB – U.S. National Labor Relations Board

Non-bulk packaging – A packaging, which has a maximum capacity of 450 L (119 gallons) as a receptacle for a liquid, a maximum net mass less than 400 kg (882 pounds) and a maximum capacity of 450 L (119 gallons) or less as a receptacle for a solid, or a water capacity greater than 454 kg (1,000 pounds) or less as a receptacle for a gas as defined in Section 173.115 of 49CFR.

N.O.S. – Not otherwise specified

Not in my backyard (NIMBY) – An expression representing opposition by residents to exposure to a threat that they feel is too close in proximity to their community.

NPRM – Notice of proposed rulemaking

NRHM – Non-radioactive hazardous materials.

NTMIC – National Traffic Incident Management Coalition, an alliance of national organizations representing the public safety, transportation, and towing and recovery communities.

NTSB – U.S. National Transportation Safety Board.

OSHA – U.S. Occupational Safety and Health Administration

Other regulated materials (ORM) – A class of materials used by the Department of Transportation which does not meet the definition of a hazardous material but poses some risk when transported in commerce.

Packing group – A grouping according to the degree of danger presented by hazardous materials. Packing Group I indicates great danger; Packing Group II, medium danger; Packing Group III, minor danger.

PHMSA – Pipeline and Hazardous Materials Safety Administration, U.S. Department of Transportation

PIH – poison inhalation hazard

Placard – 10-3/4 inch square diamond marker required on transport vehicles, such as trucks, rail cars, or freight containers 640 cubic feet or larger.

PPE (Personal Protective Equipment) – The correct protective worker clothing and respiratory equipment needed to perform a job involving hazardous materials. PPE includes proper boots, gloves, splash protective clothing, gas protective clothing, suits, eye protection, hearing protection, air purifying respirators and air supplying respirators.

Portable tank – Bulk packaging (except a cylinder having a water capacity of 1,000 pounds or less) designed primarily to be loaded onto, or on, or temporarily attached to a transport vehicle or ship and equipped with skids, mountings, or accessories to facilitate handling of the tank by mechanical means. It does not include a cargo tank, tank car, multi-unit tank car tank, or trailer carrying 3AX, 3AAX, or 3T cylinders.

Preemption – The authority of the federal government to override a requirement imposed by a state, political subdivision of a state or Indian tribe.

Preparedness – Activities, tasks, programs and systems developed and implemented prior to an emergency to support prevention, mitigation, response and recovery.

RAM – Radioactive material.

Receiver – The recipient of the hazardous materials shipment.

Recovery – Activities and programs designed to return conditions to a level that is acceptable to the entity.

Reportable quantity (RQ) – The quantity specified in Column 2 of the Appendix to 49 CFR Sec. 172.101 for any material identified in Column 1 of the Appendix.

Response – Immediate and ongoing activities, tasks, programs and systems to manage the effects of an incident that threatens life, property, operations or the environment.

Responsible Care[®] – A global, voluntary initiative developed by the chemical industry in which member companies agree to improve their performance in the fields of environmental protection, occupational safety and health protection, plant safety, product stewardship and logistics, as well as to continuously improve relations with the communities in which they operate.

Responsible Distribution – A set of safety management guiding principles established by the National Association of Chemical Distributors (NACD) to which all NACD members are committed.

Risk – The combination of the likelihood and the consequence of a specified hazard being realized. It is a measure of harm or loss associated with an activity.

Risk analysis – The study of risk in order to understand and quantify risk so it can be managed.

Risk assessment – The systematic approach to organizing and analyzing scientific knowledge and information about potentially hazardous activities

Risk control point – A place or step within a given process where actions can be taken to reduce risk.

Risk management – The systematic application of policies, practices and resources to assess and control risks affecting human health and safety and the environment.

RITA – Research and Innovative Technology Administration, U.S. Department of Transportation

RMSEF – Risk Management Self-Evaluation Framework, developed by the U.S. Pipeline and Hazardous Materials Safety Administration (PHMSA) as an approach for assessing and managing risk as part of the hazardous materials transportation process.

Route – A designated path through a transportation network that connect the shipment origin with the shipment destination.

Safe haven – An approved place for parking unattended vehicles carrying hazardous materials, the location of which is often designated by local authorities.

SERC – State emergency response commission, established as part EPA legislation, as an entity within each state whose mission is to improve emergency planning, preparedness, mitigation, response and recovery, with special emphasis associated with hazardous chemicals.

Shipper – An entity whose cargo is transported from their premises by a carrier to a specified destination.

Shipping paper – A shipping order, bill of lading, manifest, waybill or other shipping document serving a similar purpose and containing the information required by Sec. 172.202, 172.203 and 172.204 of 49 CFR.

Shipper's certification – A statement on a shipping paper, signed by the shipper, saying he/she prepared the shipment properly according to law.

Short ton – U.S. ton, equivalent to 2,000 pounds.

SNF – spent nuclear fuel

Special nuclear material – defined by Title I of the Atomic Energy Act of 1954 as plutonium, uranium-233, or uranium enriched in the isotopes uranium-233 or uranium-235, or any other material that the Commission determines to be special nuclear material (none to date).

STB – U.S. Surface Transportation Board, administratively affiliated with the U.S. Department of Transportation

Supply chain – the resources and activities involved in moving a product from a supplier to a customer.

Terminal – a fixed facility where freight is processed, often involving loading the shipment onto or off of a transport vehicle.

TIH – toxic inhalation hazard

TOFC – Trailer-on-flatcar, an arrangement that allows a truck trailer to be transported on a railroad flat-car.

Ton-mile – Unit of freight transportation equivalent to a ton of freight moved one mile.

Track class – A designation given to a segment of railroad track by the U.S. Federal Railroad Administration that establishes a maximum allowable speed of trains that operate over that segment.

TRANSCAER – **T**ransportation **C**ommunity **A**wareness and **E**mergency **R**esponse) ®. Voluntary national outreach effort that focuses on assisting communities to prepare for and to respond to a possible hazardous materials transportation incident, focusing on rail.

Transportation – The movement of property and loading, unloading, or storage incidental to the movement. Transportation functions are defined at 49 CFR 171.1(c).

Transport vehicle – A cargo-carrying vehicle such as an automobile, van, tractor, truck, semi-trailer, tank car, or rail car used for the transportation of cargo by any mode. Each cargo-carrying body (trailer, rail car, etc.) is a separate transport vehicle.

TSA – Transportation Security Administration, U.S. Department of Homeland Security

TWIC – Transportation Worker Identification Credential. A tamper-resistant biometric credential issued to transportation workers requiring unescorted access to secure facilities and vessels.

Unified command – The system of command used in the ICS where multiple agencies or jurisdictions will assign a person to share key responsibilities within the ICS, including that of incident commander.

Uniform Hazardous Waste Manifest – A standard shipping document required by the EPA for hazardous waste shipments.

UN number – A four-digit number that identifies a specific hazardous material in the framework of international transport.

UN standard packaging – A packaging specification conforming to the standards in the UN recommendations.

USACE – U.S. Army Corps of Engineers. An agency of the U.S. Department of Defense with responsibilities for the nation's waterways, including building and operating locks and dams, dredging for navigation, flood control, and environmental regulation and enhancement. Sometimes referred to as USACOE, COE, or "the Corps."

USCG – U.S. Coast Guard, U.S. Department of Homeland Security.

Warehousing – A procedure by which an entity stores an inventory of goods prior to its delivery.

Water reactive – Any solid substance that, by interaction with water, is likely to become spontaneously flammable or to give off flammable or toxic gases in dangerous quantities.

Waybill – The shipping paper used by the railroads indicating origin, destination, route and product.

APPENDIX G

INTRODUCTION TO THE TOOLKIT FOR HAZARDOUS MATERIALS TRANSPORTATION EDUCATION (THMTE)

The THMTE provides eight modules and supporting material to facilitate post-secondary education for hazardous materials transportation. The curricula was designed to be adaptable for the needs of post-secondary students, including multiple disciplines, undergraduate and graduate, community college, professional and executive development. Instructors should adapt and supplement the materials to address their specific course objectives, characteristics of the student group, and the instructional time available.

THMTE contains eight (8) modules in PowerPoint format. Module #1 serves as an introduction and a summary of the other seven. Modules are arranged in a recommended order of presentation for an entire course. Additionally, individual modules or excerpts of modules may be used independently to supplement another course. The titles of the modules are as follows:

- Module 1: Introduction to Hazardous Materials Transportation
- Module 2: Hazmat Transportation Logistics
- Module 3: Hazmat Legal and Regulatory Environment
- Module 4: Hazmat Mode and Route Selection
- Module 5: Hazmat Risk Management
- Module 6: Hazmat Transportation Incident Management
- Module 7: Security of Hazmat Transportation Shipments
- Module 8: Hazmat Transportation Workforce Development Issues

At the end of each module are suggested student exercises or homework assignments as well as a listing of resources for additional learning.

The toolkit was designed with the expectation that instructors will condense, combine, rearrange, or expand the modules to meet the goals and constraints of specific courses for specific audiences. The goal was for each module to be useable separately or in combination with one or more of the other modules. Instructors should also be mindful of the following:

- Some slides contain a lot of information, graphics, and/or small fonts that may not be easily visible when projected in a typical classroom setting. Instructors may want to convert such slides (or the original material from the cited sources) to a student handout to supplement or substitute for projected slides.
- Links to multimedia and online materials as well as references to current regulations, standards, and policies in the modules will change over time; thus, requiring updating of the materials and links.
- A limited number of slides include notes to expand on content or to suggest ways to facilitate classroom discussion, but more work is needed to enhance these notes and to develop notes for other slides based on experience in actual use of the modules.

In addition to the eight modules, the following are suggested as supplementary materials:

- Definitions of Hazardous Materials (Appendix E)
- Hazmat Transportation Glossary of Terms and Acronyms (Appendix F)
- Suggested Student Handouts (Appendix H)
- Incident Reports, Reviews, and Case Studies
 - U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration Calendar Year 2010 Notice of Hazardous Materials Regulations Enforcement
http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/2010_Penalty_ActionReport_II..pdf
 - U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration Calendar Year 2011 Notice of Hazardous Materials Regulations Enforcement
http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/2011_Hazmat_Penalty_Action_Report.pdf
 - Case Studies of Transportation Accidents Involving Hazardous Materials by S. Becker and S. Clark
<http://rpitt.eng.ua.edu/Class/EffectsandFates/Module9/Module9.htm>
 - National Hazardous Materials Fusion Center Hazmat History, Kingman, Arizona
http://www.hazmatfc.com/hazmatResources/HazmatHistory/Documents/Kingman_Arizona_Incident.pdf
 - National Hazardous Materials Fusion Center Hazmat History, Miamisburg, Ohio Train Derailment
http://www.hazmatfc.com/hazmatResources/HazmatHistory/Documents/HAZMAT_HISTORY_MIAMISBURG.pdf

- National Hazardous Materials Fusion Center Hazmat History, The Texas City Disaster
http://www.hazmatfc.com/hazmatResources/HazmatHistory/Documents/HazmatHistory_Texas_City_Disaster_Final.pdf
- FEMA Emergency Management Institute *Hazardous Materials Tabletop Exercises Manual*
[http://training.fema.gov/EMIWeb/pub/HazMat Tabletop Manual.pdf](http://training.fema.gov/EMIWeb/pub/HazMat%20Tabletop%20Manual.pdf)
- National Transportation Safety Board Hazardous Materials Accident Reports Links
http://www.nts.gov/investigations/reports_hazmat.html
- NTSB Safety Recommendation letter A-08-1 and -2
http://www.nts.gov/doclib/reletters/2008/A08_1_2.pdf
- NTSB HZM-99/02 Hazardous Materials Accident Report, Overflow of Gasoline and Fire at a Service Station-Convenience Store, Biloxi, Mississippi, August 9, 1998
<http://www.nts.gov/doclib/reports/1999/HZM9902.pdf>
- NTSB original letter regarding Safety Recommendations H-11-4 thru 6
[http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/NTSB/NTSB response to H-11-4 to -6 to PHMSA 1-10-2012.pdf](http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/NTSB/NTSB_response_to_H-11-4_to_-6_to_PHMSA_1-10-2012.pdf)
- NTSB Safety Recommendation letter P-11-8 through -20 and P-11-1 and P-11-2.
<http://www.nts.gov/doclib/reletters/2011/P-11-008-020.pdf>
- NTSB PAR-11/01 Pipeline Accident Report, Pacific Gas and Electric Company Natural Gas Transmission Pipeline Rupture and Fire
<http://www.nts.gov/doclib/reports/2011/PAR1101.pdf>
- NTSB Safety Recommendation letter H-95-37 Propane with Reference to Memphis incident
http://www.nts.gov/doclib/reletters/1995/H95_37.pdf
- NTSB Safety Recommendation letter R-12-5 through -8 and R-07-4
[http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/NTSB/R-12-5 thru-8 PHMSA Original Letter.pdf](http://phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/NTSB/R-12-5_thru-8_PHMSA_Original_Letter.pdf)
- NTSB Railroad Accident Report, Department of Louisville & Nashville Railroad Company's Train No. 584 and Subsequent Rupture of Tank Car Containing Liquefied Petroleum Gas, Waverly, Tennessee, February 22, 1978
<http://fire.omeka.net/items/show/595>
- *SS Santa Clara Case Study: An Environmental and Transportation First* by Robert D. Jaffin.
<http://www.trb.org/Main/Blurbs/169272.aspx>
- U.S. Fire Administration Technical Report Series, *Gasoline Tanker Incidents in Chicago, Illinois and Fairfax County, Virginia*, USFA-TR-032
<http://www.usfa.fema.gov/downloads/pdf/publications/tr-032.pdf>

- U.S. Fire Administration Technical Report Series, *Major Ship Fire Extinguished by CO₂*, USFA-TR-058
<http://www.usfa.fema.gov/downloads/pdf/publications/tr-058.pdf>
- U.S. Fire Administration Technical Report Series, *CSX Tunnel Fire*, USFA-TR-140
<http://www.usfa.fema.gov/downloads/pdf/publications/tr-140.pdf>

Instructors who use this material are encouraged to share their experiences with the toolkit and to note any errors, omissions, or suggested additions by contacting:

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APPENDIX H

SUGGESTED STUDENT HANDOUTS FOR THE TOOLKIT FOR HAZARDOUS MATERIALS TRANSPORTATION EDUCATION

Each module in the toolkit ends with suggested “Sources for Support and Additional Learning,” and many of those sources are available electronically. Also, several of the modules include imbedded links to electronic depositories and copies of specific documents.

However, instructors are encouraged to assemble a set of materials for distribution to students at the beginning of the course. The following list includes sources of background information as well as basic references that may be helpful in multiple modules. Most are available in electronic format, but some may be more useful to students in “hard copy.” Many can be obtained without charge from the Pipeline and Hazardous Materials Safety Administration (PHMSA; www.phmsa.dot.gov/hazmat/training/publications) or other federal or state agencies, as noted:

1. Definitions of Hazardous Materials (Appendix E of this publication)
2. Hazmat Transportation Glossary of Terms and Acronyms (Appendix F of this publication)
3. NCHRP Research Results Digest 333/TCRP Research Results Digest 90: A Guide to Planning Resources on Transportation and Hazards (<http://www.trb.org/Main/Blurbs/162332.aspx>)
4. PHMSA’s “HAZMAT Digipack” (currently version 7.2) which includes a number of the key references listed below
5. *Emergency Response Guidebook (ERG) 2012*
6. *DOT Chart 14* (or more recent version)
7. PHMSA Hazmat General Awareness/Familiarization Training CD
8. Timelines prepared by Claire Rubin, Irmak Renda-Tanali, and William R. Cumming to illustrate the relationships among “major focusing events” and “policy outcomes,” e.g., legislation, regulations, directives, organizational changes.

One version, *Disaster Timeline: Major Focusing Events and U.S. Outcomes (1978-2006)* was published as a supplement to TR News #250 (May-June, 2007), and a copy can be downloaded from: http://onlinepubs.trb.org/onlinepubs/trnews/trnews250_insert.pdf.

Other versions are available for purchase at <http://disaster-timeline.com/>, including *Emergency Management: The American Experience, 1900 – 2005* (Century Timeline) and *Disaster Timeline: Major Focusing Events and U.S. Outcomes (1988-2008)*.

9. *How to Use the Hazardous Materials Regulations* (PHMSA)
10. *Guide for Preparing Hazmat Incidents Reports* (PHMSA)
11. *National Response Framework* (FEMA)
12. *Globally Harmonized System of Classification and Labeling of Chemicals (GHS) (Third Revised Edition, 2009)*, available at: <http://www.unece.org/?id=3636>
13. *A Guide to the Globally Harmonized System of Classification and Labeling of Chemicals (GHS)*, from OSHA, available at: <http://www.osha.gov/dsg/hazcom/ghs.html#2.4>
14. HMCRP published reports, including for instance HMCRP Report 1: *Hazardous Materials Transportation Incident Data for Root Cause Analysis* (http://onlinepubs.trb.org/onlinepubs/hmcrp/hmcrp_rpt_001.pdf)
15. Published reports from the respective State Emergency Response Commission (SERC), the Local Emergency Planning Committee (LEPC), or other state or local agencies with responsibilities related to hazardous material (dangerous goods) transportation
16. Recent news media reports on hazmat transportation incidents in the area where the course is offered or incidents of particular interest to the student group, for use as case studies and to help illustrate the relevance of the course
17. Reports from NTSB or other sources that could be used as cases studies on hazmat transportation incidents in the area where the course is offered or that cover a topic of particular interest to the student group
18. Other materials that the instructor intends to use as a frequent reference throughout the course

Instructors may also want to make copies of toolkit slides with graphics or other material that might be difficult for students to view on a classroom screen.