HMCRP

Web-Only Document 1:

Current Hazardous Materials Transportation Research and Future Needs

Visual Risk Technologies, Inc.
Arlington, VA

Contractor's Final Report for HMCRP Project 10
Submitted April 2012

Hazardous Materials Cooperative Research Program
TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

ACKNOWLEDGMENT

This work is sponsored by the Pipeline and Hazardous Materials Safety Administration (PHMSA). It was conducted through the Hazardous Materials Cooperative Research Program (HMCRP), which is administered by the Transportation Research Board (TRB) of the National Academies.

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. On the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Ralph J. Cicerone is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Charles M. Vest is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, on its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Ralph J. Cicerone and Dr. Charles M. Vest are chair and vice chair, respectively, of the National Research Council.

The **Transportation Research Board** is one of six major divisions of the National Research Council. The mission of the Transportation Research Board is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal. The Board's varied activities annually engage about 7,000 engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia, all of whom contribute their expertise in the public interest. The program is supported by state transportation departments, federal agencies including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. **www.TRB.org**

www.national-academies.org

TABLE OF CONTENTS

List of Tables

1. Introduction

This Final Report documents a project to identify current hazardous materials transportation research and future needs. The first phase of the project involved developing the framework for capturing existing research, planned research, and research gaps. It also sets the stage for prioritizing future research needs. The second phase of the project focused on developing a prioritized list of research projects for the Transportation Research Board's (TRB) Hazardous Materials Cooperative Research Program (HMCRP).

The following sections of this report contain the results of the first seven project tasks:

- Section 2: lists the research organizations that were identified as potentially sponsoring or conducting hazmat transportation research (Task 1).
- Section 3: identifies the recent and planned research projects by organization and includes contact information, context and subject areas, and project descriptions (Tasks 2 and 3).
- Section 4: contains future research needs as identified by each organization (Task 3).
- Section 5: provides a matrix of research areas by organization (Task 4).
- Section 6: documents the gaps and overlaps in the research and provides a list of research needs and project descriptions (Task 5).
- Section 7: includes the finalized framework for prioritizing research needs and projects (Task 6 and Task 8).
- Section 8: provides a prioritized list of the research projects (Task 9).

This report constitutes the second deliverable for Task 10 of the project.

2. Relevant Research Organizations

The project team identified the organizations listed in Table 1 as potentially conducting hazardous materials-related research. The list includes organizations identified by the Project Panel in the solicitation and those added by the project team and enumerated in the project's working plan. Some additional organizations were identified through the interview process or by

- Conducting an Internet search for organizations conducting relevant research,
- Conducting an Internet search for completed research projects,
- Reviewing the HMCRP and other cooperative research program websites to identify organizations performing work that relates to hazardous materials transportation, and
- Reviewing the TRB Research Needs Database for organizations performing relevant work.

A final step included a conference call with the Project Panel, which generated some additional contacts.

Note that Table 1 shows the number of research projects that the project team identified as being relevant to hazardous materials transportation research. While the inclusion of consulting firms in Table 1 may appear duplicative, given that many of the research projects were conducted under contract, they were included because these were organizations specifically identified for an interview to ensure that the project team did not miss any research projects. Projects are only counted once in Table 1, generally assigned to the sponsoring organization. The individual projects and the performing organizations are listed in Table 2 on page 6.

Table 1. Relevant Agencies and Research Organizations

Relevant Research Organizations	Projects
Federal	
Bureau of Transportation Statistics (BTS)	
Chemical Security Analysis Center (CSAC)	5
Civilian Radioactive Waste Management Program, Office of Logistics Management	
Environmental Management	
Environmental Protection Agency (EPA)	
Federal Aviation Administration (FAA)	4
Federal Emergency Management Agency (FEMA)	
Federal Motor Carrier Safety Administration (FMCSA)	4
Federal Railroad Administration (FRA)	14
Intelligent Transportation Systems Joint Program Office (ITS JPO)	
Maritime Administration (MARAD)	
National Transportation Safety Board (NTSB)	
Nuclear Regulatory Commission (NRC)	1
Oak Ridge National Laboratory (ORNL) Center for Transportation Analysis (CTA)	5
Occupational Safety and Health Administration (OSHA) – Dept. of Labor	
Office of Research, Development, and Technology (RDT)	
Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Hazardous Materials Safety	8
Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety	38
Research and Innovative Technology Administration (RITA)	
Sandia National Laboratories	
Savannah River National Laboratory	
Science and Technology Directorate (S&T)	1
Surface Deployment and Distribution Command (SDDC)	
Transportation Security Administration (TSA)	
United States Coast Guard (USCG)	
U.S. Transportation Command (USTRANSCOM)	
Volpe National Transportation Systems Center (VOLPE)	
Academic/Research	
Illinois Center for Transportation	
Johns Hopkins University Applied Physics Laboratory (APL)	
Midwest Research Institute	
National Pipeline Safety & Operations Research Center	9
North Carolina State University	
Rensselaer Polytechnic University	
Standing Committee on Transportation of Hazardous Materials (AT040)	
Transportation Research Board (TRB)	18
Texas Transportation Institute	1
Texas A&M University	2
University of Buffalo	1

Relevant Research Organizations	Projects
University of Kentucky	
University of Illinois Urbana-Champaign	5
Vanderbilt University	4
Virginia Polytechnic Institute	1
International	
Australia Department of Infrastructure and Transport – Dangerous Goods Policy Unit	
Civil Aviation Authority of Singapore	
Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT)	6
Maritime & Port Authority of Singapore's Hazardous Cargo Section	
Singapore Civil Defense Force Hazmat Department	
Transport Canada – Surface and Intermodal Security Directorate	2
Transport Canada – Transport Dangerous Goods Directorate (TDG)	11
UK Department for Transport – Dangerous Goods Division	
UK Department for Transport – Vehicle Certification Agency - Dangerous Goods Office	
States	
California Department of the Highway Patrol	
California Office of Emergency Services	
Commercial Vehicle Safety Alliance (CVSA)	
Illinois DOT	
National Council of State Legislatures (NCSL)	1
General Hazmat	
Council on the Safe Transportation of Hazardous Articles (COSTHA)	2
Dangerous Goods Advisory Council (DGAC)	
Shippers	
American Chemistry Council (ACC)	
Center for Chemical Process Safety (CCPS)	1
Compressed Gas Association (CGA)	
Dow Chemical Company	
E. I. du Pont de Nemours and Company (DuPont)	3
Institute of Makers of Explosives (IME)	3
National Association of Chemical Distributors	
Olin Corporation	
The Chlorine Institute	1
The National Industrial Transportation League (NITL)	
TRANSCAER	
Insurers	
XL Insurance	
Zurich	
Carriers	
Air Transport Association (ATA)	
American Transportation Research Institute (ATRI)	
American Trucking Associations (ATA)	

Relevant Research Organizations	Projects
Association of American Railroads (AAR)	21
Association of American Railroads/Rail Research Foundation (AAR/RRF)	2
Association of American Railroads/Railway Supply Institute (AAR/RSI)	6
CSX	
BNSF	
International Vessel Operators Dangerous Goods Association (IVODGA, formerly VOHMA)	
National Tank Truck Carriers, Inc. (NTTC)	
Norfolk Southern	
Sentinel Trucking	1
SLT Expressway	2
Union Pacific	1
Response	
International Association of Fire Chiefs (IAFC)	
International Chiefs of Police (IAPC)	
Consulting	
ABS Consulting	
Battelle	
Booz Allen Hamilton	
Engineering Systems, Inc.	
SAIC	
Visual Risk Technologies, Inc. (VRT)	
Professional	
Security Analysis and Risk Management Association (SARMA)	
DHS University Centers	
Awareness and Localization of Explosives-Related Threats	
Center for Island, Maritime, and Extreme Environment Security	
National Center for Border Security and Immigration	
National Center for Food Protection and Defense	
National Center for Risk and Economic Analysis of Terrorism Events (CREATE)	4
National Center for the Study of Preparedness and Catastrophic Event Response	
National Consortium for the Study of Terrorism and Responses to Terrorism	
National Transportation Security Center of Excellence	
Natural Disasters, Coastal Infrastructure and Emergency Management	
Purdue University Regional Visualization and Analytics Center	
University Transportation Centers	
None of the University Transportation Centers conducted relevant hazmat transportation research.	

3. Hazardous Materials Transportation Research Projects

One of the main tasks in this project was the compilation of recent, current, and planned hazmat research projects. The project specifications limited past projects to those from 2009 and later, so a number of well-known and important projects were not included. These older projects include the

Hazardous Materials Safety and Security Operational Test completed by the Federal Motor Carrier Safety Administration in 2004 and the Volpe Transportation Center's 2003 study, "The Role of Hazardous Material Placards in Transportation Safety and Security."

The process to identify potential hazmat transportation research organizations and the resulting list of organizations is described in the preceding section of this report. There were one or more identified contacts for each organization based on project team or Project Panel experience. Each of these individuals was contacted and the project was explained. Some representatives indicated that, while their organization may be very involved in hazmat transportation, they did not conduct any related research. For the others, an in-person or telephone interview was scheduled or an interview was conducted on the spot. In some cases, additional contacts were identified from that organization and they were also contacted. Since the project team was also conducting a related Hazardous Materials Cooperative Research Program effort related to hazmat transportation risk assessment, an interview template was developed that served both projects. The research elements of that template are included in Appendix A.

The list of hazardous materials transportation-related research projects in Table 2 was compiled from interviews with research organizations and other supplemental research, such as Internet searches. This list was augmented throughout the project as additional information was obtained.

The project list in Table 2 is ordered by group and organization. Key attribute information includes the context and subject areas for each project; its status and estimated completion date; a point of contact; a link to online project information, if available; and a brief description.

The context and subject areas listed for each project are derived from the solicitation (marked with an asterisk below) for the project and augmented by the project team. The context areas capture the setting and perspective under which the research was, is, or will be conducted. The context areas used in this report are:

- Regulatory*/Enforcement
- Business*
- Economic*
- Safety
- Security

The subject areas listed for each project describe the general area that the research addresses and are:

- Packaging*
- Routing*
- Emergency Response*
- Enforcement*
- Risk Assessment*
- Operations
- Training
- Technology
- Material Classification
- General Policy

Table 2. Research Projects

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
ACADEMIC/RESEARCH			
National Center for Risk and Economic Analysis of Terrorism Events (CREATE)			
1. Chlorine Spill Resource Allocation --- Isaac Maya, isaac.maya@usc.edu, (213) 740-3865 http://create.usc.edu/publications/publications_by_primary_author.html	Security Economic --- Risk Assessment Emergency Response	Complete June 2010	Development of a methodology for determining optimal emergency response resource allocation for chlorine spill events
2. Nuclear Material Resource Allocation --- Isaac Maya, isaac.maya@usc.edu, (213) 740-3865 http://create.usc.edu/publications/publications_by_primary_author.html	Security Economic --- Risk Assessment	Ongoing September 2011	Developing resource allocation strategies for detecting movements of nuclear materials within urban areas. Factors in costs associated with deployment, congestion and delays, as well as costs of consequences of failure to detect/deter. Methods can be used for deployment on a local level, such as at a port or airport, or for building a systems-type approach on a large scale, such as state-wide, or multiple metropolitan areas.
3. TransNEMO --- Isaac Maya, isaac.maya@usc.edu, (213) 740-3865 http://create.usc.edu/publications/publications_by_primary_author.html	Security Economic --- Risk Assessment	Complete September 2010	Developing a model for tracking the economic effects throughout the national economy, spatially and temporally, of a terrorist attack. Model has been used to study attack on ports and considers impact on transportation networks.
4. Transportation Resiliency --- Isaac Maya, isaac.maya@usc.edu, (213) 740-3865	Security Economic --- Risk Assessment	Planned	Research into methods for determining the resiliency of transportation network infrastructure to terrorist attacks
National Pipeline Safety & Operations Research Center			
5. Waterway policy and pipeline operation --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety Regulatory/Enforcement --- Risk Assessment	Planned	Compliance of port and waterway policies with pipeline construction and operation

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
6. Pipeline policy and infrastructure expansion --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety Regulatory/Enforcement --- Risk Assessment	Planned	Impact of pipeline policies on the expansion of transportation infrastructures
7. Use of demographic data in pipeline research --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety --- Risk Assessment Technology	Planned	Incorporation of demographic data into risk analyses/GIS applications
8. Marine pipeline research --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety --- Risk Assessment	Planned	Integrity and monitoring of coastline and offshore pipelines
9. Advanced leak detection technologies --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety --- Risk Assessment Technology	Planned	Leak detection using fluid transport technology
10. Pipeline applications of NDE technologies --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety --- Risk Assessment Technology	Planned	Nondestructive examination (NDE) applications to monitor structural integrity
11. Third-party damage of pipelines --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety --- Risk Assessment	Planned	Prediction and prevention of accidental third party damage
12. Standards for static testing of pipelines --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety Regulatory/Enforcement --- Risk Assessment	Planned	Review of codes and specifications for static testing
13. Application of technologies for pipeline monitoring and communication --- Les Olsen, l-olson@tamu.edu, (979) 862-2846,	Safety --- Risk Assessment Technology	Planned	Use of remote sensors and low-cost electronics to communicate pipeline conditions, leaks, pipeline locations, pipeline encroachments - specifically for use in Chinese pipelines

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
Texas A&M University			
14. An integrated vulnerability-based detection/interception model for the protection of regional infrastructure from covert attack --- Justin T. Yates, jtyates@tamu.edu, 979.845.1506	Security --- Risk Assessment Routing	Complete 2009	This project produced a modified shortest path network interdiction formulation for the placement of detection sensors within a geographic region of interest in lieu of direct placement (or interdiction) of network arcs to assess regional network vulnerability. An integrated interception team model uses these resource location results to allocate interception units on the network and analyze their effectiveness in responding to generated sensor alarms. Various models are adapted to locate units and assess interception performance, and a demonstrative case analysis is examined.
15. Utilization of accident databases and fuzzy sets to estimate frequency of Hazmat transport accidents --- Yuanhua Qiao, seraph@tamu.edu	Safety --- Risk Assessment	Complete 2009	Development of a methodology to estimate hazardous materials transportation accident frequency by utilizing publicly available databases and expert knowledge. The integrated methodology provides the basis for an overall transportation risk analysis.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
Texas Transportation Institute			
16. Managing the Movements of Hazardous Materials Shipments through Texas Population Centers --- Jeffery E. Warner, j-warner@tamu.edu, (979) 862-2915 http://tti.tamu.edu/projects/project_details.htm?id=2715	Regulatory/Enforcement Safety --- Risk Assessment Routing Operations/Training	Complete 2009	This project examined the quantities, origins, and destinations of hazardous materials flows in Texas by mode of transportation; reviewed the respective roles of stakeholders; investigated the hazmat route relocation potential of multimodal corridors and other rail routes; and provided guiding principles on effective state and sub-state strategies for the management of hazardous materials movements. A guidebook of management strategies provides tools and activities that planners at all levels can utilize to reduce the potential negative effects of shipping hazardous materials through urban centers. Additionally, planners and officials can use the data evaluation to better understand the overall movements of hazardous materials in Texas.
Transportation Research Board (TRB) - Hazardous Materials Cooperative Research Program (HMCRP)			
17. A Guide for Assessing Emergency Response Needs and Capabilities for Hazardous Materials Releases (HM-03) --- Battelle Arthur Greenburg, greenbea@battelle.org http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1605	Safety --- Emergency Response	Complete 11/2010	The objective of this project is to develop a guide for conducting assessments of emergency response needs and capabilities for hazardous materials releases.
18. Accident Performance Data of Bulk Packages Used for Hazardous Materials Transportation (HM-07) --- ESI Phil Daum, pjdaum@esi-il.com http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2659	Safety Regulatory/Enforcement --- Packaging Risk Assessment	In progress 05/2012	The objectives of this research are to (1) recommend methodologies for collecting and analyzing performance data for U.S. DOT-specified hazardous materials bulk packages (i.e., portable tanks and cargo tank motor vehicles) and (2) identify and evaluate institutional barriers to data collection and recommendations for overcoming these barriers.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
19. Best Practices in Hazardous Materials Pipeline Emergency Response Plans (HM-15) --- http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3139	Safety --- Emergency Response	Pending	The objective of this research is to develop a best practices guide that addresses both the appropriate content as well as dissemination of Hazardous Materials Pipeline Emergency Response Plans.
20. Consolidated Security Credential for Persons Who Transport Hazardous Materials (HM-08) --- Virginia Polytechnic Institute Darrell S. Bowman, Darrell.Bowman@vt.edu http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2660	Security Regulatory/Enforcement --- Operations/Training	In progress 02/2011	The objective of this research is to identify options for achieving the objective of a single, universally recognized credential that establishes (a) identity; (b) eligibility to access secure areas; and (c) eligibility to obtain or hold transportation-related licenses, credentials and other government certifications required of persons who transport hazardous materials by all modes in the U.S.
21. Current Hazardous Materials Transportation Research and Future Needs (HM-10) --- Visual Risk Technologies, Inc. Mark Lepofsky, mlepofsky@vrisk.com, (703) 816-5244 http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2928	Research Needs --- General Policy	In progress 01/2012	The objective of the research is to review and compile current and proposed hazardous materials transportation research and prioritize future research needs for HMCRP.
22. Emerging Technologies Applicable to Hazardous Materials Transportation Safety and Security (HM-04) --- Battelle Bill Tate, tatew@battelle.org http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1606	Safety Security --- Operations/Training Technology	Complete 11/2010	The objectives of this project are to (1) develop a list of near-term (less than 5 years) and longer-term (5–10 years) technologies that are candidates for use in enhancing the safety and security of hazardous materials transportation; (2) identify emerging technologies during these near- and longer-term spans; and (3) identify potential impediments to and opportunities for their development, deployment, and maintenance.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
23. Evaluating the Effectiveness of Hazmat Transportation Training (HM-17) --- Project Performance Corporation Dan Kocher http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3141	Safety --- Operations/Training	In progress 3/16/2013	The objective of this research is to develop a guide that describes methodologies, metrics, and best practices used to evaluate the effectiveness of training programs and instructional methods (including preparation and delivery) used to impart hazardous materials (hazmat) transportation safety and security regulatory requirements to public- and private-sector hazmat employees.
24. Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments (HM-05) --- Battelle Bill Tate, tatew@battelle.org http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2425	Regulatory/Enforcement Business --- Operations/Training	In progress 01/2012	The objective of this research is to develop a roadmap for the use of electronic shipping papers as an alternative to the current paper-based hazardous materials communication system. The roadmap will address the electronic transfer of safety, operational, regulatory compliance, and emergency response data and documentation, for and amongst all transport modes.
25. Guidebook for Developing Sub-national Commodity Flow Data (NCFRP 20) --- Cambridge Systematics Dike Ahanotu, dahanotu@camsys.com, (404) 460-2601 http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2662	Regulatory/Enforcement Safety Security --- Risk Assessment Routing Emergency Response	In progress 03/2011	The objective of this research is to provide state DOTs and other sub-national agencies with a guidebook for obtaining and compiling commodity flow data useful for their analyses. This study does not focus on hazmat, but does have a tie in through the language in Task 1, which requires a review of examples of sub-national-level compilation and use of commodity flow information, "including the results of HMCRP-01, 'Hazardous Materials Commodity Flow Data and Analysis.'"
26. Hazardous Materials Commodity Flow Data and Analysis (HM-01) --- Texas A&M University George O. Rogers, grogers@tamu.edu, (979) 845-7284 http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1603	Regulatory/Enforcement Safety Security --- Risk Assessment Routing Emergency Response	Complete 03/2010	The objective of this project is to produce a guidebook for conducting hazardous materials commodity flow surveys to support local risk assessment, emergency response preparedness, and resource allocation and to support analyses across jurisdictional boundaries.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
27. Hazardous Materials Transportation Incident Data for Root Cause Analysis (HM-02) --- Battelle Arthur Greenburg, greenbea@battelle.org http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1604	Safety --- Risk Assessment	Complete 06/2009	The objectives of this research are to (1) develop a set of practical recommendations for methods to improve the availability and quality of hazardous materials transportation incident data, (2) identify gaps and redundancies in reporting requirements, and (3) provide an estimate of the under-reporting of serious incidents. The scope of this research includes all transportation modes covered by 49 CFR Parts 100-180.
28. Hazardous Materials Transportation Risk Assessment: State of the Practice (HM-12) --- Visual Risk Technologies, Inc. Mark Lepofsky, mlepofsky@vrisk.com, (703) 816-5244 http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2930	Safety Security --- Risk Assessment	Pending 05/2012	The objectives of this project are to (a) identify existing tools, methodologies, approaches, and key sources of data for assessing hazardous materials transportation risks in the public and private sectors; (b) characterize the capabilities and limitations of each; (c) identify where there are significant gaps and needs in the available tools and approaches; and (d) recommend paths forward. Transportation risks of particular concern relate to acute releases of significant quantities of hazardous materials for all modes of transportation.
29. Improved Classification and Categorization of Water-Reactive Substances (HM-14) --- Edward T. Harrigan, eharriga@nas.edu, (202) 334-3232 http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3138	Safety --- Operations/Training Risk Assessment Emergency Response	Planned	The objective of this research is to investigate new or enhanced test procedures and classification criteria for water-reactive substances in order to take into account the potential buildup of flammable or toxic gases within a container or cargo hold that could lead to explosions.
30. Improving Local Community Recovery from Disastrous Hazardous Materials Transportation Incidents (HM-11) --- ABS Consulting Rick Ranous, RRanous@absconsulting.com http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2929	Safety Regulatory/Enforcement --- Emergency Response	Pending 04/2012	The objective of this research is to develop a compendium of best practices that can be used by local communities to plan for recovery from disastrous hazardous materials transportation incidents.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
31. Model Post-Secondary Education Curricula for the Transportation of Hazardous Materials (HM-16) --- 3 Sigma Consultants Michael Bronzini http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3140	Safety --- Operations/Training	In progress 4/1/2013	The objective of this research is to develop model post-secondary education curricula that address the knowledge, skills, and abilities needed by the public (e.g., regulators, inspectors) and private (e.g., shippers, receivers) sectors for the safe and efficient transportation of hazardous materials.
32. Role of Human Factors in Preventing Cargo Tank Truck Rollovers (HM-13) --- Battelle Doug Pape, paped@battelle.org http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2931	Safety --- Operations/Training Risk Assessment	Pending 01/2012	The objectives of this research are to (1) identify and analyze the root causes of the major driver factors contributing to cargo tank truck rollovers and (2) determine best safety, management, and communication practices that can be used to minimize or eliminate driver errors in cargo tank truck operations.
33. Soil and Groundwater Impacts of Chemical Mixture Releases from Hazardous Materials Transportation Incidents (HM-06) --- HAS Richard Lewis http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2426	Safety --- Risk Assessment Emergency Response	Complete 10/2010	The objective of this research is to develop a tool to assess, classify, predict, and quickly communicate fate and transport characteristics of chemical mixtures released into the soil and groundwater as a result of hazardous materials transportation incidents. The tool will allow carriers, shippers, responders, risk compliance specialists, and regulators to assess, compare, classify, and communicate the environmental hazards to soil and groundwater posed by chemical mixtures in transport.
34. Technical Assessment of Dry Ice Limits on Aircraft (HM-09) --- Battelle Thomas McSweeney, mcsween@battelle.org http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2661	Safety --- Operations/Training	In progress 5/2012	The objective of this research is to develop a decision tool(s) to assist passenger and cargo-only aircraft operators in determining the maximum quantity of dry ice that can be safely carried as cargo.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
University of Buffalo			
35. Value-at-Risk Model for Hazardous Material Transportation --- Norfolk Southern Corporation Yingying Kang, yingying.kang@nscorp.com	Safety --- Risk Assessment Routing	Complete 2010	This project develops a Value-at-Risk (VaR) model to generate route choices for a hazmat shipment based on a specified risk confidence level. The objective is to determine a route which minimizes the likelihood that the risk will be greater than a set threshold. Several properties of the VaR model are established. An exact solution procedure is developed and tested to solve the single-trip problem.
University of Illinois Urbana-Champaign			
36. Ambient intelligence for freight railroads --- Riccardo Crepaldi, rcrepal2@illinois.edu	Safety --- Operations/Training Technology	Complete 2009	Explores the benefits of intelligent telemetry for freight trains and its application to environmental protection by its potential to reduce hazmat releases.
37. Communication and Interpretation of Results of Railroad Hazardous Materials Transportation Route Risk Analyses --- Athaphon Kawprasert, akawpra2@uiuc.edu	Safety --- Risk Assessment Routing Operations/Training	Complete 2009	Using results from a quantitative risk analysis of hazardous materials shipped by rail to develop and illustrate several new techniques to more effectively present, interpret, and communicate risk results. The analysis accounted for the major factors affecting risk: infrastructure quality, traffic volume, population exposure along the shipment routes, as well as tank car design and product characteristics. Approaches for system level and route specific analyses are presented.
38. Effect of Train Speed on Risk Analysis of Transporting Hazardous Materials by Rail --- Athaphon Kawprasert, akawpra2@uiuc.edu	Safety --- Risk Assessment	Complete 2009	Study of the effect of train speed on railroad hazardous materials transportation risk. A statistical method was developed to estimate the speed-dependent conditional probability of release (CPR) of hazardous material from tank cars involved in accidents. The objective was to assess how accounting for speed affects the results of risk analysis.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
39. Optimizing railroad tank car safety design to reduce hazardous materials transportation risk --- Mohd Rapik Saat, mohdsaat@uiuc.edu	Safety --- Packaging Risk Assessment	Complete 2010	Development of a modeling approach in which tank car safety design optimization is considered as a two-phase process. The first phase addresses the tradeoff between safety and transportation efficiency by using Pareto optimization to identify the most efficient design combinations to improve safety while minimizing incremental weight. The second phase involves estimation of chemical-specific hazard levels and calculation of the consequent benefits and costs to determine the optimal level of protection for tank cars transporting different hazardous materials.
40. An environmental screening model to assess the consequences to soil and groundwater from railroad-tank-car spills of light non-aqueous phase liquids (LNAPL) --- Charles J. Werth, werth@uiuc.edu	Safety --- Risk Assessment Emergency Response	Complete 2010	This study presents the development and application of an environmental screening model to assess NAPL infiltration and redistribution in soils and groundwater, and to assess groundwater cleanup time using a pumping system. Model simulations use parameters and conditions representing LNAPL releases from railroad tank cars.
University of Kentucky/Kentucky Transportation Center			
41. Fedtrak --- Doug Kreis, dkreis@engr.uky.edu, (859) 257-6898	Safety Security --- Operations/Training Technology Risk Assessment	In progress Ongoing (in R&D phase)	This project will support the Transportation Security Administration's (TSA's) efforts to track and manage the security risks of Tier 1 hazardous materials shipments. It will provide TSA with situational awareness.
42. Marine transportation of hazardous materials --- Doug Kreis, dkreis@engr.uky.edu, (859) 257-6898	Safety Security --- Operations/Training Risk Assessment	Planned	The University plans to undertake research related to supporting the movement of hazardous materials (and other freight) in maritime transportation. This would include defining the associated risks and policies to address them.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
Vanderbilt University			
43. A proof of concept study for analyzing hazmat transportation risks in an all-hazards environment --- Mark Abkowitz, mark.abkowitz@vanderbilt.edu	Safety Security Economic --- Risk Assessment	Complete 2009	Early stage development of an all-hazards risk management (AHRM) approach focusing on hazardous materials transportation risk. The methodology expresses relevant risks in monetary terms, creating a consistent basis from which one can identify risks that warrant priority attention. An early stage case-study application is examined.
44. Climate Change Impacts on Transportation Infrastructure --- Mark Abkowitz, mark.abkowitz@vanderbilt.edu	Safety Security Business --- Operations/Training	Planned	Climate change risk how it impacts transportation infrastructure - affects hazmat transportation. Will be looking at scenarios of how transportation infrastructure is impacted by climate change and what investments will be required.
45. Determining Climate Change Thresholds --- Mark Abkowitz, mark.abkowitz@vanderbilt.edu	Safety Security Business --- Operations/Training	Planned	Will be holding a summit on freight transportation to determine climate change thresholds for determining/prescribing changes in operations and infrastructure investments.
46. Terrorism risk assessment methodology --- Mark Abkowitz, mark.abkowitz@vanderbilt.edu	Security --- Risk Assessment	Complete 2011	Development of a methodology for modeling terrorism-related risk on a regional scale
Virginia Polytechnic Institute			
47. Development of Hazardous Materials Shipper Prioritization Application --- William Andrew Schaudt, aschaudt@vtti.vt.edu	Safety Regulatory/Enforcement --- Operations/Training	Complete 2010	This study reviews, documents, and recommends improvements to the Hazardous Materials Package Inspection Program. A thorough review and examination of the program was performed, and a prioritization software application was developed.
CARRIERS - HIGHWAY			
Sentinel Trucking			
48. Advanced Safety Technologies --- Sentinel Trucking	Safety Security --- Operations/Training Technology	In progress	Investigating the use of advanced safety technologies, such as onboard recorders, remote shutdown, and front and back video cameras.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
CARRIERS - RAIL			
Association of American Railroads (AAR) Tank Car Committee			
49. Alternatives to Qualification Markings --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to discuss alternative approaches to the current requirements for tank car markings to make it easier for car owners to manage their fleets using an electronic database.
50. Bottom Outlet Performance --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force investigating incidents where valves opened during transportation, possibly due to vibration. They are reviewing securement methods in the context of current environment conditions.
51. Consider Modifications to Current Steel Specifications --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to develop modifications to current steel specifications. Both higher silicon content steel and low sulfur TC-128 steel are being discussed.
52. Consider New Steels for Tank Car Tanks --- Bob Fronczak, RFronczak@aar.org	Safety Security --- Packaging	In progress	Ongoing Task Force to investigate new steels for use in the construction of tank car tanks. Currently exploring DHS interest in a test on new tank car steels.
53. Consider Permanent Marking for AAR Class Cars --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to consider permanent markings for AAR class tank cars. There are plans to develop a proposal explaining how cars are maintained under AAR specifications and determine what is needed to upgrade an AAR specification car to a DOT specification car.
54. Consider Responsibilities of Parties in Tank Car Maintenance --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to review the responsibilities of parties involved with the modifications, conversions, alterations, and heavy repairs to tank cars.
55. Effects of Environmental Harmonics on Safety Relief Devices --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to investigate the effects of harmonics on safety relief devices. Catastrophic failure of these devices has been observed on 30,000 gallon tank cars.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
56. Evaluation and Use of Nondestructive Evaluation Techniques --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to address non-destructive testing issues for all methods except acoustic emission.
57. Extended Life of Tank Cars --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force examining requirements and markings for extended-life tank cars.
58. Grounding Requirements for Tank Cars --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to review the grounding requirements for tank cars.
59. Non-Accident Release Program --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing joint efforts to reduce non-accident releases, including efforts to build a Rail Industry NAR Reduction Contact Network to help in the process of notifying shippers of their NARs.
60. Performance Standard for Surge Pressure Reduction Devices --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to develop a performance standard for surge suppression devices.
61. Pressure Relief Valve Inspection Intervals --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to consider the appropriate path forward regarding testing of safety valves, including the possibility of a petition for rulemaking.
62. Recommended Practice for Joint Design --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force reviewing basic philosophies and best practices for fluid sealing to develop a recommended practice.
63. Replacement of Eyebolts during Qualification --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to review the ability to replace eyebolts on hinged and bolted manways during qualification.
64. Review Allowable Materials of Tank Car Fasteners --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to review allowable materials of tank car fasteners.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
65. Review Manway Cover Design for Non-Pressure Cars --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to review the design and application of hinged and bolted manways with the goal of eliminating non-accident releases.
66. Review of Hinged and Bolted Manways --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to review the ability to eliminate hinged and bolted manways as well as review redesign options.
67. Review of the Design and Performance of Vacuum Relief Valves --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to review the design and performance of vacuum relief valves.
68. Safety Relief Devices Exposed to Commodity Surge --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force to investigate the effects of commodity surging on safety relief devices that protrude below the bottom of the mounting nozzle. They appear to be causing valve spring stem failures.
69. Requirements for Installation of Surge Suppression Devices --- Bob Fronczak, RFronczak@aar.org	Safety --- Packaging	In progress	Ongoing Task Force for determining the suitability of retrofitting tanks cars prior to 1994 with surge suppression devices.
Association of American Railroads/Rail Research Foundation (AAR/RRF)			
70. Advanced Tank Car Collaborative Research Program (ATCCRP) --- AAR, FRA, TSA, S&T, Transport Canada, American Chemistry Council, Chlorine Institute, The Fertilizer Institute, Railway Supply Institute Bob Fronczak, RFronczak@aar.org	Regulatory/Enforcement Safety Security --- Operations/Training Risk Assessment	In progress	A cooperative arrangement for collaboration on research which will inform the development of new, risk-based, designs, standards and regulations for tank cars carrying toxic inhalation hazard (TIH) materials.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
71. Rail Corridor Risk Management System (RCRMS) --- ABS Consulting Bob Fronczak, RFronczak@aar.org	Safety Security Business --- Routing Risk Assessment Operations/Training Emergency Response	In progress	The Rail Corridor Risk Management System (RCRMS), a web-based software tool used by railroads to analyze the safest, most secure routes for the transportation of certain hazardous materials. The technology is being developed in coordination with the Federal Railroad Administration (FRA), the Federal Emergency Management Agency (FEMA), the Transportation Security Administration (TSA), and the Pipeline and Hazardous Materials Safety Administration (PHMSA).
Association of American Railroads/Railway Supply Institute (AAR/RSI)			
72. Tank Car Operating Environment Test --- TTCI Todd Treichel, ttreichel@aar.org, (540) 822-4800	Safety Business --- Packaging Operations/Training Enforcement	Complete Early 2010	Measured all the various loads and forces during transportation to help design tank cars and inspection intervals.
73. Impact Tests of Potential New Tank Steels --- various Todd Treichel, ttreichel@aar.org, (540) 822-4800	Safety --- Packaging	In progress	This project included impact tests of potential new tank car steels to see whether they could survive the impacts; measure the transition temperatures (between ductile and brittle); and measure the weldability and formability of the steels.
74. Accident Data Analysis --- Todd Treichel, ttreichel@aar.org, (540) 822-4800	Safety Business --- Packaging	Complete 2010	Used accident data to examine issues that had not been looked at before. This included the effect of outage (remaining vapor space) in a car. The more room the lading has to move, the more survivable it may be, but there will be cost implications from reduced capacity. This also included study of the effect of standoff distances between the jacket and insulation. Do heater coils add to the puncture resistance of tank cars?

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
75. Database of Railcar Inspection Results --- Sims Professional Engineers Todd Treichel, ttreichel@aar.org, (540) 822-4800	Safety --- Packaging	Under development	In conjunction with FRA, this project will create a database of FRA and AAR required railcar inspection results. This will allow AAR to examine the data for all fleets and produce findings of use to smaller fleet owners whose fleets are too small to support such analysis.
76. Examination of Non-Accident Releases (NARs) --- Todd Treichel, ttreichel@aar.org, (540) 822-4800	Safety --- Packaging Operations/Training Risk Assessment	In progress	There are a number of NAR-related studies underway, including an industry-wide exploration of the NAR data, communication awareness training, etc.
77. Tank Car Fire-Related Safety Activities --- various Todd Treichel, ttreichel@aar.org, (540) 822-4800	Safety --- Packaging	In progress	This involves a number of upgrades to the AFFTAC simulation program and a series of lab tests and other kinds of work. Improving the failure model will improve the overall simulation model. One project of note was one that involved testing tank car steels at high temperatures to better understand tensile and stress rupture behavior (completed in 2010).
Union Pacific			
78. Product Substitutions --- Scott Hinckley, wshinckl@up.com	Safety Security --- Risk Assessment	Planned	Continued investigation into product substitutions to reduce transportation risk

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
FEDERAL			
Department of Homeland Security (DHS) Chemical Security Analysis Center (CSAC)			
79. Behavior of Toxic Chemical Releases from Large Transportation Packages --- George Famini, george.famini@dhs.gov	Safety Security --- Emergency Response Risk Assessment	Complete 2010	This project, also referred to as Jack Rabbit, involved field tests to empirically measure the behavior of toxic chemical releases from large transportation packages, such as rail cars. The focus was on chlorine and ammonia releases. Explored whether ammonia could be used as a cheaper and less dangerous gas for studying large-scale TIH releases. Also included evaluation of instrumentation and development of a methodology for future tests.
80. Chemical Infrastructure Risk Assessment (CIRA) --- George Famini, george.famini@dhs.gov	Safety Security --- Emergency Response Risk Assessment	In progress	This is a probabilistic risk assessment focused on the chemical supply chain and sector, specifically on large-scale releases from facilities or while in transportation. The scope included the 46 TIH chemicals listed in the Chemical Facility Anti-Terrorism Standards (CFATS). This project seeks to provide an additional risk engine to support the CFATS program. The project has three elements: (1) review of current dispersion models and others that might be applied, (2) developing toxicity estimates, and (3) developing or enhancing scenarios and modules to reflect chemical supply chain risk.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
81. Increasing Safety of Hazardous Chemicals (ISHC) --- George Famini, george.famini@dhs.gov	Safety Security --- Emergency Response Risk Assessment	In progress end of FY 2011	This project is attempting to develop tools for assessing if a process or element of the supply chain is safer and more secure than another. As an example, what would be the result of a change in the typical packaging for a specific material from 90-ton cylinders to 20-ton cylinders? This project goes beyond examining inherently safer technologies as it examines inherent, active, and passive technologies and procedural changes. There is a component of this work focused on developing a risk-based method to place CFATS Appendix A materials into tiers.
82. New Source Terms for Modeling Toxic Chemical Releases from Large Transportation Packages --- George Famini, george.famini@dhs.gov	Safety Security --- Emergency Response Risk Assessment	In progress Almost finished	This project builds on the prior project to determine the real-world behavior of large releases of toxic chemicals. The intent is to produce new source terms for input into consequence models. It included gap analysis for source emissions, dispersion, deposition, and consequence assessment for TIH materials.
83. Risk Estimation for Large-Scale Chlorine Road Transport Networks --- Towson University, Applied Math Lab George Famini, george.famini@dhs.gov	Safety Security --- Emergency Response Risk Assessment	In progress 06/2011	This project is applying linear match to look at elements along a highway route to determine how to develop a path model that can be overlaid with a transport and dispersion model (such as HPAC or CHARM).

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
Department of Homeland Security (DHS) Science and Technology Directorate (S&T)			
84. Chemical Terrorism Risk Assessment (CTRA) --- George Famini, george.famini@dhs.gov	Security --- Risk Assessment	In progress Biennial	The Science & Technology (S&T) Directorate Chemical & Biological Division biennial Chemical Terrorism Risk Assessment (CTRA), required by the Domestic Chemical Defense Policy (DCPD), provides the basis for risk-informed investments for national strategic chemical defense planning while identifying key knowledge gaps and defining critical vulnerabilities. It is a computationally intensive, probabilistic event-tree model for assessing chemical terrorism risks.
Federal Aviation Administration (FAA)			
85. Lithium Battery Research --- FAA Tech Center Harry Webster, Harry.Webster@faa.gov	Safety Regulatory/Enforcement --- Packaging Operations/Training	In progress	The FAA Tech Center will continue research on improved cell separator materials to stop or slow down thermal runaway propagation. In addition, the Tech Center will research packaging materials to adequately control the properties lithium batteries exhibit in a fire condition. Other research will explore the effectiveness of water mist in extinguishing lithium battery fires, evaluation of the ability of current hazmat shipping containers to withstand lithium battery fires, and development of a standard for a shipping container for lithium batteries.
86. Measurement Study of Vibration and Temperature on Aircraft --- Michigan State Janet McLaughlin, janet.mclaughlin@faa.gov	Safety Regulatory/Enforcement --- Operations/Training Enforcement Risk Assessment	Partially complete abandoned	This project was designed to determine normal transportation forces during air transport.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
87. Preliminary Investigation of the Fire Hazard Inherent in Micro Fuel Cell Cartridges --- FAA Tech Center Harry Webster, Harry.Webster@faa.gov	Safety Regulatory/Enforcement --- Packaging Operations/Training	Complete 06/2010	The FAA Tech Center performed a series of tests to evaluate the flammability hazard associated with fuel cell fuel cartridges. Tests were conducted with various fuel chemistries including methanol, formic acid, butane, hydrogen gas, and borohydrides. The response of each fuel cartridge to an external alcohol fire was evaluated.
88. Flammability Assessment of Lithium-Ion and Lithium-Ion Polymer Battery Cells Designed for Aircraft Power Usage --- FAA Tech Center Steven M. Summer, Steven.Summer@faa.gov	Safety Regulatory/Enforcement --- Packaging Operations/Training	Complete 2010	Tests were performed at the FAA William J. Hughes Technical Center by the Fire Safety Team of the Airport and Aircraft Research and Development Division to examine the fire safety hazards that cylindrical- and polymer-type lithium-ion batteries may pose onboard aircraft. Tests were conducted on individual, manufacturer-supplied battery cells to determine how the cells would react in a fire situation, as well as what potential fire hazard the battery cells themselves may pose and the effectiveness of a typical hand held extinguisher on a fire involving the battery cells.
Federal Motor Carrier Safety Administration (FMCSA)			
89. Cargo Tank Research --- Paul Bomgardner, paul.bomgardner@dot.gov	Safety Regulatory/Enforcement --- Packaging Operations/Training Risk Assessment	Planned	FMCSA intends to conduct continued research into cargo tank safety, including examination of the benefits of the outreach conducted through the recently released video.
90. Causes of Stress Corrosion Cracking of Nurse Tanks --- Iowa State Paul Bomgardner, paul.bomgardner@dot.gov	Safety Regulatory/Enforcement --- Packaging Risk Assessment	In progress nearly complete	This project is looking at the causes of stress corrosion cracks in nurse tanks.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
91. Evaluation of Hazmat Safety Permit Program --- Booz Allen Hamilton Paul Bomgardner, paul.bomgardner@dot.gov	Safety Regulatory/Enforcement --- Operations/Training Enforcement Risk Assessment	Complete 2009	This project is examining the strengths and weaknesses of the program and where it could be improved.
92. Pinhole Leaks in Welds of Nurse Tanks --- Iowa State Paul Bomgardner, paul.bomgardner@dot.gov	Safety Regulatory/Enforcement --- Packaging Risk Assessment	In progress late 2012	This project is looking at the causes of pinhole leaks in nurse tanks and whether they currently present an imminent hazard.
Federal Railroad Administration (FRA)			
93. Hazmat Risk Assessment --- ICF Francisco Gonzalez, francisco.gonzalez@dot.gov	Safety --- Risk Assessment	In progress March 2012	Develop a rail hazmat transportation risk model and associated risk metrics. Tasks: 1.-Estimate base case (2008) rail hazmat transportation risk. 2.-Estimate risk reduction after implementation of safety requirements enacted in 2008/9, individually and in combination 3.-Identify and evaluate further opportunities for risk reduction
94. Post Accident Investigation --- RA/TTCI Francisco Gonzalez, francisco.gonzalez@dot.gov	Safety --- Operations/Training	In progress December 2012	Develop an improved data acquisition for better understanding of accidents. Acquire samples of tank cars involved in accidents.
95. Loading/Unloading Ethanol, reducing NAR --- RFA Francisco Gonzalez, francisco.gonzalez@dot.gov	Safety --- Operations/Training	In progress March 2012	Develop a better loading and unloading procedures for the transportation of Ethanol in tank cars.
96. Liquid Flow Test for Valves --- CEESI Francisco Gonzalez, francisco.gonzalez@dot.gov	Safety --- Packaging	In progress March 2012	Determine the liquid flow coefficient of different pressure relief valves to use in fire models.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
97. Stub Sills --- VOLPE/Sharma and Associates Francisco Gonzalez, francisco.gonzalez@dot.gov	Safety --- Packaging	In progress December 2012	Investigate several failures of stub sills.
98. Evaluation of Different Impactors on Different Tank Car Designs --- ARA Francisco Gonzalez, francisco.gonzalez@dot.gov	Safety --- Packaging	In progress May 2012	The purpose of this task is to evaluate the puncture behaviors of tanks under a more general range of impact conditions and will help to better understand the damaged caused by the different impactors on different tank cars and should provide us with conclusions/recommendations for performance tests for tank head and shell for each impactor.
99. Loading/Unloading of Molten Sulphur - best practices to reduce spills --- The Sulphur Institute Francisco Gonzalez, francisco.gonzalez@dot.gov	Safety --- Operations/Training	In progress December 2012	The FRA wants to work with The Sulphur Institute and with industry to reduce these occurrences of solid sulphur residue on molten sulphur rail tank cars.
100. Deformation Behavior of Welded Steel Sandwich Panels under Quasi-Static Loading --- Volpe National Transportation Systems Center Francisco Gonzalez, francisco.gonzalez@dot.gov http://www.fra.dot.gov/rpd/downloads/TR_Deformation_Behavior_of_Welded_Steel_final.pdf	Safety --- Packaging	In progress December 2012	This project involves engineering studies that were conducted to examine the deformation behavior of flat, welded steel sandwich panels under two quasi-static loading conditions: (1) uniaxial compression; and (2) bending with an indenter. Testing and analysis were conducted to study the force-displacement response of sandwich structures with different core geometries: (1) pipe or tubular cores with outer diameters equal to 2, 3, and 5 in; (2) a 2-inch square diamond core; and (3) a double corrugated core called an X-core with a 5-inch core height. Deformation and local collapse modes of sandwich panels under these loading conditions were also studied. The previous phase ended in March 2011 and a follow-on project is in progress.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
101. Survivability of Railroad Tank Car Top Fittings in Rollover Scenario Derailments - Phase 2 --- Sharma & Associates, Inc. Francisco Gonzalez, francisco.gonzalez@dot.gov http://www.fra.dot.gov/downloads/Research/ord0920.pdf	Safety --- Packaging	In progress December 2013	Phase 2 of this project is a continuation from Phase 1 and investigates the survivability of railroad tank car top fittings in rollover scenarios using Failure Element Analysis techniques. It also explores additional protective concepts intended to survive more severe impacts than those of the Phase 1 study. Three new protective concepts, a roll bar assembly using an elliptical shape to allow the car to roll with little resistance, a fabricated deflective skid, and recessed fittings, are developed and analyzed. A scenario is simulated for the new concepts, which includes longitudinal car velocity and impact into a concrete barrier. The previous phase ended in October 2009 and a follow-on project is in progress.
102. Quantitative Nondestructive Testing of Railroad Tank Cars Using the Probability of Detection Evaluation Approach --- TTCI Francisco Gonzalez, francisco.gonzalez@dot.gov http://www.fra.dot.gov/downloads/Research/ord0910.pdf	Safety --- Packaging	In progress December 2012	The project performed a joint government/industry evaluation of possible replacement tests/inspections for the prescribed hydrostatic test/visual inspection of tank cars. The work involved evaluating non-destructive evaluation (NDE) techniques and determining how such techniques can best be applied for periodic testing and inspection of all tank cars that transport hazardous materials. A baseline was established to compare methods and evaluations were performed at the TTCI, Pueblo, Colorado. The previous phase ended in May 2009 and a follow-on project is in progress.
103. Over-the-Road Testing of the Instrumented Tank Car - A Load Environment Study --- ENSCO, Inc. Francisco Gonzalez, francisco.gonzalez@dot.gov http://www.fra.dot.gov/downloads/Research/DOT-FR-09-10enscofg3sept25.pdf	Safety --- Operations/Training Packaging	In progress December 2012	The objective is to better understand the operational environment and forces exerted on tank cars in over-the-road service using methods based on results from the initial efforts conducted during Phase II of the Tank Car Operating Environment Task Force (TCOE-TF)/Stub Sill Working Group (SSWG) research program. The previous phase ended in March 2011 and a follow-on project is in progress.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
104. Engineering Studies on Structural Integrity of Railroad Tank Cars Under Accident Loading Conditions --- Volpe National Transportation Systems Center Francisco Gonzalez, francisco.gonzalez@dot.gov http://www.fra.dot.gov/downloads/Research/ord0918.pdf	Safety --- Packaging	In progress December 2012	This project involves engineering studies entailing analysis and testing, which include (1) analysis of derailment dynamics based on lumped-parameter models, (2) analysis of the structural behavior of tank car components (such as the head and shell) based on finite element modeling, (3) tank car steels characterization based on laboratory testing of samples obtained from tank cars. The previous phase ended in October 2009 and a follow-on project is in progress.
105. Torsional Stiffness of Railroad Coupler Connections --- Sharma & Associates, Inc. Francisco Gonzalez, francisco.gonzalez@dot.gov http://www.fra.dot.gov/rpd/downloads/TR_Torsion_REPORT_final.pdf	Safety --- Packaging	Complete November 2010	This project investigated the torsional behavior of freight car coupler connections through analysis and test. Tests included the following coupler combinations: no-shelf to no-shelf, shelf to no-shelf, and shelf to shelf combinations in both clockwise to counterclockwise directions. Coupler specimens of each test run were mounted in a test fixture with one coupler receiving a torque application.
106. Emergency Escape Breathing Apparatus --- Technical Products, Inc. Francisco Gonzalez, francisco.gonzalez@dot.gov http://www.fra.dot.gov/downloads/Research/ord0911.pdf	Safety --- Packaging	Complete May 2009	This project developed information and recommendations relative to the use of emergency escape breathing apparatus (EEBA) by train crews who may have exposure to hazardous materials and would pose an inhalation hazard in the event of unintentional use. The research included defining the scope of the triggering criteria—the presence on trains of hazardous material that would pose an inhalation hazard in the event of unintentional release, the state of EEBA technology, the methods by which EEBAs might be provided to crews, the incidence rate of accidents with fatalities and serious injuries attributable to the inhalation of released hazardous material, and the economic issues involved with the provision of these devices to all train crew members.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
Nuclear Regulatory Commission (NRC)			
107. Spent Fuel --- http://www.nrc.gov/about-nrc/regulatory/research/waste-rsch.html	Safety --- Operations/Training Packaging	Ongoing	NRC research is developing the technical basis to ensure the continued safe performance and structural integrity of spent fuel transport casks during severe accidents.
Oak Ridge National Laboratory (ORNL) Center for Transportation Analysis (CTA)			
108. GeoSAT: GeoSecurity Analysis Tool --- Pat Hu, hups@ornl.gov, (865)946-1525 http://www-cta.ornl.gov/cta/One_Pagers/GeoSAT.pdf	Safety Security --- Emergency Response Risk Assessment Routing Technology	In progress	GeoSAT is a geospatial information-based risk analysis tool that allows security managers and first responders to assess risk and prepare for emergency responses for natural disasters or acts of terrorism. It can also be used by first responders to assess the initial impacts of a transportation security incident. GeoSAT focuses on transportation and other critical infrastructure systems within high-threat urban areas.
109. Rail Cargo Screening Simulation Modeling and Analysis --- Rekha Pillai, pillairs@ornl.gov, (865) 576-5324 http://cta.ornl.gov/cta/One_Pagers/Rail_Cargo_Screening.pdf	Regulatory/Enforcement Business Economic Safety Security --- Operations/Training Technology	In progress	Development of simulation software for the Domestic Nuclear Detection Office (DNDO) that models the screening of rail cargo at US rail ports of entry. Contains three components: A secure web-based user interface, a relational database for storing system and model level data, and the simulation software itself. The software will help DNDO to Develop a system to detect hazardous (nuclear, radiological, and narcotics) material entering US by freight railroads, minimize the adverse effects on the supply chain due to rail cargo screening processes, investigate the impacts of given screening technologies with respect to performance and reliability characteristics, and investigate rail screening resource utilization, e.g. staff and equipment.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
110. Readiness and Resiliency Assessment --- Rekha Pillai, pillairs@ornl.gov, (865) 576-5324 http://cta.ornl.gov/cta/One_Pagers/RRAS.pdf	Regulatory/Enforcement Business Economic Safety Security --- Risk Assessment	In progress	Systematic characterization of transportation system facilities, systems, and its security, and facilitates the transition of existing transportation systems to one that is more secure, structurally sound, can absorb attacks without major damage, respond to attach and with abilities to recover quickly from an attack. RRAS assesses security readiness of an individual transportation asset or group of assets (system—mode, asset type, supply chain, state, national, operators, etc.) and transportation system services based on security measures, technology, people, training, etc. and threats at different scope, duration, magnitude, and severity. The RRAS can also be used to assess threats, vulnerabilities, and protective measures (i) allocate scarce resources, (ii) dynamically measure the current readiness and resiliency level leading to effective response, containment of and rapid recovery from threats, and (iii) help transition to a reliable and low risk transportation system.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
111. Tracking Barges Carrying Hazardous Cargo: Detecting Anomalies and Predicting Risky Situations --- ORNL CTA and Geosystems Research Institute, Mississippi State University Mike Hilliard, hilliardMR@ornl.gov, (865) 576-5337 http://www-cta.ornl.gov/cta/One_Pagers/BargeTracking.pdf	Safety Security --- Operations/Training Emergency Response Risk Assessment Technology	In progress	In response to increased terrorist threats related to hazardous material movements on the U.S. inland waterway system, towing vessel operators and fleet area managers, at specified reporting points, are required to notify the U.S. Coast Guard's Inland River Vessel Movement Center (IRVMC) of the movement of barges loaded with certain dangerous cargo (CDC). Less than 100 shipments of these types occur daily, but each is extremely large (avg. > 2200 tons). Any incident could have extreme consequences. Tracking is not done continuously or consistently, no means for identifying strange activity or predicting high risk areas. The objective of this study is to develop and field test a prototype system that provides more accurate, uniform, and timely data on hazardous movements by barges, especially those certified as CDC, and to identify and report barges with potential security threats. The system being developed, namely TRACC, is expected to automatically track and monitor barges with CDC and communicate the real-time information to a data server. The event prediction and anomaly detection modules of the system will analyze the collected real-time data and other information to identify any potential security threats, and visually display locations and routes of suspicious barges. It will benefit homeland security community, first responders, local law enforcement personnel and business by providing timely and accurate barge information to make quick and right decisions in disasters involving CDC movement on the inland waterway.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
112. Regional Technology Integration Initiative --- ORNL CTA Oscar Franzese, (865) 946-1304, franzeseo@ornl.gov http://cta.ornl.gov/cta/One_Pagers/Trans_DHS_RTI.pdf	Safety Security --- Emergency Response Technology	In progress	A pilot program for facilitating the transition of innovative technologies and organizational concepts to regional, state, and local jurisdictions.
Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Hazardous Materials Safety			
113. Cargo Tank Rollovers --- James Simmons, james.simmons@dot.gov	Safety Regulatory/Enforcement --- Packaging Risk Assessment	Planned	This planned research area will explore what can be done to the entire vehicle system to improve stability, in addition to driver training. This work is in concert with NHTSA and FMCSA.
114. Composite Cylinder Life-Cycle In-Service Assessment --- WavesinSolids LLC Thomas R. Hay, 814-237-1031	Safety --- Packaging Risk Assessment	SBIR Phase I Recommendation Not awarded	This project will support the SBIR problem to enhance in-service testing of composite cylinders.
115. Energetic Hazardous Materials Research --- James Simmons, james.simmons@dot.gov	Safety Regulatory/Enforcement --- Packaging Risk Assessment	Planned	This planned research area will focus on better ways to package and transport lithium batteries and high-energy capacitors.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
116. Examination of HM Portable Tanks within Transportation System --- Volpe contractor James Simmons, james.simmons@dot.gov http://www.volpe.dot.gov/sbir/sol11_2/topics.html#Pipeline	Safety Regulatory/Enforcement --- Packaging	Planned	This research will examine the forces and stress on portable tanks throughout the transportation system and assist the modes of transportation to determine what effects may occur during loading and unloading from mode to mode. In addition, what conditions the HM packages will experience while it is in control of that specific mode of responsibility. This research will in turn provide DOT with a means to improve the modal regulations, evaluate current test and inspection methods, and collect shipping experiences of these HM package characteristics in an intermodal freight environment.
117. Feasibility of Implementing Electronic Shipping Papers --- James Simmons, james.simmons@dot.gov	Safety Regulatory/Enforcement --- Operations/Training Enforcement Emergency Response Risk Assessment	Planned	This planned research area will continue the work of HM-05 and PHMSA's HM-ACCESS program.
118. Hazardous Materials Cooperative Research Program (HMCRP) --- Transportation Research Board (TRB) James Simmons, james.simmons@dot.gov http://www.trb.org/HMCRP/Public/HMCRPOverview.aspx	Safety Security Regulatory/Enforcement --- Packaging Emergency Response Enforcement Risk Assessment Operations/Training	In progress Waiting for authorization for future beyond March 2012	The HMCRP is intended to complement other U.S. DOT research programs as a stakeholder-driven, problem-solving program, researching real-world, day-to-day operational issues with near- to mid-term time frames. The TRB will carry out applied research projects to improve the information used in managing risk associated with the transportation of hazardous materials. Using the funding provided by the U.S. DOT each year, this new program will conduct studies intended to advance current knowledge and practice relating to hazardous materials transportation.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
119. Long-Term Behavior, Failure Analysis & In-Service Testing of Composite Cylinders --- Texas Research Institute Austin, Inc. George P. Hansen, 512-263-2101	Safety --- Packaging Risk Assessment	SBIR Phase I Recommendation Not awarded	This project will support the SBIR problem to enhance in-service testing of composite cylinders.
120. Research and Development Program Plan Development --- James Simmons, james.simmons@dot.gov PHMSA website when approved	Safety Regulatory/Enforcement --- Packaging Emergency Response Enforcement Risk Assessment Operations/Training	In progress Summer FY11	The Office of Hazardous Materials Safety is developing a R&D Program Plan for the first time. This effort is breaking down research needs into different areas, including package integrity, human factors, analysis of risk, risk management and communication, and mitigation of emerging risks.
Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety			
121. Acoustic-based Technology to Detect Buried Pipes --- Operations Technology Development NFP Frank Licari, Frank.Licari@dot.gov, (202) 366-5162 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=365	Safety --- Risk Assessment Technology	In progress 07/2011	The main objective is to improve performance of the current acoustic locator to detect multiple buried pipes, integrate components into a pre-commercial device, and test at gas utility sites.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
122. Advanced Development of PipeGuard Proactive Pipeline Damage Prevention System --- Northeast Gas Association James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=364	Safety --- Risk Assessment Technology	In progress 03/2012	The objective is to develop a pre-commercial proactive in-ground warning system that uses advanced security technology to warn against encroachment to transmission and DISTRIBUTION lines. This project directly addresses the Threat Prevention category of the BAA in the area of localized and early warning damage prevention monitoring. PipeGuard™, developed and marketed by Senstar, is an acoustic/geophone-based system designed to provide an early warning to operators when an excavating event occurs in the vicinity of a buried pipeline. An improved PipeGuard™ system will meet distribution company needs for remotely monitoring critical pipelines sections. This will enable gas companies to reduce or eliminate the need for certain physical on-site surveys and improve overall pipeline safety by mitigating pipeline damages.
123. Advanced Learning Algorithms for the Proactive Infrasonic Pipeline Evaluation Network (PIGPEN) Pipeline Encroachment Warning System --- Physical Sciences Inc. James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=366	Safety --- Risk Assessment Technology	In progress 03/2012	This research will advance development of self-training algorithms supporting seismic sensor systems that provide real-time warning of unauthorized right-of-way encroachment and excavation activity near a pipeline. The outcome will enable the sensor system to optimize its intruder detection algorithms based on learned characteristics of its local environment. Field tests are expected to demonstrate better than 97% alarm reliability with few alarms.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
124. Compatibility of Non-Ferrous Metals with Ethanol --- DNV Columbus Joseph Mataich, joseph.mataich@dot.gov, (404) 832-1159 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=322	Safety --- Risk Assessment Packaging	In progress 04/2011	Pipeline transportation of fuel grade ethanol (FGE) is vital to the cost-effective delivery of this fuel to the end users. While the potential for stress corrosion cracking (SCC) of steel in the presence of ethanol is one of the main concerns in the transportation of FGE, the compatibility of non-ferrous metals found in pipeline and downstream systems also is an area of concern. Previous studies have addressed the compatibility of some non-ferrous metals with ethanol and other alcohols but a comprehensive assessment of this issue, with respect to ethanol transportation, has not been conducted. This research project aims to develop guidelines on the selection of non-ferrous metal for use in FGE. The major benefit of the project is the development of comprehensive guidelines that could be used to develop ethanol transportation standards.
125. Completion of Development of Robotics Systems for Inspecting Unpiggable Transmission Pipelines --- Northeast Gas Association Robert Burrough, robert.burrough@dot.gov, (609) 989-2171 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=353	Safety --- Risk Assessment Technology	In progress 12/2012	The main objective is to complete the development of the Explorer II and TIGRE robotics systems for inspecting unpiggable transmission pipelines. In response to the field demonstration program that industry and DOT/PHMSA have with the commercial partner, design enhancements and additional demonstrations have been identified as needing R & D funding support by industry and government to ensure timely introduction of a reliable and economically-viable and unique product for addressing unpiggable pipelines. The work will complete the development and field demonstrations of these two systems and allow for successful commercialization.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
126. Consolidated Research Program, Right of Way Automated Monitoring Threat Prevention --- Electricore, Inc. Randy Berthold, randall.w.berthold@nasa.gov, (650) 604-3408 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=389	Safety Security --- Risk Assessment Technology	In progress 03/2014	Develop a new generation of surveillance management systems by delivering a step-change improvement in the proactive prevention of threats to pipelines. Technologies developed will be used for the detection, identification, and communication of threats and vulnerabilities to underground pipeline infrastructure. The program will develop an integrated, autonomous sensor/detector system for near real-time automated detection, identification, and notification of threats and leaks.
127. Corrosion and Integrity Management of Biodiesel Pipelines --- DNV Columbus Robert Smith, Robert.W.Smith@dot.gov, (919) 238-4759 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=319	Safety --- Packaging	In progress 04/2014	This project combines two objectives concerning Biodiesel Pipelines. The first objective is to investigate the performance of selected corrosion inhibitors commonly used in diesel transportation and determine whether new corrosion-related issues could arise from the use of biodiesel blends above B5. The second objective is to understand and quantify the degradation of non-metallic and non-ferrous metallic pipeline components in biodiesel blends above B5.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
128. Cost-Effective Techniques for Weld Property Measurement and Technologies for Improving Weld HE and IGSCC Resistance for Alternative Fuel Pipelines --- The University of Tennessee James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=323	Safety --- Risk Assessment Operations/Training Technology	In progress 04/2013	Built upon proven technologies, this proposal research aims at (i) advancing the general knowledge related to fatigue and fracture properties of pipeline steel welds subject to high-pressure hydrogen atmosphere and (ii) developing technologies for weld property improvement. The project objectives are as follows: -Apply Multiple-Notch Tensile and Spiral Notch Torsion Tests for measuring the local tensile strength and fracture toughness of weld region in high-pressure hydrogen. -Develop a cost-effective low-frequency cyclic fatigue testing technique for measuring the weld fatigue property in high-pressure hydrogen. -Develop the technical basis and database of hydrogen-induced degradation of weld mechanical properties as a function of pressure, temperature and microstructure. -Evaluate technologies for improving the hydrogen embrittlement (HE) and intergranular stress corrosion cracking (IGSCC) resistance of steel welds. The technologies include (1) tailoring residual stress by overlay welds, (2) new welding consumables, and (3) friction stir welding.
129. Dent Fatigue Life Assessment - Development of Tools for Assessing the Severity and Life of Dent Features --- BMT Fleet Technology Limited James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=358	Safety --- Risk Assessment Technology	In progress 09/2012	The objective of this research is to use elements of the previously validated dent assessment tool to develop a mechanical damage assessment strategy, validate it and ultimately develop an easily applied mechanical damage fatigue life assessment tool. The existing BMT dent assessment model will be further validated and used alongside the existing BMT plain dent geometry based severity ranking criteria to extend these criteria to consider dents interacting with welds, and to consider the effect of line pressure.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
130. Design, Development, and Testing of Optimized Composite --- Engineering Mechanics Corporation of Columbus (EMC²) James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=290	Safety --- Risk Assessment Technology	In progress 12/2012	The development of the "Soft Crack Arrestor" validated design procedure will allow this device to be used for a wide variety of natural gas and liquid CO2, pipeline projects. This device will reduce the risk associated with catastrophic fracture of large-diameter natural gas or liquid CO2, pipelines.
131. Design, Development, and Testing of Optimized Composite 'Soft Crack Arrestors --- Engineering Mechanics Corporation of Columbus (EMC²) Dr. Gery Wilkowski, (614) 459-3200	Safety Regulatory/Enforcement --- Packaging	SBIR 2009 Phase II Award	This project will support the SBIR problem to develop in-field pipeline inspection tools.
132. Development and Field Testing of a Highly Sensitive Mercaptans Instrument --- Northeast Gas Association Vincent Holohan, vincent.holohan@dot.gov, (202) 366-1933 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=367	Safety --- Risk Assessment Technology	In progress 07/2011	The main objectives are to develop and field test a new, portable low-cost instrument to measure hydrogen sulfites and mercaptans, routinely encountered in liquid propane, natural gas, renewable natural gas, biogas, landfill gas and other gases. The instrument will allow detection and measurement of such compounds at the parts per billion level addressing a long-standing need for a technology that can replace the human nose for leak detection. The instrument will also be capable of detecting trace constituents in renewable gas.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
133. Development of a Limit States Standard for Onshore Pipelines --- C-FER Technologies Robert Smith, Robert.W.Smith@dot.gov, (919) 238-4759 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=314	Safety --- Risk Assessment	In progress 01/2012	- Develop a Load and Resistance Factor Design (LRFD) checks for the basic group of limit states associated with internal pressure, thermal expansion and equipment impact. This will involve the definition of appropriate reliability targets, selection of a number of test cases and calibration of the required design checks. - Develop a plan to address geotechnical loads in a subsequent project phase. This will involve investigation of available models, and data from project participants.
134. Development of a Model to Accurately Predict the Conditions of Carrier Pipe within Casings Based on Conditions at the Casing Ends --- Southwest Research Institute Steve Nanney, steve.nanney@dot.gov, (713) 272-2855 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=355	Safety --- Risk Assessment	In progress 09/2012	The objective of this project is to develop a general model that will allow for the prediction of conditions in the middle section of a casing based on conditions at the casing ends. This model will also be capable of predicting the conditions in the entire casing (casing ends and middle section) based on the conditions outside of the casing. The locations and levels of cathodic protection depressions at downstream and upstream locations from the casing ends can also be predicted given the conditions away from the casing.
135. Development of Damage Severity for Pipeline Steel Inspection --- Generation 2 Materials Technology LLC Angelique N. Lasseigne, 303-304-9785	Safety --- Packaging Risk Assessment	SBIR Phase I Recommendation Not awarded	This project will support the SBIR problem to develop a non-destructive, quantitative residual stress assessment tool.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
136. Digital Imaging of Pipeline Mechanical Damage and Residual Stress --- JENTEK Sensors Inc. James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=292	Safety --- Risk Assessment Technology	Complete 02/2010	This project addresses the need for a more reliable means of characterizing pipeline mechanical damage through application of digital eddy current imaging. JENTEK's patented Meandering Winding Magnetometer (MWM) arrays have demonstrated capability to use lift-off measurements to profile the surface of a dented area, while MWM-Array measured magnetic permeability can be correlated with residual stresses around and within the mechanical damage site. Successful completion of this program will result in enhanced remaining life prediction capability for pipelines suffering mechanical damage and a reliable decision support tool for pipeline owners and operators. This will enable operators to avoid overly conservative decisions while enhancing pipeline safety.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
137. Effect of Microstructure of Pipeline Steels on Ductility and Fatigue Properties in High-Pressure Hydrogen Atmosphere --- The University of Tennessee James Merritt james.merritt@dot.gov, (303)638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=324	Safety --- Risk Assessment	In progress 04/2013	A number of studies have been conducted in the past to understand the effect of the steel composition and microstructure on the tendency to lose ductility through hydrogen-induced embrittlement. Although some general rules have been developed to relate the properties of steels with the tendency for hydrogen embrittlement, much needs to be learned on the effect of many alloying elements on the hydrogen embrittlement in steels. The main objective is to conduct fatigue and fracture-toughness property test. Fatigue damage is typically divided into three stages: crack initiation, crack propagation and final failure. These three stages are important in determining the fatigue life of structural components. Fatigue-crack-growth-rate properties are of vital importance for the structural-reliability assessment, when a structural component is subjected to cyclic loading. Fatigue-crack propagation-rate results can be used to predict the crack-growth life of a component.
138. ERW Pipe Failure Study --- James Merritt, james.merritt@dot.gov, (303) 638-4758	Safety Regulatory/Enforcement --- Risk Assessment Enforcement	Planned	Study of ERW pipe failures mandated by NTSB as a result of the San Bruno explosion

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
139. Feasibility of Chemical Inhibition of Ethanol SCC --- DNV Columbus Robert Smith, Robert.W.Smith@dot.gov, (919) 238-4759 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=321	Safety --- Risk Assessment	In progress 10/2011	- Obtain the consensus of all stakeholders on the selection of inhibitors to be evaluated for Stress Corrosion Cracking (SCC) prevention and develop a general understanding of the criteria to select inhibitors acceptable to the operators and end users. This will be done through a workshop. - Evaluate the performance of selected inhibitors in long-term crack growth experiments under flowing conditions simulated by jet impingement. - develop a method to rapidly Evaluate and select SCC inhibitors for use in Fuel Grade Ethanol (FGE).
140. Fuelfinder: Remote Leak Detector for Liquid Hydrocarbons --- Physical Sciences Inc. James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=362	Safety --- Risk Assessment Technology	In progress 09/2012	The projects main objective is to develop a portable, hand-held sensor for detection of petroleum product leaks from buried pipelines at stand-off distances up to 30 meters or about 98 feet.
141. Integrated Internal Inspection and Cleaning Tool Technology for Pipelines --- Electricore, Inc. Al Schoen, al.schoen@dot.gov, (609) 989-2239 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=356	Safety --- Operations/Training	In progress 06/2013	The main objective is to develop an integrated and scalable cleaning and inspection tool that measures, records, and provides analysis of a range of parameters during conventional pipeline cleaning runs. Data collected will be used in trending and prioritization for indications of changing environments to improve integrity management through earlier response to integrity threats. The project represents step change in how the industry manages its integrity inspection program.
142. Low-Cost, Full-Field Tool for In-Ditch Deformation Measurement --- Intelligent Optical Systems, Inc. Marvin Klein, 424-263-6361	Safety --- Packaging Risk Assessment	SBIR Phase I Recommendation Not awarded	This project is designed to study, develop and demonstrate advanced deformation measurement tools for transmission and or distribution pipelines.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
143. Low-Cost, Full-Field, Surface Profiling Tool for Mechanical Damage Evaluation --- Intelligent Optical Systems, Inc. James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=291	Safety --- Risk Assessment Technology	Complete 03/2010	Mechanical damage (typically from third party excavations) is the most frequent source of leaks and ruptures in pipelines. The most common type of mechanical damage is dents, sometimes associated with secondary features such as gouges, external corrosion, or cracks. Currently used techniques for assessing dents are not accurate enough for reliable determination of fitness for service. In this project, Intelligent Optical Systems will determine the feasibility of implementing a novel surface-profiling tool for mechanical damage evaluation based on the real-time processing of a single digital image. This inexpensive, full-field approach provides the full shape of the damaged region with high accuracy, and overcomes current limitations in the assessment process. In Phase I, Intelligent Optical Systems will develop detailed proof of principles of the proposed technology, determine precision as a function of lighting and environmental conditions, and determine preliminary software and hardware designs.
144. Modeling of Microbial Induced Corrosion on Metallic Pipelines Resulting from Biomethane & the Integrity Impact of Biomethane on Non-Metallic Pipelines --- Gas Technology Institute Anthony Rallis, Anthony.rallis@dot.gov, (713) 272-2850 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=293	Safety --- Risk Assessment	In progress 09/2011	As biogas production sources increase, they will eventually be fed into a gathering network that allows the common collection and distribution of the fuel to processing locations followed by distribution to the end user. The main objective of this research is on the immediate need to understand the impacts of transporting various biogas blends on the integrity of non-metallic materials (thermoplastics and elastomers) that could be used to construct regional gathering networks.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
145. MWM-Array Characterization of Mechanical Damage and Corrosion --- JENTEK Sensors, Inc. James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=354	Safety --- Risk Assessment Technology	In progress 09/2013	The objective of this program is to enhance the MWM-Array imaging capability, especially at very low frequencies, and provide quantitative characterization of mechanical damage and corrosion through coatings/insulation along with higher resolution capability with coatings removed. Delivery of a practical field deployable tool is the goal; thus, we will target specific needs defined by DOT, Chevron, BP and pipeline operators such as TransCanada.
146. New Design and Construction Techniques for Transportation of Ethanol and Ethanol/Gasoline Blends in New Pipelines --- Electricore, Inc. Chris Taylor, Chris.Taylor@dot.gov, (404) 832-1166 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=295	Safety --- Risk Assessment	In progress 03/2012	- Develop supporting data, related analyses and recommendations for cost-effective design and construction methods for reducing the effects of stress-corrosion cracking (SCC) that can be implemented in new pipeline systems to allow safe and efficient transportation of Fuel Grade Ethanol (FGE) - Evaluate design aspects for control and monitoring of oxygen uptake and internal corrosion for pipelines transporting FGE - Recommend the most advantageous direction for expanded and improved pipeline design and testing standards for operations involving exposure to FGE
147. Odorant Effectiveness --- Gas Technology Institute Joseph Sieve, joseph.sieve@dot.gov, (202) 366-5064 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=363	Safety --- Operations/Training	In progress 03/2012	Gas Technology Institute's (GTI) objective of the project is to provide a "Practical Pipeline Operator Guide" to manage odor fade issues associated with typical gas system operating conditions and materials of construction. This will include a tested model and methodology to validate additional combinations of gas, system, and material scenarios as they become available in the future.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
148. Optimization of Multi-Wire GMAW Welding Procedure for Heavy-Wall Offshore Pipeline Construction --- Center For Reliable Energy Systems Robert Smith, Robert.W.Smith@dot.gov, (919) 238-4759 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=360	Safety --- Risk Assessment Technology	In progress 09/2012	The proposed work will perform research for the optimization of welding processes for heavy-wall applications, address key technological issues in multi-wire GMAW processes, and fill important gaps in welding practice for offshore pipeline construction. The objectives are to 1) conduct quality evaluation of girth welds made with multi-wire Gas Metal Arc Welding (GMAW) processes, 2) establish correlations between welding conditions and girth weld properties, and 3) assist the implementation of new knowledge base and guideline for welding practice in offshore high-strength pipeline construction.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
149. Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation --- Center For Reliable Energy Systems James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=294	Safety --- Risk Assessment	In progress 09/2011	The project addresses the most critical issues related to the safe and efficient transportation of hydrogen using pipelines. The impact of high-pressure hydrogen on the fatigue behavior of commonly used line pipe steels will be studied systematically by conducting fatigue tests and developing a mechanistic-based analysis model/procedure to correlate and predict the test results. The testing system can greatly accelerate the time-consuming fatigue tests and the analysis model can provide critical inputs to the test matrix design and data interpretation. The combination of the test data and analytical procedure will enable a better understanding of the hydrogen effects on the materials proposed for hydrogen transportation. The project objectives are to: 1) develop a multi-specimen, high-pressure fatigue system that can test multiple specimens at the same time, 2) conduct fatigue tests on well-selected practical pipeline materials, 3) review and identify the physical mechanisms responsible for hydrogen damage to line pipe from available test data, develop a mechanistic-based model, 4) develop mechanistic-based model and use the model to correlate test data, and 5) provide recommendations for code revisions for hydrogen pipelines.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
150. Pig Mounted Trials for Internal Corrosion Monitoring Fluidized Sensors --- DNV Columbus Juan Mendoza, juan.a.mendoza@dot.gov, (713)272-2824 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=277	Safety --- Risk Assessment Technology	In progress 10/2010	Because of the successful development of a low-cost, easy to use, prototype fluidized sensor system that is capable of locating areas of water accumulation and internal corrosion in both piggable and non-piggable lines, field trials in operating pipelines is the next crucial step in refining the sensor and obtaining industry and regulator acceptance and adoption. Since this methodology has the potential to significantly reduce the discovery time and cost of detecting internal corrosion as compared to the use of existing expensive inspection techniques for identifying internal corrosion sites, keen interest has been expressed by numerous pipeline operating companies to conduct field trials. The objective of this project is to build upon a soon to be completed PHMSA project that developed the prototype system by conducting a series of validation field trials.
151. Quality Management Systems for Pipelines --- DNV Columbus Kenneth Lee, kenneth.lee@dot.gov http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=357	Safety --- Operations/Training	In progress 03/2013	The project has two principal objectives: 1) to develop general guidelines for a Quality Management Systems (QMS) for pipeline projects (from design to commissioning) to ensure consistent and acceptable quality; and 2) to develop enhanced QMS guidelines that provide assurance of pipeline safety and integrity without having a pre-service hydrotest.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
152. Realistic Strain Capacity Models for Pipeline Construction and Maintenance --- Center For Reliable Energy Systems Steve Nanney, steve.nanney@dot.gov, (713) 272-2855 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=361	Safety --- Risk Assessment	In progress 09/2012	This work builds up the latest developments in compressive and tensile strain capacity models and extends these models to realistic design and application scenarios. There are two major components (1) development of a unified SBD methodology in which the compressive and tensile strain limit states can be analyzed in a consistent manner, and (2) refinement of existing compressive models to the same level of sophistication and consistency as the tensile strain models. Both new pipeline construction and maintenance of existing pipelines will benefit from the output of this work.
153. Selection of Pipe Repair Methods --- Operations Technology Development NFP Christian Sellu, christian.sellu@dot.gov, (609) 989-2177 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=359	Safety --- Risk Assessment	In progress 03/2013	Perform Long-term pressure and shear strength tests on composite repair materials. Evaluate their durability in lab degradation tests, and determine long-term cathodic disbondment. Communicate with material manufacturers and work with ASME Sub-Committee PCC-2 on Non-Metallic Composite Repair System to establish comprehensive evaluation tests and procedures for long-term performance of composite repairs.
154. Setting Safe Limits on Biodiesel Constituents for Pipeline Integrity --- DNV Columbus Robert Smith, Robert.W.Smith@dot.gov, (919) 238-4759 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=352	Safety Regulatory/Enforcement --- Risk Assessment	In progress 09/2012	The objectives of this work are to: (1) understand the effects of minor constituents beyond the ASTM D 6751 on corrosivity of biodiesel under pipeline-specific conditions, (2) develop safe limits for any deleterious constituents in biodiesel, and (3) develop a method to rapidly monitor biodiesel corrosivity in terms of any deleterious effect on pipeline integrity.
155. Stress and Geometry Imaging from Outside the Pipeline --- JENTEK Sensors Inc. Todd Dunford, 781-642-9666	Safety --- Packaging Risk Assessment	SBIR Phase I Recommendation Not awarded	This project will support the SBIR problem to develop a non-destructive, quantitative residual stress assessment tool.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
156. Stress Corrosion Cracking of Pipeline Steels in Fuel Grade Ethanol and Blends --- Georgia Tech Research Corporation Greg Hindman, gregory.c.hindman@dot.gov, (404) 562-3530 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=296	Safety --- Risk Assessment	In progress 09/2012	- Develop and evaluate standardized tests for stress corrosion cracking (SCC) of pipeline steel in ethanol to compliment the slow strain rate tests used in the initial research programs. These standard tests should be reproducible and also be representative of the operating conditions for pipelines - Develop a phenomenological understanding of stress corrosion cracking of pipeline steel in fuel grade ethanol (FGE) and FGE blends and develop mitigation strategies, including the use of naturally occurring inhibitors, against stress corrosion cracking and corrosion of pipeline steels.
157. Technical and Economic Feasibility of Preventing SCC through Control of Oxygen --- DNV Columbus James Merritt, james.merritt@dot.gov, (303) 638-4758 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=320	Safety --- Risk Assessment	In progress 10/2011	1.Evaluate the performance and efficacy of oxygen scavengers under flowing conditions; 2.Develop a model to calculate the oxygen consumption in the pipeline under flowing conditions; this model will also enable the evaluation of the pipeline length affected by oxygen; 3.Develop a system that can provide rapid and direct oxygen concentration measurement; 4.Perform an engineering and economic feasibility evaluation of preventing stress corrosion cracking (SCC) by the control of oxygen and provide recommendations;
158. Landfill and Wastewater Treatment Renewable Natural Gas (RNG) Chemical and Physical Profiling: Increasing the Database Set --- Gas Technology Institute Robert Smith, Robert.W.Smith@dot.gov, (919) 238-4759 http://primis.phmsa.dot.gov/matrix/PrjHome.rdm?prj=351	Safety --- Operations/Training Risk Assessment	In progress 3/31/2012	The objective is to increase the knowledge in chemical and physical characterization of landfill and wastewater treatment biomethane (renewable natural gas) through an expanded sampling and analysis program. Data will be used to augment the existing database constructed through a PHMSA project and further refine the associated Guidance Document. The existing database is limited and focus on trace constituents is of most interest, to assist with studies on odorant fade or instrumentation development.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
GENERAL HAZMAT			
Council on the Safe Transportation of Hazardous Articles (COSTHA)			
159. Enhancing the Image --- COSTHA Lara Currie, lara@costha.com http://www.costha.com/initiatives/enhancing-the-image/	Business Economic Regulatory/Enforcement --- General Policy	In progress	Broad-scope initiative to elevate hazmat professionals within the business community, develop partnerships between government entities and industry, expand professional development curriculum, improve public awareness and perception among senior industry officials, associations and regulators
160. Reverse Logistics --- COSTHA Lara Currie, lara@costha.com http://www.costha.com/initiatives/reverse-logistics-initiative/	Regulatory/Enforcement Safety Business --- Packaging	In progress	Broad-scope investigation of potential standards/regulations for return shipments of hazmats from consumers or retail outlets to manufacturers
INTERNATIONAL			
Transport Canada - Surface and Intermodal Security Directorate			
161. Dangerous Goods Security Risk Assessment --- Shelley Wang, shelley.wang@tc.gc.ca, (613) 993-5315	Security Regulatory/Enforcement --- Risk Assessment	Complete 02/2011	Information on this completed project is still classified, but the process involved federal, provincial, and industry participation to address threat, vulnerability, and impact elements of security risk. Scope is limited to truck and rail. An unclassified version should be released in the future.
162. Developing a dangerous goods transportation policy --- Shelley Wang, shelley.wang@tc.gc.ca, (613) 993-5315	Security Regulatory/Enforcement --- Risk Assessment Operations/Training	In progress	Security was not added to the responsibilities of Transport Canada until the Transport Dangerous Goods Act amendment in 2009. They are developing a policy that will consider both regulatory and voluntary regimes. A key consideration in their policy development is close alignment with the US approach.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
Transport Canada - Transport Dangerous Goods Directorate (TDG)			
163. Assessing the Toxicity Risks of the Transport of Petroleum Sour Crude Oil --- Tagenine Alladin, tagenine.alladin@tc.gc.ca	Safety Regulatory/Enforcement --- Material Classification Risk Assessment Packaging	In progress 04/2012	The objective of this project is to gather data and establish correlations that can assist shippers with determining the inhalation toxicity of their crude oil shipments, and in turn properly classify their shipments. The tasks for this project include: determining a methodology to correlate the H2S amount in petroleum sour crude to the H2S vapors generated during transportation in highway tanks under equilibrium conditions, and perform testing under the proposed methodology; and determining the sensitivity of the correlation between H2S in sour crude and H2S in the vapor space during transportation to the varying composition of sour crude (including the presence of light and dense hydrocarbons, acidity, other volatile compounds), temperature, agitation, and viscosity.
164. BLEVE Prevention for Highway Tanks Transporting Liquefied Petroleum Gas and Propane --- Thermdyne Technologies Ltd. Barbara Di Bacco, barbara.dibacco@tc.gc.ca	Safety Regulatory/Enforcement --- Packaging Risk Assessment	Complete 03/2010	The objective of this project is to identify and determine the benefits and costs of selected measures to reduce the risk of fire-induced rupture of highway tank trucks and tank trailers used to transport LPG such as propane.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
165. Dangerous Goods Research Collection and Information Management --- Barbara Di Bacco, barbara.dibacco@tc.gc.ca; Tagenine Alladin, tagenine.alladin@tc.gc.ca	Safety Knowledge Management --- General Policy	Planned - 2011-13 fiscal years TBD	The results of past TDG Research work and other relevant dangerous goods studies/research (e.g. research conducted by academia, research institutes, other departments, other governments, etc.) are not readily accessible to TDG. DGs research information resources have not been clearly and logically collected, organized, and stored, making it difficult for the TDG Research staff, and TDG Directorate in general, to become informed and aware of past work. Furthermore, not all information has been stored electronically. This, in turn, makes it difficult to communicate DG research information (reports, results, recommendations, outcomes) to the interested public, stakeholders and partners and could lead to duplication of work for future projects. This project would involve information gathering (key DGs research contacts, TDG research project information/reports, DG research reports published by organizations other than TDG) and cataloguing this information for easy access.
166. Domino Effect Project - Investigation of Multiple Tank Car Rollover Derailments Related to Double Shelf Couplers and its Solutions --- National Research Council Canada - Centre for Surface Transportation Technology Barbara Di Bacco, barbara.dibacco@tc.gc.ca	Safety Regulatory/Enforcement --- Packaging	In progress 03/2012	The objective is to examine and determine effective solutions to reduce coupler associated multiple tank car rollover derailments, and associated potential releases of dangerous goods. Deliverables include a literature review, energy analysis of the domino effect, computer simulation model, dynamic full scale testing, and project report. This is a follow-on project to one completed in 2009.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
167. Handling Dangerous Goods - Issue Brief --- Barbara Di Bacco, barbara.dibacco@tc.gc.ca; Tagenine Alladin, tagenine.alladin@tc.gc.ca	Safety Regulatory/Enforcement --- Risk Assessment General Policy	Planned - 2011-12 fiscal year TBD	Drafting an "issue brief" that clearly defines "handling" of DGs and provides an overview of existing research and risk analysis work, the risks involved with handling DGs, including (where possible) significant accidents and their causes, processes/equipment of highest concern, applicable regulations, any knowledge gaps, and recommendations on areas that could benefit from further research or risk analysis work. This would involve searching, collecting and reviewing information related to the risks involved with handling DGs [i.e. existing research/risk analysis work completed in Canada or by other countries, available accident information (US and Canada), investigation reports, etc.], and a review of standards/regulations/codes of practice that apply to handling DG in Canada and where authority lies.
168. Highway Tank Vent and Burn Project - Emergency Offloading of LPG Containers Using the Vent and Burn Technique --- A.M. Birk Engineering, Explosives Limited, Orica Canada, Economy Carriers Barbara Di Bacco, barbara.dibacco@tc.gc.ca	Safety --- Emergency Response	Complete 11/2010	The objective is to develop a capability and procedure for using the Vent and Burn emergency product removal technique in highway tanker accidents when the threat of imminent catastrophic tank failure exists and alternatives to deal with the contents are not available. Deliverables include awareness video and separate technical document. (Project partner: Liquefied Petroleum Gas Emergency Response Corporation)
169. Investigation of Multiple Tank Car Rollover Derailments Related to Double Shelf Couplers and its Solutions --- Centre for Surface Transportation Technology of National Research Council Canada Barbara Di Bacco, barbara.dibacco@tc.gc.ca; Tagenine Alladin, tagenine.alladin@tc.gc.ca	Safety --- Packaging	Complete 03/2009	Investigation of multiple tank car rollover derailments related to double shelf couplers and its solutions.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
170. Next Generation Tank-Car Project - Heat and Mass Transfer Model for Polyurethane Foams used for Rail Tank Car Thermal Protection --- A.M. Birk Engineering Barbara Di Bacco, barbara.dibacco@tc.gc.ca	Regulatory/Enforcement Safety --- Packaging	Complete 03/2009	Determine the thermal behavior of multi layered foam and steel jacket systems and compare against Federal fire test requirements for thermal protection.
171. Research and risk analysis of the transport of foreign specification cylinders removed from ships for refilling in Canada --- Tagenine Alladin, tagenine.alladin@tc.gc.ca	Safety Regulatory/Enforcement --- Risk Assessment	In progress 04/2012	The objective of this project is to develop a fact base to support policy on the transport and refilling of non-TC compliant cylinders that are considered an integral part of a ship operating in Canada. This includes: a review of current regulatory requirements (in Canada and other jurisdictions) applicable to the transport of foreign cylinders considered integral to a means of transport (when removed from the means of transport for retesting and filling); a risk analysis using available data.
172. Review of Existing Dangerous Goods Transportation Research, Experts List, and Identification of Future Needs --- Barbara Di Bacco, barbara.dibacco@tc.gc.ca; Tagenine Alladin, tagenine.alladin@tc.gc.ca	Safety --- General Policy	Planned - 2011-13 fiscal years TBD	The objective of this research will be to review the collected research in the field of transportation of dangerous goods (see Project "Dangerous Goods Research Collection and Information Management"), identify knowledge gaps and the future research needs for the TDG Research Division, and develop a network/listing of experts in this field.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
173. Tank Car Emissivity Project - Study the Thermal Emissivity and the Absorptivity of Rolled Tank Car Steel Plates and Liquid Propane When Involved in a Fire --- National Research Council Canada - Institute for Research in Construction Barbara Di Bacco, barbara.dibacco@tc.gc.ca	Safety Regulatory/Enforcement --- Packaging	In progress 04/2011	Project goal is to perform research and tests to gather data on the thermal emissivity and absorptivity of steel, liquid propane and other dangerous goods when involved in a fire situation. It is hoped to obtain a better understanding of the models and parameters to be used in programs such as AFFTAC when describing the heat transfer phenomena taking place in the vapor space of a tank car during a fire. Phase 1 concentrated on measuring LPG tank and jacket steel emissivity. Phase 2 involves validating the results of Phase 1 and measuring tank and jacket steel emissivity at elevated temperatures.
INTERNATIONAL/ACADEMIC			
Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT)			
174. A bi-level representational model of hazardous material supply chains --- Nathalie De Marcellis-Warin, Nathalie.DeMarcellis-Warin@cirrelt.ca, (514) 340-4711	Economic Business --- Operations/Training Risk Assessment	Complete 2010	Proposal of the use of new graphical tools into transportation models to improve the representation of hazardous material supply chains, enabling the visual inspection of physical and contractual flows simultaneously and highlighting the responsibility interactions and risk transfers among the numerous stakeholders involved: producers, carriers, storage enterprises, intermediaries, and consumers.
175. A lead-time approach to rail-truck intermodal transportation of dangerous goods --- Manish Verma, Manish.Verma@cirrelt.ca, (709) 737-6230	Business --- Operations/Training	Complete 2010	The development of an analytical framework for planning rail–truck intermodal transportation of hazmats. A bi-objective optimization model to plan and manage intermodal shipments is developed. To represent the current practice, the routing decisions in the model are driven by the delivery-times specified by the customers. An iterative decomposition based solution methodology which takes advantage of the problem structure is provided.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
176. A Tactical Planning Model for Railroad Transportation of Dangerous Goods --- Manish Verma, Manish.Verma@cirrelt.ca, (709) 737-6230	Business Economic Safety --- Routing Risk Assessment	Complete 2010	Development of an optimization methodology for the railroad tactical planning problem with risk and cost objectives.
177. Cross-analysis of hazmat road accidents using multiple databases --- Martin Trépanier, Martin.Trepanier@cirrelt.ca, (514) 343-6111	Safety --- Risk Assessment	Complete 2009	Cross-analysis of multiple accident databases to support hazmat accident analysis.
178. Safety management in hazardous materials logistics --- Marie-Hélène Leroux, Marie-Helene.Leroux@cirrelt.ca, (514) 340-5121	Business Economic Safety Security --- Risk Assessment Operations/Training Routing	Complete 2010	A survey of firms that handle hazmat about their practices for hazmat transportation routing, highlighting disparity in safety and security management between on-site vs. transportation and large firms vs. small firms.
179. Toll policies for mitigating hazardous materials transport risk --- Patrice Marcotte, Patrice.Marcotte@cirrelt.ca, (514) 343-5941	Regulatory/Enforcement Economic Safety --- Risk Assessment Routing	Complete 2009	Investigation of toll setting as a policy tool to regulate the use of roads for dangerous goods shipments. Includes comparative analysis of proposed mathematical models that shows that toll policies can be more effective than the popular network design policies that identify road segments to be closed for vehicles carrying hazardous materials.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
SHIPPERS			
Center for Chemical Process Safety			
180. Definitions for Inherently Safer Technology in Production, Transportation, Storage and Use --- George R. Famini, George.famini@dhs.gov	Regulatory/Enforcement Safety Security --- Operations/Training Packaging	Complete 2010	Study for DHS to provide a technically based definition of inherently safer technology (IST) involving literature review and expert opinion.
Chlorine Institute			
181. Chlorine Industry Liquid Pumping Methods --- Bruce Fleming, bafleming@olin.com, (423) 336-4120 http://www.chlorineinstitute.org/files/PDFs/2009-04-01%20cep%20pumping%20method.pdf	Safety --- Operations/Training	Complete 2009	Verification of methods for pumping chlorine from a breached car to a receiving container
DuPont			
182. GPS Hazmat Shipment Tracking --- Gary Fraze, (302) 992-3381, gary.e.fraze@usa.dupont.com	Safety Security --- Operations/Training Technology	In progress	Investigation of the use of real-time GPS tracking of rail-based hazmat shipments. Pilot project to allow the weighing of pros and cons of real-time GPS tracking vs. standard AEI-reader tracking.
183. Ride-Tight --- Gary Fraze, (302) 992-3381, gary.e.fraze@usa.dupont.com DuPont/VSP Technologies http://vsptechnologies.com/core-industries/ride-tight/	Safety --- Operations/Training Packaging	In progress	Development of best practices to reduce leaks and improve securement of liquid hazmats. Includes a focus on the standardization of gaskets and procedures for their use, such as standardization of bolts and torque, maintenance, training, etc.
184. Standardized Program for Loading and Unloading Operator Training and Certification --- Gary Fraze, (302) 992-3381, gary.e.fraze@usa.dupont.com	Safety --- Operations/Training	In progress	Development of a standardized program for loading and unloading operator training/certification.

Organization & Project Title --- Research Entity, Point of Contact, & Online Info.	Context Area(s) --- Subject Area(s)	Status & Completion Date	Project Description
Institute of Makers of Explosives (IME)			
185. Continuous development of standards and best practices --- SLT Express Way Mike Norton, xway.mike.norton@gmail.com, (602) 722-8686	Business Safety Security --- Operations/Training Risk Assessments	In progress	Continuous development of standards and best practices, particularly with regard to risk assessments.
186. Shipment and Truck Tracking --- SLT Express Way Mike Norton, xway.mike.norton@gmail.com, (602) 722-8686.	Safety Security --- Operations/Training Technology	In progress	Tracking of shipments and trucks from origin to destination in response to the 23 action items from DHS. Exploring how to broadcast from the tractor "security-hardened communications" and do so in a way that allows the technology to be globally applicable, not just in the continental US.
187. Institute of Makers of Explosives Safety Analysis for Risk (IMESAFR) --- IME/APT Research Lon Santis, ldsantis@ime.org http://www.apt-research.com/products/models/IMESAFR.html	Regulatory/Enforcement Business Economic Safety Security --- Risk Assessment Operations/Training	In progress	Development of a Department of Defense (DOD) risk assessment methodology into a software tool for commercial explosives handlers.
STATE			
National Conference of State Legislatures			
188. Alliance for Uniform Hazmat Transportation Procedures --- Battelle Jim Reed, jim.reed@ncsl.org, (303) 856-1510 http://www.ncsl.org/?tabid=18882	Regulatory/Enforcement --- Operations/Training	Complete 09/2009	Study of the benefits and costs to member states of membership in the Alliance, identify case for new states to join, and examine obstacles to expansion. The study established a safety benchmark for the performance of carriers in Alliance states compared to those in non-Alliance states.

4. Future Research Needs

The list of needed hazardous materials transportation-related research needs in Table 3 was compiled from interviews with research organizations. It includes any stated potential impediments to conducting the research or reasons why the organization does not plan to pursue it. Context and subject areas for the research needs are listed as well (these terms are discussed in Section 3). This list was augmented throughout the project as additional information was obtained.

Table 3. Research Needs

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
CARGO PACKAGING AND HANDLING		
1. Human Factors in Hazardous Materials Air Cargo Handling - there is a need to further explore a number of areas, including (a) the interaction of people watching packages going by (looking for undeclared or otherwise problematic packages) and the speed of the process, (b) how moving the observation process to a more remote location (using technology) affects the accuracy and potential throughput and how safety systems account for the changes, (c) what are carriers really responsible for regarding undeclared hazardous materials packages, and (d) what are the training and language requirements, and (e) how do shipper permits and approvals affect carrier responsibility?	Limited funding and staffing. [Federal Aviation Administration (FAA)]	Safety Business ---------- Operations
2. Undeclared packages related to returns involving small businesses and retailers (and the consumer). There are issues related to USPS air shipment of these packages as well.	Limited funding and staffing. [Federal Aviation Administration (FAA)]	Safety Business ---------- Operations
3. Research into gaps in training and succession planning – there is an inability throughout the industry to hire experienced, trained workers, specifically in regard to senior management and trucking operators. With regard to management, the average age of managers is high and many are nearing retirement, but not many new qualified people are available for replacement.	This is an industry-wide issue and beyond the scope of a single company. [DuPont]	Business Safety ---------- Operations
4. Studying the contributions of operator performance/human reliability to hazmat transportation risk beyond fatigue. There are a dozen or so factors that can be tied to human reliability and fatigue seems to have been singled out in the research thus far.	This is an idea for future research that is not necessarily something Vanderbilt will not research in the future - no special major impediments [Vanderbilt University]	Safety Security Regulatory/Enforcement ---------- Risk Assessment Operations/Training

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
EMERGENCY PLANNING AND RESPONSE		
5. Hazmat Transportation Emergency Response Guidelines There is a need for comprehensive guidebook that covers all types of incidents and all probable types of hazardous materials releases, arranged in a hierarchical manner. Biological and infectious substances, as an example, could trigger significant response actions that, without proper guidance, may be too aggressive. The existing North American Emergency Response Guide (NAERG) provides a very good resource for first responders during the initial response phase of an incident but does not address actions to be taken by qualified responders; this document is intended primarily for qualified responders.	Funding may be an impediment. [Standing Committee on Transportation of Hazardous Materials (AT040)]	Safety ---------- Emergency Response
6. How much training do emergency responders need?	Funding availability is the primary reason that research of this type is not done. Finding the right approach for getting the research started is another reason. [Federal Railroad Administration (FRA)]	Safety ---------- Emergency Response
7. Further research into rural emergency response to follow on to their earlier work that looked at three different communities; (1) volunteer, and fire service-based, (2) law enforcement based, and (3) fully funded, paid, and fire service-based. There have been lots of changes since that work was done.	Funding availability is the primary reason that research of this type is not done. Finding the right approach for getting the research started is another reason. [Federal Railroad Administration (FRA)]	Safety ---------- Emergency Response
8. Emergency response sustainability is a problem where long-term response "campaigns" can suffer when the mostly volunteer fire service personnel return to their regular jobs, including mutual aid and equipment issues.	Funding availability is the primary reason that research of this type is not done. Finding the right approach for getting the research started is another reason. [Federal Railroad Administration (FRA)]	Safety ---------- Emergency Response

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
9. PARTICIPATION IN LOCAL PROCESSES – Local Emergency Planning Committees (LEPCs) often suffer from passive participation, turnover, and apathy. HMCFS are often conducted by LEPCs or their contractors. In either event participation, turnover, and apathy often provide considerable barriers to conducting, communicating, and implementing the outcomes associated with the HMCFS. How do organizations maintain proactive participation from stakeholders and decision makers for high-consequence–low-probability events such as hazardous materials accidents? Methods to maintain and encourage participation in local processes on an ongoing basis should be evaluated to see which provide consistent results under identified circumstances. Future research that created an inventory of methods, techniques, and activities used to attract and maintain voluntary participation in public service organizations would prove invaluable. Conversely, actions and behaviors that inadvertently create barriers to participation, encourage turnover, or increase apathy could be identified and detailed in terms of how they can be avoided. Each method could be classified with respect to the types of conditions under which they work best, anticipated results, and examples of use.	Funding limitations; overlap with general focus of LEPCs, which is not limited to hazmat. [HM-01 Recommendations]	Regulatory/Enforcement Safety Security ---------- Emergency Response
10. TRACKING LEPC MEMBERS, EXECUTIVE COMMITTEES AND LEADERSHIPS - The U.S. EPA is faced with the difficulty of keeping track of LEPC members and leaders. Maintaining membership information, contact information, responsibilities for various roles and activities is an important part of effective hazardous materials planning and implementation. Maintaining this information on a LEPC-by-LEPC basis in conjunction with boundary maps would improve planning and response. Emergency planning and response are inherently limited by knowledge of the membership and leadership—their contact information, knowledge, resources, skills, abilities and limitations. Future research that developed an internet-based self-updating national registry of LEPC members would allow more accurate records of LEPC leadership and members to be kept up to date. These records would allow LEPC members in various roles to network with members in similar roles in other locations. It could be used to address training needs associated with various roles on the LEPC, and generally better describe the roles and responsibilities of LEPC members. This self-updating directory could also be used for dissemination of key materials.	Funding may be an issue here and the passivity, turnover, and apathy cited in another HM-01 recommendation may hamper efforts. [HM-01 Recommendations]	Regulatory/Enforcement Safety Security ---------- Emergency Response

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
11. INTEGRATING THE HMCFS INTO COMMUNITY COMPREHENSIVE EMERGENCY PLANS - Integrating the Hazardous Materials Commodity Flow Study (HMCFS) into comprehensive emergency planning is often left to the vagaries of future activities, which means the outcomes are often left either un-addressed or weakly integrated into the comprehensive plan. The data developed in the HMCFS are useful planning, preparedness, and response information. For example, know the volume of traffic flow along a route or route segment is critical in establishing alternative routes to allow emergency response operations should they be needed. Hence engaging response personnel in conducing the HMCFS, and integrating that information into the comprehensive emergency plan can provide integration that cannot be duplicated through training alone—it goes beyond learning and knowing to understanding and acting on that knowledge. Integrating the HMCFS maps (e.g., of hotspots) with the comprehensive emergency planning maps may highlight areas where resources are needed. Research that examined this process of integration could inventory techniques, evaluate their utility, establish their limitations, and assess synergistic opportunities.	Funding may be an impediment. [HM-01 Recommendations]	Regulatory/Enforcement Safety Security ---------- Emergency Response
12. Research into improving placarding with technological advances. There has been debate over whether or not to placard hazmat shipments because while placarding provides information for responders, it also serves as an advertisement to potential terrorists. It has generally been decided that placarding is better than not placarding, but is there a better, more secure way to handle it? For example, RFID signals may be used so that responders could pick up the signals when in proximity, but the placarding would not be so obvious to the general public.	JHU APL does not have a specific focus on hazmat transportation. [John's Hopkins University Applied Physics Lab (JHU APL)]	Safety Security Regulatory/Enforcement ---------- Operations Packaging Emergency Response
COMMODITY FLOW DATA		
13. There is a need for federal as well as state/local governments to access all the existing data, including shipment and quantity information. The data are extremely valuable; models and risk assessments do not work without the data.	The proprietary issues surrounding the data need to be overcome. [Department of Homeland Security (DHS) Chemical Security Analysis Center (CSAC)]	Safety Security Data Availability ---------- Risk Assessment

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
14. Consolidated commodity flow information for the entire state of California is needed. Currently commodity flow information is done piecemeal, on a local level, with no continuity across the state. Having a statewide commodity flow survey would help local and rural planners who often lack the resources to conduct commodity flow surveys themselves. This research would similarly benefit local emergency responders who could use it to better prioritize their use of resources and funding to be sure they have or have access to the necessary equipment for the hazards they face and that it is deployed in the right locations.	Impediments to doing this research include high expense, gathering the data from private entities such as railroads with proprietary concerns, and that such initiatives often require legislation and/or funding streams to initiate. [California Office of Emergency Services]	Safety Security Regulatory/Enforcement ---------- Risk Assessment Emergency Response
15. TEMPORAL VARIABILITY OF HAZARDOUS MATERIAL TRANSPORT - The extent to which hazardous material flows vary by season, month, week, day-of-the week, and hour-of-the-day is not well documented. The funding mechanisms most often used by LEPCs to conduct HMCFS limit most empirical efforts to collection of primary data in Spring and Summer months; and most of that is limited to weekday and daylight hour observations. Hence, these data often fail to reflect the seasonal variations of use of hazardous materials in a community (e.g., agricultural communities). In addition, seasonal variations in road conditions (e.g., snow-covered roads, pot-holes), accident rates, and population distribution (e.g., tourism locations such as winter and summer resort areas) are equally under-represented. Future research that explores these current gaps in the data on the transport of hazardous materials would be well received.	Funding limitations; the localization of the variability makes a national-level project more complex. [HM-01 Recommendations]	Regulatory/Enforcement Safety Security ---------- Risk Assessment
16. MULTILEVEL COMMUNICATION, DATA COLLECTION AND ARCHIVING - Effective communication among various levels of government is often reported as a barrier. Local participants are often frustrated with lack of information provided from higher levels, short deadlines for completion, and limited funding for implementation. Federal and state organizations often find local outcomes ineffectual, undocumented, and poorly archived. Resulting outcomes often disappear with changing personnel, either literally or through lack of transitional institutional behavior. What methods can be employed to overcome these issues? What are their primary advantages and disadvantages? Which mechanisms have been most effective under what circumstances?	Committed funding source. [HM-01 Recommendations]	Regulatory/Enforcement ---------- Emergency Response Risk Assessment

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
17. Research into information flows regarding whereabouts of shipments. Better communication is needed among federal, state, and local agencies and carriers. Federal stakeholders often ship through a state without informing the state (one example is the movement of nuclear materials). A state is not often aware of what a shipper is sending through its territory, which can cause delayed response following an incident. One such example is the tunnel fire in Baltimore, where Maryland officials did not have information on hand regarding the shipment involved and found it hard to retrieve information from CSX headquarters in Florida. Sharing of this information in a secure and timely fashion is critical.	JHU APL does not have a specific focus on hazmat transportation. [John's Hopkins University Applied Physics Lab (JHU APL)]	Safety Security Regulatory/Enforcement ---------- Operations Enforcement Routing Emergency Response
HAZMAT RELEASE CONSEQUENCES		
18. Information on the cost of fatalities and injuries.	Liability issues are the main reason this research is not pursued. [Association of American Railroads (AAR)]	Safety Regulatory/Enforcement Data Availability ---------- Risk Assessment
19. Improved Methods for Categorizing Hazmat and their Associated Spill Impacts - Improved methods for estimating time-of-travel of spilled hazardous materials into riverine environments to aid in downstream contingency and mitigation plans. Such estimates would be useful for oil spills from transport pipelines at river crossings and from vessels on inland waterways.	Funding may be an impediment. [Standing Committee on Transportation of Hazardous Materials (AT040)]	Safety ---------- Emergency Response Risk Assessment
20. Sabotage Consequence from Attack on Spent Nuclear Fuel Packages - The release of spent nuclear fuel (SNF) resulting from a terrorist attack on a transportation or storage cask poses a potential threat. As the most sensitive health effect pathway for SNF is through inhalation of respirable-sized particles, this research would focus on testing of real spent fuel to determine the ratio of particle size distribution of SNF to other brittle materials already tested. This ratio, the Spent Fuel Ratio (SFR), will provide a solid technical basis for analytically assessing consequences of other types of sabotage attacks and packaging configurations without having to perform further expensive testing.	Funding and limited stakeholder group are impediments. [Standing Committee on Transportation of Hazardous Materials (AT040)]	Security ---------- Risk Assessment

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
INTEGRATION OF SAFETY AND SECURITY		
21. Integration of Safety and Security in Hazmat Risk Ranking - The objective of this project will be to produce a document that provides a framework for integrated security and safety risk assessment for the shipment of all hazardous materials by all modes of transport. This framework will guide policy makers and transportation service providers in developing appropriate and focused risk mitigations.	In addition to funding, there is increasing consensus that safety and security need to be measured or assessed separately. [Standing Committee on Transportation of Hazardous Materials (AT040)]	Safety Security ---------- Risk Assessment
22. Assessment of Opportunities to Integrate and Supplement Safety and Security - Measures for Hazardous Materials Transportation - This project will identify areas in which regulated safety and security measures complement or conflict and instances in which current security requirements require attention beyond what is prescribed for safety performance. A determination will be made as to whether there should be any difference between response and remediation of traditional hazmat incidents and those resulting from terrorist attacks and a comprehensive approach to hazmat cargo transportation addressing both safety and security will be outlined. A second phase will produce national standards for state and local safety and security decisions and a model for reasonable state and local response and management plans.	This is a suggested topic for research. Approval from the HMCRP Technical Oversight Panel is needed before any available funding will be provided. [Standing Committee on Transportation of Hazardous Materials (AT040)]	Regulatory/Enforcement Safety Security ---------- Operations/Training
MATERIALS AND EQUIPMENT TESTING		
23. Research into the standardization of hoses for the transfer of hazmat from hazmat industry users/producers to carrier containers (e.g., truck and rail tanks). Containers have been well-characterized, but hose failures have not. Some shippers, such as DuPont, have internal inspection, testing, maintenance, lifetime standards for hoses, but most carriers do not have standards nearly as stringent.	Independent nature of carriers, expense of hoses combined with a lack of regulation [DuPont]	Safety Regulatory ---------- Risk Assessment Operations Packaging
24. More data from testing of types/quantities/locations of explosions. Small quantities have generally been untested (DOD focuses on large quantities for its purposes, but commercial users often use/store only small amounts).	At IME, the main obstacle is manpower – they are a 7-person operation, and the IME constituent member companies do not have the money to put into explosives testing. [Institute of Makers of Explosives (IME)]	Safety Data Availability ---------- Risk Assessment
25. Research into the behavior of perforating guns (used to make oil/gas flow from a drilled well) when they detonate unexpectedly while packaged/stored. It is currently the norm to assume that all charges in a stored set of perforating guns would detonate if one charge detonates, which may not be the case.	At IME, the main obstacle is manpower – they are a 7-person operation, and the IME constituent member companies do not have the money to put into explosives testing. [Institute of Makers of Explosives (IME)]	Safety Data Availability ---------- Risk Assessment

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
26. Need to address shortfalls in specific risk-based analysis of high-strength steel (e.g., x80, x100, x120 pipe) – series of investigations. These pipes are lighter (cheaper to transport) and higher-strength (higher flow and operating pressures), however, better controls and modeling are needed.	Congressional budget limitations [Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety]	Safety Business ---------- Operations Packaging Risk Assessment
RISK ANALYSIS AND PERCEPTION		
27. Criteria for regulators to use to make decisions could be better fleshed out so that when they do quantitative analysis (e.g., for explosives-related facility siting) they have guidelines or rules that prescribe what decision to make based on model output.	At IME, the main obstacle is manpower – they are a 7-person operation, and the IME constituent member companies do not have the money to put into explosives testing. [Institute of Makers of Explosives (IME)]	Regulatory/Enforcement ---------- Risk Assessment
28. How & Why Public Risk Perceptions Change Over Time - This project would collect new survey data for an existing hazmat transportation program that has historical data on public risk perceptions prior to, and during the start of shipments. The new data would be compared to the large archive of existing public opinion research. The analysis would further our general knowledge how public risk perception evolves over time with increased experience; it would permit comparison of public knowledge of the transport program after ten years of nearly accident-free operation; and it would permit analysis of the relative role of familiarity, knowledge, and social factors in explaining changes in risk perceptions of hazardous materials transport.	This is a suggested topic for research. Approval from the HMCRP Technical Oversight Panel is needed before any available funding will be provided. [Standing Committee on Transportation of Hazardous Materials (AT040)]	Regulatory/Enforcement Public Perception ---------- Risk Assessment Public Perception
29. Need to have a nationally accepted risk assessment model for hazardous materials. This would combine the chemical list and a rating system. Risk management rules would be associated with various hazardous materials or classes. This would involve both safety and security, but their focus would be a little more on security.	Funding may be an impediment. [University of Kentucky]	Safety Security ---------- Risk Assessment
30. How do you do a proper risk assessment at distribution facilities (e.g., ethanol and transloading) where there are no clear lines of jurisdiction, but someone needs to step in to look at public safety.	Funding availability is the primary reason that research of this type is not done. Finding the right approach for getting the research started is another reason. [Federal Railroad Administration (FRA)]	Safety ---------- Emergency Response

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
31. How can research be better used to drive public policy?	Funding availability is the primary reason that research of this type is not done. Finding the right approach for getting the research started is another reason. [Federal Railroad Administration (FRA)]	Safety ---------- Public Policy
32. Most research to date has been reactive research and development; there has not been a detailed plan to identify areas requiring focus and a method for finding out what could not be accomplished.	Funding is always an issue. [Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Hazardous Materials Safety]	Safety Security ---------- Risk Assessment
33. There is an important need for models that allow decision makers to look at how hazardous materials shipments move (from a top-level scale), both modal and intermodal. What is the chemistry and the impact of a release of the chemical? What is transported, how is it transported, and how does it get from point to point?	The Chemical Security and Analysis Center uses, but does not develop, these types of models to make assessments. [Department of Homeland Security (DHS) Chemical Security Analysis Center (CSAC)]	Safety Security ---------- Risk Assessment
34. Event probability data could always be improved, particularly with regard to values for locations outside of the US/Canada – could be used to develop a factor for working in a certain location, for example (e.g., if you're in Africa multiply the frequency by X amount).	At IME, the main obstacle is manpower – they are a 7-person operation, and the IME constituent member companies do not have the money to put into explosives testing. [Institute of Makers of Explosives (IME)]	Safety Data Availability ---------- Risk Assessment
35. A need is to put together a defined process to select and implement hazardous materials research and development projects. The 2-3 year budget process stretches everything out. Five suggested steps would be to (1) review the project topic, (2) categorize under standardized types, (3) explore what has been done in the past on that topic (including data and risk assessments), (4) develop project description, and (5) review by internal organizational committee for approval and funding.	Funding is always an issue. [Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Hazardous Materials Safety]	Safety Security ---------- Risk Assessment
36. VULNERABILITIES ASSOCIATED WITH DIFFERENT MODES OF HAZMAT TRANSPORT - The extent to which risk and vulnerability vary by mode of transport is an important area for further research to improve safety and security of hazardous materials transport. For example, pipeline and waterway accidents seem to occur less frequently than rail and roadway accidents. What can be learned by studying pipeline and waterway events that can reduce risk of hazardous materials events associated with other modes of transport? Can risk be reduced though reallocation among modes of transport? How should modes of transport be considered in light of the potential for terrorist attacks?	Cross-modal comparisons can generate concerns from mode-specific stakeholders. [HM-01 Recommendations]	Safety Security ---------- Risk Assessment

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
37. VALIDATION OF EXISTING ACCIDENT DATA - The validation of existing data is a complex and important activity. Data derived from various institutional sources, which have functions tangentially related to the potential for hazardous materials accidents, often have years of accumulated errors. For example, one institution sorted the data to make the variables of interest more easily searched, but left other parts of the data unsorted that over time destroyed the link between the sorted and unsorted portions of the data. In other cases geo-spatial data are erroneous reported truck accidents in the middle of a local bay, where there are no bridges or tunnels. Such errors can be the result of dyslexic data entry, sloppy typing, or illegible hand-writing, but whatever the source, validating the data is an important first step in using existing data. Research that developed, and tested a series of techniques to search for, detect, and correct such errors would be an invaluable asset to the future secondary use of existing data.	Successful implementation will require the participation of numerous agencies and data collection programs. [HM-01 Recommendations]	Safety ---------- Risk Assessment
38. Large need for cities and towns to do risk assessment research on how decades-old pipelines have been affected by land use (building, utility infrastructure, etc.) since they were buried. Changes to land use can affect the pipeline's support base, cathodic protection, etc. and in most cases cities and towns, and even the pipeline company is unaware of safety risks.	Public funding is the main issue – if private funding is required, it will not be done [National Pipeline Safety & Operations Research Center]	Safety ---------- Risk Assessment
OTHER PERCEIVED AREAS FOR FUTURE RESEARCH		
39. How can we better protect the nation's supply chain?	Funding may be an impediment. May be too broadly defined. [University of Kentucky]	Security ---------- Risk Assessment Operations/Training Packaging

Research Need	Potential Impediments or Reasons for Not Pursuing [Organization Identifying Need]	Context Area(s) ---------- Subject Area(s)
40. Pipelines are overseen by the DOT at the Federal level, but at the state and local levels, the responsibility for pipelines could be with any number of agencies. Furthermore, because pipelines are an issue of interstate commerce, state and local governments rarely direct significant focus on them. Research should be done into the best way to organize responsibility for pipelines at the state and local levels so that if something happens in a given jurisdiction, the responsible parties would be prepared and obvious to other stakeholders. For example, if a pipeline is clogged in Pennsylvania and causes a lapse in flow to Maryland, who is immediately in charge? This issue also has huge security ramifications, given the enormous pipeline network within the US. For example, if a gas pipeline from TX to ME is bombed in TN, who are the local and state officials responsible for coordinating the response?	JHU APL does not have a specific focus on hazmat transportation. [John's Hopkins University Applied Physics Lab (JHU APL)]	Safety Security Regulatory/Enforcement ---------- Enforcement Emergency Response
41. Research into varying standards and their effects. International hazmat standards may be an issue and intrastate pipeline regulations (from state/local governments) may have different regulations than the federal government (could be more stringent); which creates operational issues for pipeline operators.	Congressional budget limitations [Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety]	Regulatory/Enforcement Safety ---------- Operations Routing

5. Organizational Research Focus

One of the project requirements was to "develop a matrix to categorize the areas of research by organization." The matrix of hazardous materials transportation-related research subject areas by research organization in Table 4 was derived from information gathered in the interviews. The matrix also includes the context areas and modes that are relevant to each organization to provide additional value. The solid circles in the table represent a strong connection between the organization and the research area; open circles indicate that a connection exists, but is not as strong.

Table 4. Research Areas by Organization

Organization	Context Areas							Subject Areas												Modes					
	Safety	Regulatory	Enforcement	Security	Business	Data Availability	Economic	Risk Assessment	Technology	Routing	Operations	Packaging	Training	Emer. Response	Enforcement	Risk Analysis	Danger. Goods Class.	Loading/Unloading	Hazmat Profession	All Modes	Rail	Road	Pipeline	Ship	Air
AAR Tank Car Committee	●			○			○					●									○				
Association of American Railroads/Rail Research Foundation (AAR/RRF)	○	○		○	○			○		○	○			○							○				
Association of American Railroads/Railway Supply Institute (AAR/RSI)	●	○	○		○			○			○	●			○						○				
Battelle	○	○		○	○	○		○	○		○		○	○						○		○			○
Center for Chemical Process Safety	○	○		○							○	○								○					
Chlorine Institute	○										○									○					
CIRRELT	○	○		○	●		○	●		○	●									○	○	○			
Council on the Safe Transportation of Hazardous Articles (COSTHA)	○	○			○		○					○							○	○					
CREATE				○			○	○						○						○	○	○		○	○
DHS/TSA and CSAC	●			●				●						●						○		○			
DuPont	○			○					○		○	○	○							○	○				
FAA	●	●	●					○			●	●			○										○
FMCSA	●	●	●								○	○			○							○			
FRA	●							○			●	●									○				
Institute of Makers of Explosives	○	○	○	○	○		○	○	○		○							○		○		○			
National Conference of State Legislatures		○									○									○					

Organization	Context Areas							Subject Areas												Modes					
	Safety	Regulatory	Enforcement	Security	Business	Data Availability	Economic	Risk Assessment	Technology	Routing	Operations	Packaging	Training	Emer. Response	Enforcement	Risk Analysis	Danger. Goods Class.	Loading/Unloading	Hazmat Profession	All Modes	Rail	Road	Pipeline	Ship	Air
National Pipeline Safety & Operations Research Center	○	○	○					●	●														○		
NRC	○										○	○									○	○			
Olin	○										○									○					
ORNL CTA	○	○	○	○	○		○	○	●	○	○			●						○	○			○	
PHMSA/OHM	●	○	○	○				●	○		○	●	○	○	○					○		○			
PHMSA/OPS	●	○	○	○		○		●	●		●	●			○					○			○		
Sentinel Trucking	○			○							○											○			
Texas A&M University	○	○		○				○		○	○					○				○	○	○			
Texas Transportation Institute	○	○						○		○	○										○	○			
Transport Canada - Surface and Intermodal Security Directorate		○	○	○				○			○		○								○	○			
Transport Canada - Transport Dangerous Goods Directorate	●	●	○					●				●					○			○	○	○		○	
TRB - HMCRP	●	○		○	○	○		●	○	○	●	○	●	○						○	○	○	○		
Union Pacific	○			○				○													○				
University of Buffalo	○							○		○										○					
University of Illinois Urbana-Champaign	●							●	○	○	○	○		○		○					○				
University of Kentucky/Kentucky Transportation Center	●			○				●	○		○													○	○
Vanderbilt University	○			○	○	○	○	○	○		○									○					
Virginia Polytechnic Institute	○	○	○								○									○					

6. Perceived Gap Analysis and Research Needs

6.1. Perceived Research Gaps

The *perceived* research gaps listed in this section were culled from the interviews conducted for this project. In some cases, there are one or more projects that are addressing all or some of the stated need, but these might not be familiar to the organization being interviewed. To assist the reader, these related projects are cited via project numbers, which are references to the projects listed in Section 3. The section headings below are based on a review of the specific perceived gaps and therefore differ somewhat from the subject and context areas associated with each project and presented in earlier sections of this report.

6.1.1. Cargo Packaging and Handling

Perceived research gaps involving cargo packaging and handling include two areas of study, the first of which is research into human factors affecting hazardous materials air cargo handling. FAA representatives suggested that specific areas of research in this area might include the training requirements, methods, and locations used for screening packages as well as better defining carrier responsibility with regard to discovering undeclared hazardous materials. While PHMSA's Office of Hazardous Materials Safety (OHM) is currently developing a research and development program plan (see project 120) that will specifically include studies of human factors relating to hazardous materials, there are no research initiatives planned or in progress to specifically study human factors in relation to screening air cargo for hazmat packages.

The second perceived research gap involving cargo packaging and handling involves curtailing shipments of undeclared hazardous material return shipments from small businesses and consumers. FAA personnel suggested that return shipments of hazmat from these two sources may often be shipped as standard packages processed with mainstream shipments. The volume and reporting rates of these undeclared shipments is currently not well known. The Conference on Safe Transportation of Hazardous Articles (COSTHA) is conducting a broad-scope "reverse logistics" research project that investigates standards and regulations for return shipments of hazmat. The COSTHA project does not specifically focus on air cargo transport or the production of volume data, however.

Gap Summary

- Learn more about the human factors implications to current and probable future changes to the cargo handling systems across all modes but particularly related to air shipments.
- Determine the best approach(es) for reducing the risks involved with the return shipment of hazardous materials. This includes a reduction in these shipments that are not declared as hazardous materials.

6.1.2. Emergency Planning and Response

Emergency planning and response is the area most often cited by interviewees as having current unmet research needs. One focus within this area is development, collection, dissemination, and use of hazmat commodity flow data to facilitate emergency planning. Recent TRB projects (see projects 25 and 26) have addressed improving commodity flow data while a Texas A&M project (see project 16) has investigated collection of such data and its integration into local hazmat planning. A systematic approach for ensuring the availability of such data to local emergency response planners has not yet been addressed, however.

FRA personnel suggested that research is needed into two issues involving rural emergency response. One such issue is how rural areas under differing rural response structures, such as all-volunteer vs. fully-funded, approach hazmat risks and emergency planning. The other potential area for study is to investigate how long-term (i.e., multiple-days to a week) response efforts might be sustained in rural environments given volunteer response forces, mutual aid agreements, and potentially scarce equipment resources. While a recent TRB study (see project 17) addressing the assessment of emergency response needs and capabilities is tangentially related to these research concerns, there have been no recent research initiatives focusing on these unique issues facing rural hazmat emergency planners and responders.

Two research gaps identified through the TRB HM-01 project focus on Local Emergency Planning Committee (LEPC) participants. The first involves research into how LEPCs might keep members active and involved and avoid apathy and turnover. The second research opportunity is to develop a web-based, self-sustaining national registry of LEPC members to support U.S. EPA communication and coordination with LEPCs. HM-01 also documents the need for research into improving communication, data collection, and data storage among local entities, such as LEPCs, and higher-level governments, such as state and federal organizations. No new projects have yet been initiated to address these potential research areas since the publication of HM-01.

The informational needs of hazmat responders were suggested by interviewees as an area requiring additional research. One potential research focus, suggested by an FRA representative, is to define the extent of the training required by hazmat emergency responders. This research goal has been addressed, at least in part, by recent TRB-sponsored research into the effectiveness of hazmat transportation training (see project 23) and post-secondary education curricula for emergency responders (see project 31). The AT040 committee suggested hazmat responders would benefit from a comprehensive response guidebook that includes all types of incidents and all probable types of hazardous materials releases, arranged in a hierarchical manner. This guidebook would include, for example, information on biological and infectious substances, in addition to chemicals, and would address the actions to be taken by qualified hazmat responders in addition to any first responder. To date, no initiatives have been undertaken to address the production of such a guidebook.

Local planning for pipeline incidents is another area perceived as needing additional research. Representatives for the Johns Hopkins University Applied Physics Laboratory (JHU APL) suggested that state and local responders rarely focus on pipeline response since pipelines are an issue of interstate commerce. Responsibility for pipeline oversight is not standardized from state to state or among local governments, making coordination among these entities difficult. Additionally, because a pipeline incident in one location can affect users in other counties or states, it may not be readily obvious which government entity is responsible for initiating a response effort. Research must be conducted to establish standard practices for structuring pipeline oversight and establishing responsible parties for initiating response efforts. While recent research has explored best practices for pipeline emergency response plans (see project 19), no studies have focused on pipeline response from a state and local organizational viewpoint.

An interviewee from JHU APL recommended investigating the development of improved placarding technologies. While current placards provide useful information to first responders, they can also be utilized by terrorists to select high-consequence targets. Development of more secure methods for disclosing hazmat containers' contents, such as the use of radio frequency identification signals, must be

pursued in order to continue to provide critical information to responders without revealing that information to the public at large. While no recent research has focused on alternative methods of placarding, the AAR has conducted an investigation on alternatives to qualification markings to facilitate electronic fleet management (see project 49) that has potential to be useful to researchers in this field. Recent work on electronic shipping papers (see project 24) may also prove relevant and useful in this area.

Gap Summary

- Many interviewees mentioned the need for the development, collection, dissemination, and use of hazmat commodity flow data to facilitate emergency planning.
- With the limited resources available to many rural emergency response organizations, including full-time personnel, there is a need to better understand the unique issues they face and identify best practices for addressing them.
- Improving communication and engagement with local emergency planning committee (LEPC) members is necessary to improve hazardous materials response planning and coordination.
- Beyond the information for *initial* response actions in the Emergency Response Guidebook, there is a need for specific guidance on the actions to be taken by qualified hazmat responders in addition to any first responders. This guidance could be incorporated into additional training for hazmat emergency response.
- Incorporating pipeline-specific response into planning and guidance documents would also be useful.
- The investigation of improved hazmat placarding technologies can interface with the current work on electronic shipping papers for hazmat shipments.

6.1.3. Facility Risk Assessment

Proposed research areas involving facility risk assessments include defining guidelines for conducting risk assessments at distribution facilities. FRA personnel suggested that lines of jurisdiction governing safety at distribution facilities, such as ethanol distribution and transloading facilities, are often unclear. The FRA representatives indicated that guidelines for conducting risk assessments at these facilities could be used to increase public safety, but a lack of funding and uncertainty about the best research approach are impediments to developing such guidelines. Current tools, such as IMESAFR (see project 187), and research, such as projects underway by DHS/TSA (see projects 80, 81, and 84), do address risk assessments at facilities. None of these projects, however, seem to directly address the FRA personnel's desire for development of risk assessment guidelines for individual facilities.

Representatives from the Institute of Makers of Explosives (IME) suggested that frequency data for industrial explosions outside of the U.S. and Canada are needed. Currently, explosion event probability data are relatively well-developed for the U.S. and Canada, but these data are not transferrable to other parts of the world where regulations and standard operating procedures may vary from North American practices. Development of such data, or for multiplying factors to be used to convert North American probability data to other regions, would increase the accuracy of explosive risk assessments at transportation facilities throughout the world. No research is currently being conducted to address this data need, and IME cites a lack of resources, in terms of manpower and funding, as potential impediments.

Gap Summary

- While there is a lot of research and work related to facility risk assessment, there appears to be a need for additional research or collection of best practices for *distribution* facility risk assessment.
- There is a need to develop industrial explosion event probability data or applicable proxies for application to risk assessments outside North America.

6.1.4. Commodity Flow Data

Improved collection, dissemination, and use of hazardous material commodity flow data was suggested by several interviewees as an important understudied research area. Recommendations from the HM-01 research team, DHS/TSA, California Emergency Management Agency (CalEMA), and JHU APL suggest that adequate hazmat commodity flow data is often unavailable to government entities and emergency planners at the federal, state, and local levels. Research is needed to develop a means for ensuring that these data are made available to pertinent authorities at all levels of government and that these data are considered when developing emergency management plans. DHS/TSA representatives further suggest that sound governmental and planning decisions could be bolstered through development of an educational program designed to increase decision makers' understanding of the commodities, logistics, and processes involved in hazmat transportation within their jurisdiction.

Additional suggested research involving hazardous material commodity flow information includes commodity flow surveys done on a state-wide basis and surveys that account for temporal variation in flows. The former would support local and rural planners who often lack the resources to conduct surveys themselves, while the latter would better define expected hazmat movements through a community at any given time of the day, week, month, or year.

As discussed in the section "Emergency Planning & Response" above, recent TRB projects (see projects 25 and 26) have addressed improving commodity flow data to support local emergency planning efforts. Additionally, Texas A&M (see project 16) has investigated collection of commodity flow data and its integration into hazmat planning on a local scale. Current research has not yet addressed a method for ensuring the availability of commodity flow data to local planners and its integration into emergency response plans.

Emergency planner education initiatives and research are currently limited, with COSTHA's broad-based outreach project (see project 159) being the only work related to this area. Similarly, state-wide commodity flow surveys and temporally variable surveys remain unaddressed. Potential impediments cited by interviewees to gathering commodity flow information include expense and difficulties gathering proprietary information from private companies.

Gap Summary

- There remains a strong need to better understand the flow of hazardous materials through local communities to support effective and efficient emergency response planning.
    - To augment ongoing research, there is a current need for a systematic approach for ensuring the availability of relevant local hazmat commodity flow data.
    - State-wide commodity flow studies may be a good approach to fill some large gaps at a cost-effective level.
    - Understanding the temporal variations in hazmat flows can also be beneficial to communities that have significant variations in planning for response.
- Approaches for addressing the acquisition of proprietary commodity flow data is another need.

6.1.5. Hazmat Release Consequences

Interviewees suggested several perceived gaps in research regarding data for quantifying consequences to human health and society from hazmat releases. A representative from the AT040 committee suggested developing an improved methodology for estimating contaminant travel time in rivers. Accurate estimates of this kind would facilitate emergency planning for communities positioned downstream from hazards, such as transport pipelines and vessel locations. Another AT040 suggestion involves determining the ratio of breathable particles from a terrorist attack on spent nuclear fuel packages. Defining this ratio through the use of testing on real spent nuclear fuel would help to determine the human health threat from such an attack and act as a foundation for assessing similar attacks without the expense of testing. Additionally, an AAR representative suggested that data be developed to describe the current cost of human fatalities or injuries. Such information would be useful in quantifying the potential consequences of a hazmat release, but potential legal liabilities deter the necessary research efforts. No recent research projects have specifically focused on any of these areas of hazmat release consequence estimation.

Gap Summary

- Development of an improved methodology for estimating hazardous material travel times in waterways is needed.
- Improvements to estimating the economic costs of hazardous materials incidents, including the costs of fatalities and injuries.

6.1.6. Hazmat Transportation Research

Several research areas were suggested by interviewees that focus on determining useful hazmat transportation research projects and employing their results. PHMSA OHM representatives suggested that there is a need to proactively, rather than reactively, identify new research opportunities and to establish a defined process for selecting and conducting research projects. The TRB Hazardous Materials Cooperative Research Program was developed to address these specific concerns and is currently conducting research in these areas (see projects 21 and 28). PHMSA's OHM is also currently investigating research needs (see project 120) as part of its new research and development program, as is Transport Canada (see projects 165, 167, and 172).

An FRA representative suggested that research should be conducted into how hazmat transportation research could be better used to drive public policy. While there are a number of current research initiatives underway to develop data for use in policy decisions (see projects 22, 84, 171, and 179, for examples), these projects do not focus specifically on improving the use of these data for making policy decisions. Current research in this area is constrained to integration of commodity flow data into local emergency planning decisions (see projects 16, 25, and 26).

Gap Summary

- Some interviewees mentioned the need for proactive identification and selection of candidate research projects.
- Development of a better understanding of how transportation research can be better used to support and drive public policy is needed. This research need is more focused on the use of research results for decision making than in developing those data. This research can also include development of criteria for applying risk model output to decision making.

6.1.7. Integration of Safety and Security

Representatives of the AT040 committee see the integration of safety and security in risk assessments and regulations as an area requiring new research initiatives. One suggested focus of study involves the development of a framework for an integrated safety and security assessment for the shipment of all hazardous materials by all modes of transport. Current research in this area is limited. One project by Vanderbilt University (see project 43) integrates safety and security by expressing both sources of risk in monetary terms. Research by the University of Buffalo (see project 35) similarly couches risk in terms of value, allowing for easier comparison of safety and security risks. While these two methodologies appear to be expandable to other modes of transportation, both studies have, thus far, focused on truck transportation of hazmat.

The AT040 committee also identified the investigation of the effects of integrating safety and security regulations as an important area for future research. Such a study would examine how current safety and security hazmat transportation regulations reinforce or conflict with one another. Current efforts in this area are limited to work by Transport Canada to develop a dangerous goods transportation policy that focuses on security and aligns with the U.S. approach (see project 162).

Gap Summary

- There is a belief by some interviewees that there should be a standardized approach for integrating safety and security assessments in a common framework.
- Another perceived need relates to studying the interrelationships between current safety and security regulations.

6.1.8. Materials and Equipment Testing

Interviewees mentioned several specific areas in which materials or equipment testing data is lacking. A representative from PHMSA's OPS suggested that more risk-based analyses are needed of high-strength steel pipe (e.g., x80, x100, and x120). These pipes offer the benefits of being lighter, and thus cheaper to transport, and being able to operate under higher flow rates and pressures. These pipes require additional modeling data to more accurately estimate their behavior. Little research is currently being conducted in this area; although, PHMSA's OPS is involved in efforts to evaluate the performance of high-strength steel pipelines being used for high-pressure hydrogen transportation (see projects 137 and 149).

Representatives from DuPont indicated that research is needed into the standardization of hoses used to transfer hazardous materials from industry users and producers to carrier containers. While container characteristics and failure profiles have been well characterized, hose failures have not. Some shippers have internal inspection, testing, maintenance, and lifetime standards for hoses, but many do not. Development of industry-wide standards for hoses would address the uncertainty caused by the use of differing hose types and hose management procedures. DuPont suggested that implementation of hose standards may be hampered by a number of factors, including the independent nature of carriers, expense, and a lack of regulation. No research is currently being conducted in this area.

IME personnel suggested that increased testing is needed for explosives that might be present at facilities associated with hazmat transportation. New research should expand the types, quantities, and locations of explosives tested in order to address common commercial explosives and their uses, as opposed to the data currently being derived from military-use testing databases. Beyond continued development of a general explosives testing database, an IME representative suggested that specific

research efforts be devoted to characterizing the behavior of packages of perforating guns. It is industry practice to assume that these devices, which are stored and shipped in packed groups, detonate in unison if any one device within the package detonates unexpectedly. A better understanding of the behavior of these packages would serve to increase the accuracy of risk analyses focused on their transportation. While IME is occasionally involved in developing explosives testing data, no recently published academic or industrial research related to hazmat transportation exists in this area. IME personnel suggested that the primary barrier to conducting this type of research is insufficient resources, in terms of both manpower and finances.

A representative of the National Pipeline Safety and Operations Research Center suggested that there is a large amount of research to be done at the local level regarding the conditions of aging pipelines. Pipelines are often affected by changes in land use and construction in the decades following their burial. Cities and towns should investigate the current state of the pipeline's cathodic protection, support base, etc., to be fully cognizant of safety risks. The interviewee suggested that this kind of research is heavily dependent on the availability of public funding. While there is a wealth of recent research regarding pipeline inspection techniques and technologies, localized pipeline inspection research is largely absent from the literature.

A perceived area for future research from a representative of Vanderbilt University involves examining the implications of new energy choices and alternative fuels with regard to hazmat transportation risk. This research would include investigating how the shipment and use of energy sources developed in response to climate change affect risk levels throughout the transportation system. Recent research in this area focuses on the effects on pipeline integrity for transporting alternative fuels, such as ethanol (see projects 124, 139, 146, and 156), biogas (project 144), and biodiesel (projects 127 and 154), and on thermal and fire hazards posed by batteries and fuel cells in air cargo (see projects 85, 86, and 88). PHMSA is planning research on energetic hazardous materials that will focus on better ways to package and transport lithium batteries and high-energy capacitors (see project 115). Additionally, the FRA is investigating methods for reducing non-accident releases of ethanol during loading and unloading of tank cars (see project 95). However, investigations of truck, rail, barge, and system-wide effects from increased use of alternative energy sources remain largely unexplored in recent literature.

Gap Summary

- More risk-based analyses of high-strength steel pipe are needed.
- Research is needed into the standardization of hoses and/or processes used to transfer hazardous materials from industry users and producers to carrier containers.
- Commercial explosives require additional packaging testing research to augment the military explosives assumptions that are applied to them.
- Local testing of pipeline conditions is needed as the infrastructure continues to age. This is particularly important because of the affect that changes in land use and construction can have on pipelines.
- The increasing use of new and emerging alternate fuels has implications on the transportation infrastructure—from such issues as corrosion and product compatibility—and could benefit from additional research.

6.1.9. Risk Analysis and Perception

Interviewees suggested several potential research concentrations that can be loosely grouped as pertaining to risk analysis or risk perception. A representative from IME suggested that quantitative risk assessments, particularly with regard to siting explosives-related transportation facilities, would be

more useful if regulators had criteria for using model output to make decisions. Research is needed into the establishment of guidelines that dictate decisions to be made given risk model output. While IME works primarily with the model IMESAFR, used for explosive risk analysis at facilities, these types of guidelines could be extended to other standard industry risk models.

Representatives from the University of Kentucky suggested that there is a need for the development of a nationally accepted, chemical-based risk assessment model and management system for hazardous materials. This system would provide a chemical list and associated rating system, based on each chemical or chemical group's properties, and prescribe management practices for their handling. Management practices would be developed with a focus on both safety and security. Development of such a system has not been addressed in recently reported research.

The HM-01 research team recommended investigating how risk and vulnerabilities vary from mode to mode in hazmat transportation. Certain modes of transportation are often assumed to be inherently safer than others. If these assumptions are true, there is the potential for using lessons learned from safer modes to improve less safe modes. Such research should further consider if hazmat shipments should be reallocated given the risks associated with a particular mode of transport. Additionally, this research should include investigation into the potential for terrorist attacks for each mode and how that potential should affect shipment choices. No research projects focusing on these goals have been reported since the publication of HM-01.

The AT040 committee recommended an examination of how and why public perceptions of risk in hazmat transportation change. This study would compare current perceptions of a given hazmat transportation program to previously recorded public perception data. The results of this research would improve understanding of how risk perceptions shift over time, the public's level of knowledge of the analyzed program, and facilitate the identification of factors in determining public perception. No recent research program has attempted to address these issues.

Gap Summary

- There is a need for guidance or more concrete criteria related to the decision making that relies on risk model outputs.
- Some interviewees suggest the need for a nationally accepted, chemical-based risk assessment model and management system for hazardous materials. This system would provide a chemical list and associated rating system, based on each chemical or chemical group's properties, and prescribe management practices for their handling. There would need to be some consideration for the quantities of the materials involved.
- Research into comparative risk assessment across modes is still needed to address issues with varying data sources, levels of accuracy, and considered elements (such as rail yards and transfer facilities). Such research could better support intermodal risk assessments. The information that could result from this research could lead to application of best practices from one mode to another, where possible.
- A study of how and why public perceptions of risk in hazmat transportation change would improve understanding of how risk perceptions shift over time, the public's level of knowledge of identified programs, and facilitate the identification of factors in determining public perception.

6.1.10. Other Perceived Areas for Future Research

PHMSA OPS personnel suggested that an investigation be conducted into the effects of international, state, and intrastate hazmat standards and pipeline regulations on pipeline operators. Variability in the standards and regulations governing a pipeline over its length can create operational obstacles for pipeline operators. A better understanding of these variations would facilitate alleviating some of these obstacles. While several recent projects have investigated the development of pipeline operating and testing standards (see projects 124, 133, 146, and 156), there has been no recent research focused specifically on the effects of multiple, varying regulatory schemes on the operation of a pipeline. Transport Canada, however, has recently conducted research into developing a general hazardous materials security policy that would align with U.S. policies (see project 162) and a review of the standards and regulations governing the handling of dangerous goods within Canada (see project 167).

Interviewees from DuPont recommended research into gaps in training and succession planning within the hazmat transportation industry. The DuPont representatives described difficulty throughout the industry in hiring qualified senior managers and truck operators. Furthermore, the interviewees suggested that the average age of senior management is high and that many of these managers are nearing retirement, while the availability of qualified replacements is low. Recent research related to this topic has focused on producing qualified hazmat transportation workers through training, including a study of the effectiveness of hazmat training (see project 23), an investigation of post-secondary education curricula for hazmat transportation (see project 31), and an on-going industry initiative that includes the expansion of a professional development curriculum (see project 159).

A University of Kentucky representative suggested that further investigation into means for better protecting the U.S. supply chain is necessary. This research would build upon a wealth of current and recent projects with direct applicability to supply chain protection, including research on risk assessment and risk assessment tools (for examples, see projects 41, 46, 71, 84, 93, 111, 187, etc.), safety and security technologies (for examples, see projects 22, 48, 112, 122, 126, 180, 182, 186, etc.), and policy development (see projects 84, 161, 162, 171, 179, and 185). There are several recent projects that have explicitly focused on supply-chain assessment and protection, including a probabilistic risk assessment of the chemical supply chain and industrial sites by DHS/TSA (see project 90). DHS/TSA has also conducted research into the development of a tool for assessing the safety and security of supply chain elements, which includes an examination of available technologies and potential operational alternatives (see project 81). ORNL's CTA has created simulation software to support the development of a hazardous material detection system that will identify potential hazards while minimizing the effect of the screening process on the supply chain (see project 109). ORNL's CTA has also been involved in the development of a methodology for assessing the readiness and resiliency of transportation systems, such as supply chains, to terrorist attacks (see project 110). CIRRELT has developed new graphics-based tools for hazardous material supply chain management to facilitate the simultaneous tracking of materials and their associated contracts, responsible parties, and risk transfers (see project 174).

The HM-01 project team found a need for the validation of existing hazmat accident data. This effort would address the accumulation of errors into these resources that have been introduced by data entry, collection of poor-quality spatial information, and the conglomeration of data from multiple sources that were not originally focused on hazmat accidents. This research would involve developing a methodology for detecting and correcting such errors. A recently completed TRB Hazardous Materials Cooperative Research Project (see project 27) sought to develop recommendations for such a methodology to improve the quality and accessibility of hazmat transportation incident information.

Beyond this project, there are several recent research efforts that are less focused on building a detection and correction methodology, but may be applicable to such an effort. These projects include research by Transport Canada in which available accident information in the U.S. and Canada is reviewed (see project 167) and by CIRRELT in which multiple databases were cross-analyzed in order to facilitate hazmat accident analyses. Rail-related projects that may be useful in this field include research by the AAR that employed accident data to examine hazmat-related issues (see project 74), and work by the FRA on post-accident analysis (see project 94).

Gap Summary

- Exploring the effects of multiple, varying regulatory schemes on the operation of a pipeline.
- There are gaps in training and succession planning within the hazmat transportation industry.
- Exploring better means for protecting the U.S. supply chain can build on a wide variety of relevant projects. Given the nature of that work, the focus of this research could be on implementation; for example, on potential study area is the identification of appropriate countermeasures to address specific risks.
- There is a need to validate existing hazmat accident data. Research in this area would involve developing a methodology for detecting and correcting such errors.

6.1.11. Summary Matrix

Table 5. Perceived Gaps by Organization

Perceived Gaps	AAR	California EMA	DHS/TSA and CSAC	Chemical Companies	FAA	FRA	IME	JHU APL	NPS&ORC	PHMSA/OHM	PHMSA/OPS	Texas A&M	TRB - AT040	TRB - HMCRP	UK/KTC	Vanderbilt
Human factors implications for cargo handling systems					●											
Best approaches for reducing risks for return hazmat shipments					●											
Commodity flow data for emergency planning		●	●					●						●		
Better understand and address rural emergency response issues						●										
Improve communication and engagement with LEPCs														●		
Qualified hazmat responder actions beyond initial response												●		●		
Incorporating pipeline-specific response into planning and guidance								●								
Investigate improved hazmat placarding technologies								●								
Best practices for distribution facility risk assessment						●										
Industrial explosion event probability data or applicable proxies							●									
Ensuring availability of relevant local hazmat commodity flow data		●	●					●						●		
State-wide commodity flow studies		●														
Understanding temporal variations in hazmat flows												●		●		
Approaches for acquisition of proprietary commodity flow data			●													
Improved methods for estimating hazmat travel time in waterways													●			

Perceived Gaps	AAR	California EMA	DHS/TSA and CSAC	Chemical Companies	FAA	FRA	IME	JHU APL	NPS&ORC	PHMSA/OHM	PHMSA/OPS	Texas A&M	TRB - AT040	TRB - HMCRP	UK/KTC	Vanderbilt
Improved methods for estimating economic costs of hazmat incidents	●															
Proactive identification and selection of candidate research projects										●						
Better understand how research can drive public policy						●										
Standardized approach for integrating safety and security assessments													●			
Study the interrelationships between current safety and security regulations													●			
More risk-based analyses of high-strength steel											●					
Standardization of hoses and/or processes for transferring hazmat				●												
Additional packaging testing research for commercial explosives							●									
Local testing of pipeline conditions as infrastructure ages									●							
Alternate fuel implications on the transportation infrastructure																●
More guidance on decision making that relies on risk model outputs							●									
Nationally accepted, chemical-based risk assessment model															●	
Address issues with comparative risk assessments across modes												●		●		
Study public risk perception in hazmat transportation													●			
Explore the effects of multiple, varying regulatory schemes on pipelines								●			●					
Examine the gaps in training and succession planning				●												
Explore better means for protecting the US supply chain												●			●	
Validate existing hazmat accident data												●		●		

6.2. Research Overlaps

As one might expect, there are some overlaps in the hazmat transportation research being conducted by the many organizations contacted during this project. This section discusses the key areas of common research. In many cases, it is not possible to determine whether projects that cover the same or similar topics overlap each other in scope or whether they are complementary based on the information that the project team was able to obtain. Entities interested in research in these areas should follow up with the research organizations, using the contact information provided in Table 2, to determine the extent of overlap or complement between efforts and explore collaboration, if appropriate. Appendix B contains a cross-referenced list of all of the overlaps the project team identified.

One general area of overlap is “new technologies.” Many identified projects are focused on developing or enhancing new or emerging technologies that have the potential to improve the safety or security of hazardous materials transportation. One study in particular, TRB’s HM-04, developed a list of near- and

long-term technologies that hold particular promise. For some of the other new technology projects, see HM-04's entry in Appendix B (project 22).

6.2.1. Incident Data Analysis and Availability

Multiple organizations are involved in research efforts to analyze hazardous materials transportation incidents data and to create methodologies to predict or prevent future incidents. One current TRB project is researching incident data for root cause analysis, including estimating the underreporting of serious incidents (see project 27). Texas A&M is using existing accident databases and fuzzy sets to estimate the frequency of hazmat transportation incidents (see project 15), and a project by CIRRELT is performing a cross-analysis of accidents using multiple databases (see project 177). The Association of American Railroads (AAR) is conducting research projects to study hazmat releases and the impacts of potentially contributing factors in accident (see project 74) and non-accident (see projects 59 and 76) releases. Railroad accident information is also being addressed by the FRA, which is developing data through a post-accident evaluation project (see project 94).

6.2.2. Commodity Flow Data Analysis and Availability

Several recent projects have been undertaken to address the quality and availability of hazmat commodity flow data. One TRB project is providing recommendations and guidelines for collecting and analyzing hazmat commodity flow data to make the information more readily available for local decision makers, responders, and regulators (see project 26). A similar Texas A&M study focused on state and sub-state hazmat movements in Texas, but is potentially applicable to hazmat management and research efforts in other states (see project 16). Research through the National Cooperative Freight Research Program (NCFRP) has also investigated sub-national commodity flows (see project 25). While the NCFRP looks more broadly at all freight commodities, it does specifically consider hazardous materials and the hazmat commodity flow work done through TRB (see project 26).

6.2.3. Pipelines

Because the U.S. pipeline network stretches over one million miles, pipeline maintenance and protection are critical hazmat transportation safety issues. One specific area of concern for pipelines is the ability to protect pipelines from damage caused by third parties, through deliberate attack or from construction activities near the pipelines. Research sponsored by the National Pipeline Safety and Operations Research Center (NPSORC) is focused on improving detection techniques for underground pipes. This work is similar to a PHMSA-sponsored research project investigating improvements in acoustic-based detection and alerting systems (see projects 121 and 132). An additional PHMSA study on pipeline encroachment detection and alerting involves the development of a seismic sensor system to prevent potential strikes (see project 123).

Several research projects have recently been undertaken that involve the development of tools to remotely monitor pipelines and assess signs of cracks, dents, corrosion or leaks. Projects include research on pipelines that carry specific commodities, such as hydrocarbons (see projects 122 and 140) and ethanol (see project 156), and determine the potential for new technologies to be used with these materials. An example of this type of research is the PHMSA OPS soft crack assessor project that has developed tools for assessing cracks in large-diameter natural gas and carbon dioxide pipelines (see projects 130 and 131). Additional pipeline monitoring projects that are less specifically focused on a given commodity include development of a combined pipeline inspection and cleaning tool (see project 141), dent assessment tools (see projects 129 and 143), a fluidized sensor system (see project 150), and various non-destructive pipeline inspection methods (see projects 135 and 136) by PHMSA's Office of

Pipeline Safety (OPS). NPSORC is conducting similar monitoring and detection research including investigations of coastline and offshore pipelines (see project 8), leak detection using fluid transport technologies (see project 9), non-destructive monitoring techniques (see project 10), and the use of remote sensors (see project 13).

Improvements in construction methods and investigations into the compatibility of construction materials with specific commodities have also been a focus of pipeline research in recent years. Projects in this field include an examination of the pipeline construction and performance for transporting ethanol (see projects 124, 146, and 156), biodiesel (see project 127), high-pressure gaseous hydrogen (see projects 128, 137, and 149), and biomethane (see project 144).

6.2.4. Risk and Effects of Terrorism

Following the large-scale terrorist events of the past decade, there is increased research regarding the risk of a terrorist attack against the transportation network. A major portion of this research focuses on risk assessments and related data development. DHS has conducted a number of projects in this area, including those involving transportation and industrial infrastructure (see projects 80, 81, 83, and 84) and modeling chemical releases from bulk packages (see projects 79 and 82). IME has developed a tool for addressing explosives risks on a facility-level (see project 187), while research from Vanderbilt University has developed a methodology for addressing terrorism risks on a regional scale (see project 46). Transport Canada has recently undertaken a wide-ranging security-based risk assessment for truck and rail transportation of hazardous materials within Canada that is soon to be declassified (see project 161). Recent security risk assessment research has also resulted in the development of software tools including ORNL Center for Transportation Analysis' (CTA) GeoSAT, which helps prepare security managers and first responders for events in high-threat urban areas (see project 108), and AAR's Rail Corridor Risk Management System which is used by rail operators and regulators to assess security and safety risks for shipments (see project 71).

Multiple recent security-related projects have focused on developing tools to provide first responders, operators, law enforcement, and other stakeholders the ability to track hazardous materials in real time. The Kentucky Transportation Center (KTC) is conducting research to support the TSA's tracking of truck-based hazardous materials shipments (see project 41) as well as investigating tracking maritime shipments (see project 42). Research by ORNL's CTA focuses specifically on tracking and assessing threats from barge shipments (see project 111), while DuPont is investigating GPS-tracking of rail shipments (see project 182). Recent work by the Institute of Makers of Explosives similarly focuses on real-time truck shipment tracking (see project 186).

Security-related hazmat transportation research has also included research projects focusing on the detection of terrorist activity and materials in recent years. One such project by ORNL's CTA involves the development of a system to detect nuclear and other hazardous materials at ports of entry within the U.S. (see project 109). A project by CREATE involves developing allocation strategies for nuclear detection devices within urban areas (see project 86). Similar work by Texas A&M has developed a methodology for the placement of threat detectors and interception units within a regional network (see project 14).

Infrastructure resiliency has been another focus of recent security-related hazmat transportation research. Organizations such as ORNL's CTA, CREATE, and PHMSA are investigating the resiliency of the transportation network (see projects 3, 4, and 110) and the ability of communities (see project 16) to quickly recover from an attack.

6.2.5. Container Improvement

Many organizations are researching potential improvements in container design and materials. While the majority of these projects examine individual components or materials of a container, all of this research is geared towards creating a safer, more effective, and more reliable vessel for hazardous materials transportation.

The University of Illinois is developing a two-phased modeling approach to tank car design that considers (a) safety improvements in light of weight trade-offs and (b) the hazards posed by specific chemicals while accounting for the costs associated with protecting against those hazards (see project 39). Transport Canada is researching the behavior of foam used for thermal protection of tank cars and the thermal emissivity and absorptivity of rolled tank car steel and liquid propane when involved in a fire (see projects 170 and 173). FMCSA is investigating the cause of stress corrosion cracks and pinhole leaks in nurse tanks (see projects 90 and 92, respectively). FMCSA is also working with PHMSA and NHTSA to determine potential tank car vehicle improvements to reduce tank car rollovers (see project 113).

A wealth of railcar hazmat research has been conducted through the AAR in recent years. The AAR Advanced Tank Car Collaborative Research Program is a program that seeks to develop better designs, standards and regulations for tank cars carrying toxic inhalation hazard commodities (see project 70). Beyond this comprehensive effort, the AAR has been involved in a number of research projects investigating specific tank car materials or components, including tank car steels (see projects 51, 52, and 73); tank car markings (see projects 49 and 53); and tank car parts, such as outlets (see project 50), valves and relief devices (see projects 55, 60, 61, 67, 68, and 69), joints (see project 62), manways (see projects 63, 65, and 66), and fasteners (see project 64). The AAR has also been involved in developing data that may be useful to researchers in the field of tank car design, including operating environment information (see project 72), accident (see project 74) and non-accident (see projects 59 and 76) event data, inspection results (see project 75), and fire-related safety testing results (see project 77). Additionally, AAR has performed research into tank car maintenance (see project 54), non-destructive evaluation (see project 56), and life extension (see project 58).

In recent years, there have also been projects that examine the safety of containers beyond highway and rail tank cars. For example, the Nuclear Regulatory Commission (NRC) is developing a technical basis to ensure the integrity of spent fuel transport casks during severe accidents (see project 107). Composite cylinders have also been examined in several projects, including two by PHMSA to enhance in-service testing of the cylinders (see projects 114 and 119) and a project by Transport Canada to review current regulations regarding cylinder specifications (see project 171).

6.2.6. Human Factors, Training, and Educational Outreach

The training of transportation workers is critical to the safety of hazardous materials transportation. Several general hazmat training projects have been conducted in recent years. One project by TRB will develop a guide for evaluating the effectiveness of training methods used to inform hazmat employees of safety and security requirements (see project 23). Another TRB project will develop a curriculum that will address knowledge, skills, and abilities needed by the public and private sectors for safe transportation (see project 31). A project from the Council on the Safe Transportation of Hazardous Articles similarly seeks to develop training curricula for hazmat professionals as well as improving public awareness of the industry and strengthening partnerships between government and industry organizations (see project 159).

Reducing cargo tank incidents and rollovers has been the focus of several recent hazmat training projects. For example, the FMCSA is examining the potential benefits to cargo tank safety from public outreach in the form of dissemination of an informational video (see project 89). Two projects specifically focus on cargo tank rollovers. In one such project, TRB is examining the effect of human factors that contribute to cargo tank truck rollovers and potential operating practices that can be employed to address these factors (see project 32). The other project, carried out by PHMSA's Office of Hazardous Materials Safety (OHM), NHTSA, and FMCSA, is examining a wide array of options for reducing rollovers, including driver training, but extending to the entire vehicle system (see project 113).

The reduction of non-accident releases through training has been a focus of recent industrial research. DuPont is involved in two such initiatives, including the establishment of best practices to reduce leaks and secure liquid hazmat (see project 183) and development of a standardized program for training and certification for loading and unloading operators (see project 184). The AAR, meanwhile, is conducting a broad-scope investigation on how to best address non-accident releases, including through the use of training efforts (see project 77).

6.2.7. Research Needs and State of the Practice

TRB is sponsoring two studies that are examining the current state of hazardous materials research; one is specifically focused on risk assessment practices, while the other is investigating general hazmat transportation research and research needs (see projects 28 and 21, respectively). A similar study of current research and needs is being conducted by PHMSA to support the establishment of the agency's research and development program (see project 120). Transport Canada is investigating and drafting an issue brief on existing research and risk analysis work, knowledge gaps, and recommendations on areas that could benefit from further research (see projects 167 and 172). The Dangerous Goods Directorate of Transport Canada is also working to collect and organize hazmat transportation research results to make this information more readily available and to research staff and other public and private stakeholders (see project 165).

6.2.8. Transportation of Alternative Energy Sources

The relatively recent focus on the use of alternative fuel and power sources has led to a number of research projects focusing on the transportation of these resources. One area of focus in this field is the effects on pipeline integrity for transporting alternative fuels, such as ethanol (see projects 124, 139, 146, and 156), biogas (see project 144), and biodiesel (see projects 127 and 154), all of which represent projects undertaken by PHMSA's Office of Pipeline Safety (OPS). The reduction of non-accident releases of ethanol during loading and unloading of tank cars has been a research focus for the FRA (see project 95). The FAA has investigated thermal and fire hazards posed by batteries and fuel cells in air cargo (see projects 85, 86, and 88) and PHMSA's OHM has examined improvements to packaging and operational practices for transporting lithium batteries and high-energy capacitors (see project 115).

6.2.9. Economic Effects of Hazardous Materials Transportation

Several recent projects have evaluated risk and risk-reduction strategies in terms of monetary value in order to create a standard basis for comparing dissimilar risks or to optimize costs and benefits. A Vanderbilt University study investigates hazmat transportation risk analysis through the development of an all-hazards risk management approach that expresses risk in terms of monetary value (see project 43). By couching risk in economic terms, the methodology facilitates the consideration of safety and security risks in concert. A University of Buffalo study uses a similar economic approach to examine the safety and security risks involved in route selection for hazardous materials (see project 35). A CIRRELT

study also investigates tactical planning using cost terms, with a focus on rail transportation (see project 176). A cost-based approach for evaluating rail shipment risks is also being developed by The University of Illinois, which is seeking to incorporate a cost-benefit analysis into tank car safety design improvements (see project 39). Two projects from CREATE focus on economic impacts related to hazmat transportation and terrorism, including the development of a model for tracking economic effects of a terrorist attack throughout the national economy (see project 3) and an optimal cost-benefit approach to placing nuclear detection equipment throughout transportation networks (see project 2).

6.3. Research Needs

The project team reviewed the perceived and remaining needs documented in Section 6.1 and incorporated many of them into a defined need statement. Therefore, there is a strong correlation between the research needs and the perceived needs in Section 6.1. The project team drew on its expertise and the interviews to augment some of the research needs to make them broader (and potentially more applicable to more stakeholders) and determined that others were not good candidates for further consideration. For example, lithium battery research was mentioned as a need, but there has been a lot of research in this area already. It is possible that more focused research on lithium batteries may be warranted in the future as the power that these batteries can produce increases from technical advances. Ultimately, the identified research needs were reconstituted into research project statements and prioritized using the approved prioritization framework as part of Task 9. These candidate research project statements are presented in this section, organized by general area.

6.3.1. Cargo Packaging and Handling

6.3.1.1. Identifying Sources and Types of Undeclared Hazmat

The shipment of hazardous materials without declaring them as such as following the federal requirements for their safe packaging and transportation is a recognized concern among carriers and regulators alike. The belief is that a large number of these shipments originate from small businesses and consumers that are returning merchandise. These ‘undeclared’ shipments are comingled with mainstream shipments and carrier personnel are unaware of the special handling and shipping requirements that are appropriate. The volume and reporting rates of these undeclared shipments is currently not well known.

The objective of this project is to develop a better understanding of the types of materials and the types of businesses that are more likely to offer an undeclared shipment for transportation and to estimate the magnitude of the problem. In addition, approaches to obtain better estimates for the volume and reporting rates should be suggested.

A second phase for this research is to engage with individuals and organizations in the key industry segments for undeclared shipments and to identify candidate strategies for reducing the number of these shipments, impediments to their implementation, and suggested approaches for addressing them.

Estimated project budget: $200,000

6.3.1.2. Human Factors Issues for Hazardous Cargo Handling

Human factors are an important element in the transportation of hazardous materials. As technology advances allow for greater use of automated and improved mechanical systems, there are concerns about the impacts of these changes on the current approaches and procedures for hazmat handling. As shipment volumes increase, are the current systems able to handle the adjustments necessary to provide a consistent level of safety and security? The screening of non-bulk hazmat for proper packaging and security issues is just one area where the implications of these changes might be particularly pronounced, especially for transportation by air. For some segments of the industry, there is more human interaction with individual packages than in other segments; for example, passenger carriers vs. cargo-only carriers. In some cases, better clarity on responsibilities may be appropriate, such as better defining the carrier responsibility for discovering undeclared hazmat shipments.

The objective of this project is to (a) identify current changes in hazmat transportation cargo handling systems and those probable changes that can be expected over the next five to ten years, (b) identify the specific areas (such as air package screening) that are particularly sensitive to these changes, (c) identify the likely impacts from these changes, and (d) develop and describe candidate options for addressing them. Training requirements, handling methods and locations, monitoring and oversight, and assigned responsibility may all be important.

Estimated project budget: $250,000

6.3.2. Emergency Planning and Response

6.3.2.1. Improving Local Emergency Planning Committees

Some hazardous materials incidents occur far outside of a major city, where smaller communities may not be as adequately prepared to manage these incidents. Local Emergency Planning Committees (LEPCs) serve a valuable role, by coordinating members of government, industry, and first responders to prepare for a hazardous materials incident. This project will provide a review of current LEPC efforts and examine why some LEPCs are more successful than others, particularly with respect to hazardous materials and differentiating between urban LEPCs and those in non-urban areas.

The objective of this is to determine strategies to strengthen a LEPC in a community. Specific questions involve (a) determining what keeps an LEPC active and functional; (b) determining why individual members remain in the LEPC or leave the committee; and (c) exploring the feasibility of a nationwide database of LEPC members, to track membership and facilitate communication and coordination across various LEPCs.

Estimated project budget: $200,000

6.3.2.2. Initial Actions by Hazmat First Responders

Providing responders with fast and accurate information is critical in order to safely assess and address any hazmat incident. Hazmat responders would benefit from a comprehensive guidebook that includes all types of incidents and all possible types of hazardous materials. This material should be arranged in a hierarchical manner, such that the most-likely scenarios will be easily available.

This guidebook should include, but not be limited to, information on biological, chemical, and infectious substances and would address specific actions for qualified hazmat responders, in addition to first responders. Because of the urgency of hazmat incidents, the guidebook should be as concise as possible, without sacrificing the quality and thoroughness of the information presented. This guidebook will also be a critical tool for responders to train and prepare for any Hazmat incident.

Estimated project budget: $300,000

6.3.2.3. Rural Hazmat Emergency Response

With the limited resources available to many rural emergency response organizations, there is a need to better understand the unique issues they face and to identify best practices for addressing them related to hazmat response. One specific issue is the difference in how all-volunteer vs. fully-funded agencies approach assessing hazmat risks and emergency planning. Another is how long-term (i.e., multiple-days to a week) response efforts might be sustained in rural environments given volunteer response forces, mutual aid agreements, and potentially scarce equipment resources.

Estimated project budget: $200,000

6.3.2.4. Systematic Approach for the Development and Use of Hazmat Commodity Flow Data in Emergency Response Planning

The ability of jurisdictions to develop a comprehensive emergency response plan is dependent, in part, upon its ability to understand the hazardous materials being transported through its region of authority. Adequate hazardous material commodity flow information is often not available to emergency planners, particularly at the local level. Gathering commodity flow data at a local level is often precluded by a lack of funding, particularly in rural areas, and can result in the use of inconsistent methodologies across jurisdictions, making aggregation or larger comparisons of the data difficult. Once collected or made available to planners, these data may not be fully utilized if the planning committee is not familiar with the processes and logistics associated with hazmat transportation. The objective of this research is to investigate the potential for developing standardized state-wide hazmat commodity flow information to meet the needs of local emergency planners. Researchers should then recommend methods for disseminating this data and educating local response planners on its appropriate incorporation into a comprehensive emergency response plan.

Estimated project budget: $200,000

6.3.2.5. Improved Hazmat Placarding Technologies

Both PHMSA's ongoing HM-ACCESS initiative and the HMCRP's HM-05, *Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments*, are considering the potential to allow for electronic shipping papers to be used in place of hard-copy shipping papers. There are expected benefits to emergency responders and to enforcement personnel that accrue from easier access to material, quantity, and packaging information, particularly in situations (inaccessible truck cabs, for example) where a physical shipping paper would be unavailable. In addition, there are some potential concerns about availability of the electronic information, depending on the adopted technology.

While the information on a shipping paper can better inform emergency response actions, the initial assessment of the type of materials involved in an incident is currently obtained from the hazmat placards on the outside of the vehicle, tank car, cargo tank, etc. This project will leverage the work already completed in HM-ACCESS and HM-05 to explore the potential for adopting alternate technologies only for placarding, the benefits that would be expected, technical and operational issues that might exist, and recommended paths forward.

Estimated project budget: $200,000

6.3.3. Facility Risk Assessment

6.3.3.1. Distribution Facility Risk Assessment

While risk assessment for facilities has been an area of research and implementation for a long time, often centered on chemical process safety, there is a need for additional research or collection of best practices for *distribution* facility risk assessment. A key focus would be on loading and unloading and the movement of raw materials into the facility and the shipment of product from the facility to the next customer in the supply chain. Transloading operations are an important element to address in the risk assessment. This project can also address the sometimes-unclear jurisdictional authority for these facilities and how that affects safety. Other issues to consider are the changing environment around facilities and the implications of changes in the types of materials and equipment that are present at the facilities over time.

Estimated project budget: $300,000

6.3.4. Commodity Flow Data

6.3.4.1. Addressing Acquisition of Proprietary Hazmat Commodity Flow Data

There is a continuing desire by many organizations, including federal, state, and local governments, to gain access to more detailed information on the number of shipments and quantity shipped of various types of materials. At the federal level, the models that drive risk assessments depend on this information to better inform policy decisions and the allocation of resources into risk reduction measures, including regulations, grants, and training. At the local level, this information could better support emergency planning efforts to align capabilities with the nature and locations of these movements.

The objective of this project is to (a) document the current impediments to obtaining hazardous materials commodity flow data from industry and (b) to identify potential approaches for making commodity and shipment data available to risk managers, while recognizing and addressing the valid concerns from industry.

Estimated project budget: $150,000

6.3.4.2. Assessing the Impact of Global Warming on Hazmat Commodity Flow

This project is a scoping study to better understand the climate change-related drivers that could influence hazmat flow patterns and the extent of their impact, including on transportation risk and emergency response. The objective is to (a) summarize what is known about anticipated climate change in the US on a regional basis, with regard to temperature, precipitation, sea level rise, and episodic events, (b) describe how various energy and other industrial process choices impact hazmat

distribution patterns (e.g., commodity type, volume, mode, origin-destination pair), and (c) define plausible climate change and related energy and industrial process choice scenarios over the coming decade, and demonstrate how these would impact hazmat commodity flow patterns.[1]

6.3.5. Hazmat Release Consequences

6.3.5.1. Travel Times of Hazmat in Waterways

Hazardous materials releases can occur in, or in close proximity to, a waterway that could carry the released material for great distances. Little research has been conducted to determine the travel time of various materials through waterways. Accurate estimates of travel time would facilitate emergency planning for communities located downstream from potential hazards, such as transport pipelines and vessel locations. The objective of this research is to develop a methodology for determining the downstream travel time of various chemicals or groups of chemicals for given stream conditions.

Estimated project budget: $200,000

6.3.5.2. Estimating the Costs of Hazmat Incidents

The costs of hazardous materials incidents often reach in to the millions of dollars, but improvements are needed to more accurately determine the costs of these incidents. This project will develop an approach for estimating the costs of a hazardous materials incident. This research should include investigation into available data sources and current best practices for estimating loss of life, damages to property, liability, long-term cleanup costs, etc. The recommended approach should account for accessibility of necessary inputs in order to allow widespread utilization of the approach by practitioners.

Estimated project budget: $200,000

6.3.6. Hazmat Transportation Research

6.3.6.1. Impact of Hazmat Transportation Research on Public Policy

There is a need for research on how hazmat transportation research could be better used to drive public policy. Where national-level risk assessments are extremely useful in making decisions between different approaches to risk management or in understanding the relative risks of different types of hazmat operations, they are generally applied at a tactical level. This research project would explore the application of risk assessment, and hazmat transportation research in general, to public policy strategy. What are the appropriate measures to consider? How can the interplay between safety/security and economic viability and international competitiveness be addressed? Should there be consideration of the concept of acceptable risk as we explore measures to address the risks of different elements of the hazmat supply chain?

Estimated project budget: $150,000

[1] This project description is taken largely from a submittal from the interviewee proposing the need to the HMCRP for funding consideration.

6.3.7. Materials and Equipment Testing

6.3.7.1. Develop Guidelines for Testing, Maintaining, and Operating Chemical Transfer Hoses

While information on the characteristics and failure statistics of bulk hazmat containers are widely available and utilized, similar information on the hoses used to transfer materials to and from these containers is not. Likewise, industry standards for the inspection, testing, maintenance, and retirement of these hoses do not exist. Many hazmat producers and carriers have not developed internal standards for such practices, while methods among those that have vary from organization to organization. The uncertainty caused by the use of differing hose types and hose management procedures presents an obstacle to holistic risk assessment and management for both shipper and carrier organizations. The objective of this research is to produce a guidance document that will inform drivers/operators, shipper/carrier maintenance personnel, and other stakeholders of the current successful practices for designing, selecting, testing, maintaining, and operating chemical transfer hoses.[2]

Estimated project budget: $300,000

6.3.7.2. Commercial Explosives Testing

Current data used in the modeling of explosives risks is largely derived from military test data. These data represent only a portion of commercially used explosive materials and were generally conducted using explosive materials in quantities much larger than commercial organizations would typically have on-hand. By augmenting currently available explosion testing data with information on a wider variety of commercial explosives, in typical quantities, more accurate estimates of explosives risks at transportation facilities and along transportation routes could be made. The objective of this research is to provide a foundation for the development of a commercial explosives database to support facility and route path risk analysis. This effort will involve investigating and reporting the types and quantities of commercial explosives commonly shipped within the US, a recommended path forward for testing, and potential avenues for funding a long-term materials testing program.

Estimated project budget: $100,000

6.3.7.3. Risk-Based Analysis of High-Strength Pipeline Steel

High-strength pipeline steels, such as x80, x100, and x120, offer the advantages of being both lighter and able to operate under higher flow rates and pressures than their predecessors. However, a better understanding of the controls necessary to operate pipelines under these more strenuous operating conditions, as well as more thorough modeling of the steels' behavior in these environments, is necessary. The availability of such information would contribute to the safety of pipeline operation, the efficient allocation of pipeline risk management resources, and more clearly define acceptable operating parameters for both operators and regulators. The project will review currently available models for determining pipeline steel behavior and control characteristics to determine their applicability to high-strength steels. The objective of this project is to (a) determine the models available for modeling high-strength steel pipelines, (b) review the literature on controls

[2] This research need was further developed into the project described here by members of the Research Needs Subcommittee of the TRB Hazardous Materials Transportation Committee and submitted to the HMCRP for funding consideration on behalf of the Committee.

and models for steel pipe and to identify gaps, (c) document the critical differences in operation, inspection, and monitoring between high-strength steel and other types of pipe. This would include how the flow rates and pressures would affect the properties of the steel, valves, etc. and the appropriate approach/ models to establish the operating pressures.

Estimated project budget: $150,000

6.3.8. Risk Analysis and Perception

6.3.8.1. Chemical-based Risk Assessment Model

While the ongoing HM-12 project will document the current approaches for conducting hazardous materials transportation risk assessments, there is a desire for a nationally accepted, chemical-based risk assessment model and management system for hazardous materials transportation. This system could provide a chemical list and associated rating system, based on each chemical or chemical group's properties, and prescribe (or suggest) management practices for their handling. There would need to be some consideration for the quantities of the materials involved.

This research project will explore the feasibility and appropriateness of developing a more detailed and standard risk assessment model that includes specific consideration for different materials, quantities, modes, entity types, and operations. Of particular concern is the appropriateness of such a national model to different types of decisions, including mode and route choice, and the application of various safety or security countermeasures. This project will suggest which elements are appropriate for further consideration. In addition, and if the prior phase so indicates, the researchers will outline the framework for a national risk assessment (to support one or more decisions, as appropriate) and the next steps required for implementation.

Estimated project budget: $300,000

6.3.8.2. Measuring the Potential Benefit of Hazmat Risk Mitigation Strategies

There are many recent and ongoing projects that are directed at better protecting the U.S. supply chain. The types of risk-mitigation strategies encompass a wide variety of safety and security countermeasures, including mode and route choice, packaging selection, carrier selection, manufacturing and distribution locations, alternate product selection, operational changes, improved monitoring and communications, emergency response planning, and inspection procedures and frequency. This research project will develop a guidebook to help identify the appropriate countermeasures to address specific risks.

Estimated project budget: $200,000

6.3.8.3. Comparative Hazmat Risk Assessment across Modes

Anecdotal evidence seems to point toward the selection of certain modes of hazmat transportation as being safer than others. This observation plays a part in shipping decisions made by a number of high-volume hazmat producers. Research into the comparative risks associated with each mode is needed to gain a better understanding of the influence of mode selection on shipment risk. Improved awareness of the sources of risks for each mode and their effect on the safety and security of shipments can lead to better shipping decisions and, potentially, mitigation of risks on a given mode through the transfer of applicable best practices and lessons learned.

The objective of this project is to investigate the effect of shipping hazmat by differing modes on the risk associated with the shipment. The project should (a) investigate data sources that can be used to compare aggregate mode safety and security; (b) investigate data sources that would allow for case studies of the influence of mode selection on the risk presented by specific commodities, (c) determine the factors that influence any variation that is observed across the modes; (d) determine the potential for positive influences to be applied to less-safe modes; and (e) discuss the potential for these results to inform mode choice decision at national and corporate levels.

Estimated project budget: $300,000

6.3.8.4. Changes in Public Perception of Risk in Hazmat

[Submitted as a research problem statement by AT040]

One of the critical constraints affecting public policies governing the transport of hazardous materials is derived from the manner in which the public understands the associated risks. *Perceived* risks feed directly into the political process, limiting the array of feasible policy actions in ways that depart from purely technical risk management strategies.

This project would collect new survey data for an existing hazmat transportation program that has historical data on public risk perceptions prior to, and during the start of shipments. The new data would be compared to the large archive of existing public opinion research. The analysis would further our general knowledge how public risk perception evolves over time with increased experience; it would permit comparison of public knowledge of the transport program after ten years of nearly accident-free operation; and it would permit analysis of the relative role of familiarity, knowledge, and social factors in explaining changes in risk perceptions of hazardous materials transport.

The objective is to understand the ways that people's perceptions of hazard materials transportation risk are formed and how they change over time. The products of this research project would include (a) an updated public survey; (b) statistical analysis of the survey results and; (c) comparison of the results with responses from previous surveys along with relevant conclusions about the factors contributing to measured changes in perceptions.

Estimated project budget: $200,000

6.3.9. Other Research Needs

6.3.9.1. Effects of Multiple Regulatory Schemes on Pipeline Operations

Variability in the standards and regulations governing a pipeline over its length can create operational obstacles for pipeline operators. While recent efforts have been made to set cross-border operating pressure standards on an international level, differences in regulations at a state and local level still present operational issues for pipeline operators. For example, a given state may have more stringent regulations than the federal government, or local government regulations may differ from those of the larger state.

The purpose of this project is to (a) identify significant variations in pipeline regulation on a local, state, and national scale and determine where these regulations are in conflict; (b) identify factors leading to the variations; (c) determine the potential for developing standard operating guidelines

for the areas in conflict; (d) analyze the impacts of the varying regulations on the pipeline industry in the context of the anticipated benefits; (e) provide a path forward toward standardized regulations, where appropriate; and (f) determine the impact that standardizing regulations would have on government and industry.

Estimated project budget: $200,000

6.3.9.2. Development of Guidance Documents for State and Local Pipeline Oversight and Response

Initial response to a pipeline incident can be hampered by several factors on the state and local level. Because issues related to pipeline transportation fall largely under the jurisdiction of the federal government, state and local emergency planners and responders rarely focus on pipeline response. Similarly, because pipelines are operated by private firms and tend to be out of view, local governments are seldom aware of the condition of pipelines within their jurisdiction, despite the threats commonly posed by changes in local land use and construction. As such, pipeline incidents are likely to catch many local governments by surprise.

When an incident does occur along a pipeline, the responsibility for initial actions may be unclear, particularly when an incident in one state or local jurisdiction affects an unrelated jurisdiction at some distance down the pipeline. Additionally, though federal responsibility for pipelines rests with the USDOT, responsible officials for pipelines at a state level (or local level, where applicable), can be a part of any number of government organizations, and tends to vary from state to state. This variation in the organization of responsibility within governments can hinder coordination among officials from different jurisdictions, slowing the critical initial response time.

The objective for this research is to produce a guidance document outlining (a) an optimal standard for the organization of pipeline oversight within state and local governments, (b) guidelines for assigning responsibility for initial response to pipeline events among state and local governments, (c) recommendations for improving the awareness of pipeline conditions by local planners, and (d) recommendations for the effective and continued incorporation of initial pipeline response into state and local emergency response plans.

Estimated project budget: $200,000

7. Framework for Prioritizing Research

Hazardous materials transportation is a very broad field. There are multiple modes of transportation. Safety, security, and efficiency are all important and can have complementary and competing relationships. Core elements that affect these three areas include carrier operations, shipper operations, material characteristics (including security sensitivity), packaging design and manufacture, human factors, regulatory structures, and human health and environmental impacts from potential releases (which involves routing issues). Defining a meaningful approach for prioritizing among research activities that are competing for limited funding is a challenge.

The proposed research prioritization framework is comprised of key attributes that try to collectively cover the various perspectives. These attributes are discussed, followed by the framework that combines them together. The framework is designed to be flexible; allowing practitioners to adjust the

relative influence of each of the attributes and their values. The attributes address three areas: benefit of the project, applicability and focus, and optionally, project cost.

Benefit

- Research Priority – at first glance, this attribute might seem somewhat redundant with the intent of the prioritization scheme; however, this framework is designed to be useful well beyond the next round of project selection. For example, there is no definitive long-term preference between understanding underlying issues such as accident or release probability or assessing the best approaches to implementing a risk reduction strategy such as certain focused inspection or enforcement strategies. This attribute allows the HMCRP Technical Oversight Panel to apply their own subjective assessment of the benefits of research in a particular area *without the need to weigh all the other relevant factors at the same time*. This is the primary attribute for capturing stakeholder interest in specific research topics and whether they believe that the problem or issue to be researched is timely and important.

- Significance of Expected Outcome – this key attribute is used to represent the type of product that the research is expected to produce and whether it closes a fundamental research gap, builds on recently completed work to advance the practice, or synthesizes prior work or provides insight into next steps.

- Practical Implementation Potential – as the HMCRP is intended to address "real-world, day-to-day operational issues," it is important to assess each research need or project in terms of how well it matches up with a practitioner's ability to implement the expected results. Some projects may be very important to advance the state of the practice, but still will require further research before there are results for practical implementation. Such a project would not score very high for this attribute.

- Clarity of Deliverables – when dealing with specific research needs or projects, the ability to precisely define project deliverables before the outset of research can be indicative of a project's potential success and utility.

Applicability and Focus

- Primary Stakeholder Focus – as with the 'modal applicability' attribute, leveraging the value of research projects across multiple stakeholder groups is desired. Here, stakeholders are the shippers, carriers, regulators, and researchers. This is also consistent with the previously selected HMCRP projects that cover a wide range of topics and issues, rather than narrowing the focus on a smaller set of problems. Maintaining a broad stakeholder base will also aid in continued support for the HMCRP.

- Modal Applicability – As the HMCRP is multi-modal, the emphasis should be on leveraging the cooperative aspects of research proposals. While there is plenty of research that is focused on only a single mode, it would be preferred if the research could support multiple modes. In other words, of two similarly ranked projects (based on the other attributes), it would be more desirable to pursue the one that affected more modes. Intermodal projects are captured through the consideration of all the modes involved, rather than an explicit value.

- Material Focus – even though risk has an important likelihood component, there is a great amount of emphasis placed on issues involving high-hazard materials due to the extent of the potential consequences that could result from a release. This attribute can give enhanced

emphasis to high-hazard materials and to research that addresses the entire gamut of hazardous materials. This attribute addresses entire classes or types of materials in addition to high-hazard materials, for example, all corrosives or all liquid hazmat.

Cost

- Project Budget – the amount of funding that is required to successfully complete a research project. For many users of this prioritization scheme, cost can be used to select between projects that have been ranked without consideration to their estimated budget. In other words, projects are ranked on their benefits alone and then the available funding is allocated among the higher-ranking projects.

  A high-cost project would need to provide significant value to be selected in this competitive environment. Of course, consideration should be given to whether the project can be divided into smaller projects, perhaps executed over several years and funding cycles.

Table 6 presents the proposed research prioritization framework with all its components, including several research-related attributes, the qualitative rankings/ratings possible for each attribute, and the attribute weights. Overall scores for each potential research need or project to be prioritized are determined by summing the product of the selected attribute value for that project and the weight assigned to that attribute. There is some conceptual overlap across the different attributes, but they help to emphasize the importance of some key elements. This framework is designed for prioritizing problem statements as well as specific projects.

Table 6. Research Prioritization Framework

Attribute	Attribute Values		Attribute Weight (%)
Benefit			
Research Priority	High-priority need	100	0.25
	Medium-priority need	50	
	Low-priority need	20	
	Not a priority need	0	
Significance of Expected Outcome	Fills a fundamental knowledge gap	100	0.20
	Builds on prior work to advance the practice	60	
	Synthesizes work in an area OR provides insight into next steps	30	
	Basic implementation of previously completed research	0	
Practical Implementation Potential	Direct applicability to practitioners, (e.g., checklist)	100	0.15
	Practitioners can apply results with some additional work (e.g., guidebook)	80	
	Applicable to practitioners, but results are not formatted for direct implementation	40	
	Useful to researchers, but not practitioners	0	

Attribute	Attribute Values		Attribute Weight (%)
Clarity of Deliverables	Clearly defined deliverables	100	0.10
	Broad deliverables that can be more clearly defined with additional work before project initiation	70	
	Broad deliverables that can be more clearly defined after the project is in progress (e.g., prior to a second phase)	30	
	Poorly defined deliverables	0	
Applicability and Focus			
Primary Stakeholder Focus	Shippers, carriers, regulators/enforcement, responders, packaging manufacturers, infrastructure owners (any five)	100	0.05
	Shippers, carriers, regulators/enforcement, responders, packaging manufacturers, infrastructure owners (any four)	80	
	Shippers, carriers, regulators/enforcement, responders, packaging manufacturers, infrastructure owners (any three)	60	
	Shippers, carriers, regulators/enforcement, responders, packaging manufacturers, infrastructure owners (any two)	40	
	Shippers, carriers, regulators/enforcement, responders, packaging manufacturers, infrastructure owners (any one)	20	
Modal Applicability	All modes (highway, rail, maritime, air, pipeline) or not mode-specific	100	0.05
	Three or four modes	60	
	Two modes	30	
	Single mode	10	
Material Focus	Applicable to all or most high-hazard materials	100	0.05
	Applicable to all/any hazmat OR one or two high-hazard materials	70	
	Applicable to a type of non-high-hazard hazmat (e.g., all liquid hazmat, all corrosive materials)	40	
	Applicable to only specific (and non-high-hazard) materials	20	

Attribute	Attribute Values		Attribute Weight (%)
Cost *(Optional)*			
Project Budget	$50K or less	100	0.15
	$100K or less	90	
	$150K or less	80	
	$200K or less	70	
	$250K or less	60	
	$300K or less	50	
	$350K or less	40	
	$400K or less	30	
	$450K or less	20	
	$500K or less	10	
	More than $500K	0	

The different values for each attribute in Table 6 (and the attribute weights) were selected by the project team based on subject matter expertise and input from the stakeholders interviewed for earlier tasks in this project. The team recommends a non-uniform distribution of values for each attribute (column 3 in the table) to represent the relative differences between them. As the weights are expressed in percentages, the maximum 'score' for a research need or problem is 100 if project budget is included (85 if not). Some of the attributes can be assigned values of zero and others have a defined non-zero minimum. In addition to the two approaches that do or do not include the project budget, a third alternative was considered that may appeal to some users: a benefit-cost ratio. As the benefits are unitless and the costs are not, the project team determined that dividing the estimated benefits by the logarithm of the project costs yielded the most reasonable results.

As an example, consider a $250,000 research project that looks at evaluating different testing methods for types of tank steel to determine how best to apply the different methods to cargo tank, tank car, and possibly pipeline testing procedures. The scope includes requirements for testing intervals, determining specifications and limitations to which the tests are applicable, and specific procedures for conducting the tests, including temperature and other relevant factors.

Based on the stakeholder interviews, recent and current research on testing methods has been quite common. Therefore, a value of 20 is assigned to the 'Research Priority' attribute to represent a 'Low-priority need.' Multiplying this rating value by the assigned weight of 25 percent results in an attribute score of 5. Plugging in sample values for the other attributes yields the following calculations for the three different approaches:

Cost not considered Score = Benefit only	Score = (Research Priority)(0.25) + (Significance of Expected Outcome)(0.2) + (Practical Implementation Potential)(0.15) + (Clarity of Deliverables)(0.05) + (Primary Stakeholder Focus)(0.05) + (Modal Applicability)(0.05) + (Material Focus)(0.05)
	Score = (20)(0.25) + (60)(0.2) + (100)(0.15) + (70)(0.10) + (60)(0.05) + (60)(0.05) + (100)(0.05) + (60)(0.15) = **50.00**
Cost incorporated as a project attribute Score = Benefit including cost component	Score = (Research Priority)(0.25) + (Significance of Expected Outcome)(0.2) + (Practical Implementation Potential)(0.15) + (Clarity of Deliverables)(0.05) + (Primary Stakeholder Focus)(0.05) + (Modal Applicability)(0.05) + (Material Focus)(0.05) + (Project budget)(0.15)
	Score = (20)(0.25) + (60)(0.2) + (100)(0.15) + (70)(0.10) + (60)(0.05) + (60)(0.05) + (100)(0.05) + (60)(0.15) = **59.00**
Uses benefit-cost ratio Score = Benefit / log(Project budget)	Score = [(Research Priority)(0.25) + (Significance of Expected Outcome)(0.2) + (Practical Implementation Potential)(0.15) + (Clarity of Deliverables)(0.05) + (Primary Stakeholder Focus)(0.05) + (Modal Applicability)(0.05) + (Material Focus)(0.05)] / log(Project budget)
	Score = [(20)(0.25) + (60)(0.2) + (100)(0.15) + (70)(0.10) + (60)(0.05) + (60)(0.05) + (100)(0.05)] / log(60) = **28.12**

In developing the framework, two other constructs were considered that relate to a tiered approach, rather than the integrated approach presented here. In the first, there would be two tiers that would prioritize on one set of attributes and then use a second set of attributes to order those in the first set. In the second approach, there would be a separate prioritization among a set of broad areas such as data, emergency planning, and first response (the three areas listed in TRB Special Report 283), with sub-prioritization performed within them. Ultimately, the project team believed that the framework attributes and uneven weightings shown in Table 6 adequately incorporate the benefits of these alternative approaches.

In practice, the HMCRP Technical Oversight Panel or any other research-sponsoring organization could begin their deliberations on prioritization with each participant scoring each project independently and then coming together for discussion. Alternatively, the entire process could be handled as a group exercise.

8. Prioritized Research Projects

The research projects described in Section 6.3 were ranked using the prioritization framework presented in Section 7. The project team members independently rated each attribute for each project and then these were collectively reviewed and discussed to reach a consensus. The projects shown in Table 7 are sorted based on the framework without the Project Budget attribute, but the ranks and scores that include the cost attribute are also shown. The first column in Table 7 lists the section in this report that contains the research project statement. The scores that the project team assigned to each attribute for each project are provided in Appendix C.

Table 7. Prioritized Research Projects

Section	Project	Overall Score			Rank		
		Excl. Cost	Incl. Cost	Using B/C	Excl. Cost	Incl. Cost	Using B/C
6.3.1.1	Identifying Sources and Types of Undeclared Hazmat	78.50	89.00	34.12	1	1	1
6.3.1.2	Human Factors Issues for Hazardous Cargo Handling	75.50	84.50	31.49	2	2	3
6.3.2.1	Improving Local Emergency Planning Committees	72.50	83.00	31.51	3	3	2
6.3.7.1	Develop Guidelines for Testing, Maintaining, and Operating Chemical Transfer Hoses	64.00	71.50	25.84	4	5	5
6.3.2.2	Initial Actions by Hazmat First Responders	63.50	71.00	25.63	5	6	6
6.3.4.1	Addressing Acquisition of Proprietary Hazmat Commodity Flow Data	61.50	73.50	28.26	6	4	4
6.3.5.1	Travel Times of Hazmat in Waterways	58.50	69.00	25.42	7	7	7
6.3.9.2	Development of Guidance Documents for State and Local Pipeline Oversight and Response	56.00	66.50	24.34	8	8	9
6.3.8.1	Chemical-Based Risk Assessment Model	55.00	62.50	22.20	9	11	13
6.3.3.1	Distribution Facility Risk Assessment	54.00	61.50	21.80	10	14	14
6.3.8.4	Changes in Public Perception of Risk in Hazmat	53.00	63.50	23.03	11	9	10
6.3.2.4	Systematic Approach for the Development and Use of Hazmat Commodity Flow Data in Emergency Response Planning	52.50	63.00	22.82	12	10	11
6.3.4.2	Assessing the Impact of Global Warming on Hazmat Commodity Flow	52.00	62.50	22.60	13	11	12
6.3.9.1	Effects of Multiple Regulatory Schemes on Pipeline Operations	50.00	60.50	21.73	14	15	15
6.3.7.2	Commercial Explosives Testing	49.00	62.50	24.50	15	11	8
6.3.8.3	Comparative Hazmat Risk Assessment across Modes	49.00	56.50	19.78	15	19	19
6.3.2.5	Improved Hazmat Placarding Technologies	48.00	58.50	20.86	17	17	17
6.3.6.1	Impact of Hazmat Transportation Research on Public Policy	47.50	58.00	20.64	18	18	18
6.3.8.2	Measuring the Potential Benefit of Hazmat Risk Mitigation Strategies	47.00	59.00	21.60	19	16	16
6.3.7.3	Risk-Based Analysis of High-Strength Pipeline Steel	44.50	55.00	19.34	20	20	21
6.3.5.2	Estimating the Costs of Hazmat Incidents	43.00	55.00	19.76	21	20	20
6.3.2.3	Rural Hazmat Emergency Response	42.50	53.00	18.47	22	22	22

Appendix A

HM-10 and HM-12 Combined Questionnaire

Note that the items in blue do not necessarily need to be asked and are intended to facilitate the discussion with the interviewee(s).

#	Question	Comment/Response
	General Hazmat Transportation Research	
A1	What are your recent and current hazmat transportation research projects (since 2009)? Provide a title and a description.	[Since 2009] [Number each project for reference in subsequent questions]
A2	What hazmat transportation research projects does your organization intend to pursue in the next 5 years?	
A3	For each, what is/was the motivation for conducting this research? Did you have other options? Who is the audience?	
A4	[If not obvious from above] How would you categorize each project? *Context areas:* a. Regulatory/Enforcement b. Business c. Economic Response d. Safety e. Security Assessment Operations/Training *Subject areas:* a. Packaging b. Routing c. Emergency d. Enforcement e. Risk f.	[Use both areas; if either is Other, please list] *Project* *Content area* *Subject area*
A5	What is the status of each current or planned project?	
A6	What is the planned completion date for each current or future project?	
A7	Do you repeat this research to keep it current? If so, how often?	
A8	For each project, are you conducting the work in-house or have you hired a consultant or contractor? If the latter, which company?	
A9	Who is the primary point of contact (POC) for each project?	
A10	For each project, do you maintain online project information (status updates, project documents, etc.)? If so, what is the URL and what information is posted there? How often is it updated?	
A11	How is/was your research funded?	
A12	For each project, is the research proprietary or security-sensitive (i.e., can it be widely shared)? What are the criteria for need-to-know?	

#	Question	Comment/Response
B1	What research needs or problem areas do you think are important, but that your organization does not currently plan to pursue?	
B2	What are the reasons or obstacles that are preventing you from pursuing each of these?	
	— Risk Assessment Questions Omitted —	
	All	
G1	Do you communicate the results of your risk assessments internally or externally?	[To first responders, sales representatives, enforcement, in developing proposed regulations, etc.?]
G2	What improvements in risk assessment methodologies, available information, or data collection would be most helpful to your organization? *Examples of limitations:* a. Applicability to a single mode b. Cannot support integration of safety and security c. Applicability only to large shipments or locations of frequent operations d. Large uncertainty makes clear choices among alternatives difficult e. Historical data do not reflect changing conditions/trends f. Applicable to generic hazard class(es) and not specific materials	[cover improving perceived limitations or gaps]
G3	What are the main barriers you see for using or performing risk assessments?	[E.g., legal ramifications from doing a benefit-cost analysis]
G4	Are there any specific organizations or people that you recommend we contact?	[Have a copy of the master interview list available.]

Appendix B

Related Projects

Organization & Project Title	Related Projects
ACADEMIC/RESEARCH	
National Center for Risk and Economic Analysis of Terrorism Events (CREATE)	
1. Chlorine Spill Resource Allocation	17, 79, 83
2. Nuclear Material Resource Allocation	14, 107
3. TransNEMO	46
4. Transportation Resiliency	46, 110
National Pipeline Safety & Operations Research Center	
5. Waterway policy and pipeline operation	6
6. Pipeline policy and infrastructure expansion	5
7. Use of demographic data in pipeline research	
8. Marine pipeline research	10, 125, 127, 141, 148, 150, 151, 154
9. Advanced leak detection technologies	150
10. Pipeline applications of NDE technologies	8, 56, 102, 135, 136, 155
11. Third-party damage of pipelines	121, 122, 123, 126, 143, 145
12. Standards for static testing of pipelines	128, 146, 149, 156
13. Application of technologies for pipeline monitoring and communication	22, 121, 122, 123, 125, 126, 132, 140, 141, 150
Texas A&M University	
14. An integrated vulnerability-based detection/interception model for the protection of regional infrastructure from covert attack	46, 2, 126
15. Utilization of accident databases and fuzzy sets to estimate frequency of Hazmat transport accidents	177
Texas Transportation Institute	
16. Managing the Movements of Hazardous Materials Shipments through Texas Population Centers	25, 26
Transportation Research Board (TRB) - Hazardous Materials Cooperative Research Program (HMCRP)	
17. A Guide for Assessing Emergency Response Needs and Capabilities for Hazardous Materials Releases (HM-03)	19, 25, 26, 1
18. Accident Performance Data of Bulk Packages Used for Hazardous Materials Transportation (HM-07)	82, 94, 177
19. Best Practices in Hazardous Materials Pipeline Emergency Response Plans (HM-15)	17
20. Consolidated Security Credential for Persons Who Transport Hazardous Materials (HM-08)	
21. Current Hazardous Materials Transportation Research and Future Needs (HM-10)	28, 120, 165, 167, 172

Organization & Project Title	Related Projects
22. Emerging Technologies Applicable to Hazardous Materials Transportation Safety and Security (HM-04)	13, 36, 41, 48, 49, 51, 52, 73, 112, 111, 113, 121, 122, 123, 125, 126, 128, 132, 136, 140, 141, 142, 143, 145, 150, 155, 180, 182, 186
23. Evaluating the Effectiveness of Hazmat Transportation Training (HM-17)	31
24. Evaluation of the Use of Electronic Shipping Papers for Hazardous Materials Shipments (HM-05)	117
25. Guidebook for Developing Sub-national Commodity Flow Data (NCFRP 20)	16, 17, 26
26. Hazardous Materials Commodity Flow Data and Analysis (HM-01)	16, 17, 25
27. Hazardous Materials Transportation Incident Data for Root Cause Analysis (HM-02)	74, 76, 94, 167, 177
28. Hazardous Materials Transportation Risk Assessment: State of the Practice (HM-12)	21, 120, 167
29. Improved Classification and Categorization of Water-Reactive Substances (HM-14)	
30. Improving Local Community Recovery from Disastrous Hazardous Materials Transportation Incidents (HM-11)	110
31. Model Post-Secondary Education Curricula for the Transportation of Hazardous Materials (HM-16)	23, 159
32. Role of Human Factors in Preventing Cargo Tank Truck Rollovers (HM-13)	89, 113
33. Soil and Groundwater Impacts of Chemical Mixture Releases from Hazardous Materials Transportation Incidents (HM-06)	40
34. Technical Assessment of Dry Ice Limits on Aircraft (HM-09)	
University of Buffalo	
35. Value-at-Risk Model for Hazardous Material Transportation	43
University of Illinois Urbana-Champaign	
36. Ambient intelligence for freight railroads	22
37. Communication and Interpretation of Results of Railroad Hazardous Materials Transportation Route Risk Analyses	
38. Effect of Train Speed on Risk Analysis of Transporting Hazardous Materials by Rail	
39. Optimizing railroad tank car safety design to reduce hazardous materials transportation risk	50, 51, 52, 55, 62, 65, 66, 67, 68, 70, 73, 77, 170, 173
40. An environmental screening model to assess the consequences to soil and groundwater from railroad-tank-car spills of light non-aqueous phase liquids (LNAPL)	33
University of Kentucky/Kentucky Transportation Center	
41. Fedtrak	22, 42, 46, 111, 182, 187, 185, 186
42. Marine transportation of hazardous materials	41, 111

Organization & Project Title	Related Projects
Vanderbilt University	
43. A proof of concept study for analyzing hazmat transportation risks in an all-hazards environment	35, 71, 161, 162, 176, 187, 185
44. Climate Change Impacts on Transportation Infrastructure	45
45. Determining Climate Change Thresholds	44
46. Terrorism risk assessment methodology	14, 41, 71, 3, 4, 80, 84, 93, 108, 109, 110, 111, 161, 162, 176, 187, 185
Virginia Polytechnic Institute	
47. Development of Hazardous Materials Shipper Prioritization Application	
CARRIERS - HIGHWAY	
Sentinel Trucking	
48. Advanced Safety Technologies	22, 78, 89, 112, 113, 180, 182, 187, 186
CARRIERS - RAIL	
Association of American Railroads (AAR) Tank Car Committee	
49. Alternatives to Qualification Markings	22, 53, 57
50. Bottom Outlet Performance	39, 55
51. Consider Modifications to Current Steel Specifications	22, 39, 52, 73, 77, 170, 173
52. Consider New Steels for Tank Car Tanks	22, 39, 51, 73, 77, 170, 173
53. Consider Permanent Marking for AAR Class Cars	49, 57
54. Consider Responsibilities of Parties in Tank Car Maintenance	
55. Effects of Environmental Harmonics on Safety Relief Devices	39, 50, 61, 67
56. Evaluation and Use of Nondestructive Evaluation Techniques	10, 102, 135, 136, 155
57. Extended Life of Tank Cars	49, 53
58. Grounding Requirements for Tank Cars	
59. Non-Accident Release Program	65, 76, 95
60. Performance Standard for Surge Pressure Reduction Devices	68
61. Pressure Relief Valve Inspection Intervals	55, 67, 96
62. Recommended Practice for Joint Design	39
63. Replacement of Eyebolts during Qualification	65, 66
64. Review Allowable Materials of Tank Car Fasteners	101
65. Review Manway Cover Design for Non-Pressure Cars	39, 59, 63, 66
66. Review of Hinged and Bolted Manways	39, 63, 65
67. Review of the Design and Performance of Vacuum Relief Valves	39, 55, 61, 96
68. Safety Relief Devices Exposed to Commodity Surge	39, 60
69. Requirements for Installation of Surge Suppression Devices	
Association of American Railroads/Rail Research Foundation (AAR/RRF)	
70. Advanced Tank Car Collaborative Research Program (ATCCRP)	39, 104, 170
71. Rail Corridor Risk Management System (RCRMS)	46, 43, 80, 84, 81, 111, 161, 162, 176, 187, 185

Organization & Project Title	Related Projects
Association of American Railroads/Railway Supply Institute (AAR/RSI)	
72. Tank Car Operating Environment Test	
73. Impact Tests of Potential New Tank Steels	22, 39, 51, 52
74. Accident Data Analysis	27, 94, 177
75. Database of Railcar Inspection Results	
76. Examination of Non-Accident Releases (NARs)	27, 59, 79, 82, 95
77. Tank Car Fire-Related Safety Activities	39, 51, 52, 164, 170, 173
Union Pacific	
78. Product Substitutions	48
FEDERAL	
Department of Homeland Security (DHS) Chemical Security Analysis Center (CSAC)	
79. Behavior of Toxic Chemical Releases from Large Transportation Packages	76, 1, 82, 83
80. Chemical Infrastructure Risk Assessment (CIRA)	46, 71, 84, 93, 161, 162, 174, 187, 185
81. Increasing Safety of Hazardous Chemicals (ISHC)	71, 161, 162, 176, 187, 185
82. New Source Terms for Modeling Toxic Chemical Releases from Large Transportation Packages	18, 76, 79
83. Risk Estimation for Large-Scale Chlorine Road Transport Networks	1, 79, 83
Department of Homeland Security (DHS) Science and Technology Directorate (S&T)	
84. Chemical Terrorism Risk Assessment (CTRA)	46, 71, 80, 93, 161, 162, 187, 185
Federal Aviation Administration (FAA)	
85. Lithium Battery Research	86, 115
86. Measurement Study of Vibration and Temperature on Aircraft	85, 115
87. Preliminary Investigation of the Fire Hazard Inherent in Micro Fuel Cell Cartridges	
88. Flammability Assessment of Lithium-Ion and Lithium-Ion Polymer Battery Cells Designed for Aircraft Power Usage	
Federal Motor Carrier Safety Administration (FMCSA)	
89. Cargo Tank Research	32, 48, 113
90. Causes of Stress Corrosion Cracking of Nurse Tanks	92
91. Evaluation of Hazmat Safety Permit Program	162
92. Pinhole Leaks in Welds of Nurse Tanks	90, 128
Federal Railroad Administration (FRA)	
93. Hazmat Risk Assessment	46, 80, 84, 161
94. Post Accident Investigation	18, 27, 74
95. Loading/Unloading Ethanol, reducing NAR	59, 76
96. Liquid Flow Test for Valves	61, 67
97. Stub Sills	
98. Evaluation of Different Impactors on Different Tank Car Designs	39, 70, 73
99. Loading/Unloading of Molten Sulphur - best practices to reduce spills	

Organization & Project Title	Related Projects
100. Deformation Behavior of Welded Steel Sandwich Panels under Quasi-Static Loading	
101. Survivability of Railroad Tank Car Top Fittings in Rollover Scenario Derailments - Phase 2	64
102. Quantitative Nondestructive Testing of Railroad Tank Cars Using the Probability of Detection Evaluation Approach	10, 56, 135, 136, 155
103. Over-the-Road Testing of the Instrumented Tank Car - A Load Environment Study	
104. Engineering Studies on Structural Integrity of Railroad Tank Cars Under Accident Loading Conditions	70
105. Torsional Stiffness of Railroad Coupler Connections	
106. Emergency Escape Breathing Apparatus	
Nuclear Regulatory Commission (NRC)	
107. Spent Fuel	2
Oak Ridge National Laboratory (ORNL) Center for Transportation Analysis (CTA)	
108. GeoSAT: GeoSecurity Analysis Tool	46
109. Rail Cargo Screening Simulation Modeling and Analysis	46
110. Readiness and Resiliency Assessment	30, 46, 4
111. Tracking Barges Carrying Hazardous Cargo: Detecting Anomalies and Predicting Risky Situations	22, 41, 42, 46, 71, 161, 162, 187, 185
112. Regional Technology Integration Initiative	22, 48
Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Hazardous Materials Safety	
113. Cargo Tank Rollovers	22, 32, 48, 89
114. Composite Cylinder Life-Cycle In-Service Assessment	119, 171
115. Energetic Hazardous Materials Research	85, 86
116. Examination of HM Portable Tanks within Transportation System	
117. Feasibility of Implementing Electronic Shipping Papers	24
118. Hazardous Materials Cooperative Research Program (HMCRP)	all TRB projects
119. Long-Term Behavior, Failure Analysis & In-Service Testing of Composite Cylinders	114, 171
120. Research and Development Program Plan Development	21, 28
Pipeline and Hazardous Materials Safety Administration (PHMSA) Office of Pipeline Safety	
121. Acoustic-based Technology to Detect Buried Pipes	11, 13, 22
122. Advanced Development of PipeGuard Proactive Pipeline Damage Prevention System	11, 13, 22, 123, 126
123. Advanced Learning Algorithms for the Proactive Infrasonic Pipeline Evaluation Network (PIGPEN) Pipeline Encroachment Warning System	11, 13, 22, 122, 126
124. Compatibility of Non-Ferrous Metals with Ethanol	127, 137, 139, 144, 146, 149, 154, 156
125. Completion of Development of Robotics Systems for Inspecting Unpiggable Transmission Pipelines	8, 13, 22, 126, 129
126. Consolidated Research Program, Right of Way Automated Monitoring Threat Prevention	11, 13, 14, 22, 122, 123, 125, 132, 140

Organization & Project Title	Related Projects
127. Corrosion and Integrity Management of Biodiesel Pipelines	8, 124, 137, 139, 144, 146, 154
128. Cost-Effective Techniques for Weld Property Measurement and Technologies for Improving Weld HE and IGSCC Resistance for Alternative Fuel Pipelines	12, 22, 92, 129, 137, 138, 148
129. Dent Fatigue Life Assessment - Development of Tools for Assessing the Severity and Life of Dent Features	125, 128, 136, 142, 143
130. Design, Development, and Testing of Optimized Composite	131
131. Design, Development, and Testing of Optimized Composite 'Soft Crack Arrestors	130
132. Development and Field Testing of a Highly Sensitive Mercaptans Instrument	13, 22, 126
133. Development of a Limit States Standard for Onshore Pipelines	
134. Development of a Model to Accurately Predict the Conditions of Carrier Pipe within Casings Based on Conditions at the Casing Ends	
135. Development of Damage Severity for Pipeline Steel Inspection	10, 56, 102, 136, 155
136. Digital Imaging of Pipeline Mechanical Damage and Residual Stress	10, 22, 56, 102, 129, 135, 143, 145, 155
137. Effect of Microstructure of Pipeline Steels on Ductility and Fatigue Properties in High-Pressure Hydrogen Atmosphere	124, 127, 128, 139, 146, 149, 156
138. ERW Pipe Failure Study	128, 148
139. Feasibility of Chemical Inhibition of Ethanol SCC	124, 127, 137, 144, 146
140. Fuelfinder: Remote Leak Detector for Liquid Hydrocarbons	13, 22, 126
141. Integrated Internal Inspection and Cleaning Tool Technology for Pipelines	8, 13, 22, 150
142. Low-Cost, Full-Field Tool for In-Ditch Deformation Measurement	22, 129, 143
143. Low-Cost, Full-Field, Surface Profiling Tool for Mechanical Damage Evaluation	11, 22, 129, 136, 142
144. Modeling of Microbial Induced Corrosion on Metallic Pipelines Resulting from Biomethane & the Integrity Impact of Biomethane on Non-Metallic Pipelines	124, 127, 139, 146, 154
145. MWM-Array Characterization of Mechanical Damage and Corrosion	11, 22, 136, 155
146. New Design and Construction Techniques for Transportation of Ethanol and Ethanol/Gasoline Blends in New Pipelines	12, 124, 127, 137, 139, 144, 156
147. Odorant Effectiveness	158
148. Optimization of Multi-Wire GMAW Welding Procedure for Heavy-Wall Offshore Pipeline Construction	8, 128, 138
149. Performance Evaluation of High-Strength Steel Pipelines for High-Pressure Gaseous Hydrogen Transportation	12, 124, 137
150. Pig Mounted Trials for Internal Corrosion Monitoring Fluidized Sensors	8, 9, 13, 22, 141
151. Quality Management Systems for Pipelines	8
152. Realistic Strain Capacity Models for Pipeline Construction and Maintenance	
153. Selection of Pipe Repair Methods	
154. Setting Safe Limits on Biodiesel Constituents for Pipeline Integrity	8, 124, 127, 144

Organization & Project Title	Related Projects
155. Stress and Geometry Imaging from Outside the Pipeline	10, 22, 56, 102, 135, 136, 145
156. Stress Corrosion Cracking of Pipeline Steels in Fuel Grade Ethanol and Blends	12, 124, 137, 146, 157
157. Technical and Economic Feasibility of Preventing SCC through Control of Oxygen	156
158. Landfill and Wastewater Treatment Renewable Natural Gas (RNG) Chemical and Physical Profiling: Increasing the Database Set	147
GENERAL HAZMAT	
Council on the Safe Transportation of Hazardous Articles (COSTHA)	
159. Enhancing the Image	31
160. Reverse Logistics	
INTERNATIONAL	
Transport Canada - Surface and Intermodal Security Directorate	
161. Dangerous Goods Security Risk Assessment	46, 43, 71, 80, 84, 81, 93, 111, 176
162. Developing a dangerous goods transportation policy	46, 43, 71, 80, 84, 81, 91, 111
Transport Canada - Transport Dangerous Goods Directorate (TDG)	
163. Assessing the Toxicity Risks of the Transport of Petroleum Sour Crude Oil	
164. BLEVE Prevention for Highway Tanks Transporting Liquefied Petroleum Gas and Propane	77, 173
165. Dangerous Goods Research Collection and Information Management	21
166. Domino Effect Project - Investigation of Multiple Tank Car Rollover Derailments Related to Double Shelf Couplers and its Solutions	
167. Handling Dangerous Goods - Issue Brief	21, 27, 28, 184
168. Highway Tank Vent and Burn Project - Emergency Offloading of LPG Containers Using the Vent and Burn Technique	
169. Investigation of Multiple Tank Car Rollover Derailments Related to Double Shelf Couplers and its Solutions	
170. Next Generation Tank-Car Project - Heat and Mass Transfer Model for Polyurethane Foams used for Rail Tank Car Thermal Protection	39, 51, 52, 70, 77, 173
171. Research and risk analysis of the transport of foreign specification cylinders removed from ships for refilling in Canada	114, 119
172. Review of Existing Dangerous Goods Transportation Research, Experts List, and Identification of Future Needs	21
173. Tank Car Emissivity Project - Study the Thermal Emissivity and the Absorptivity of Rolled Tank Car Steel Plates and Liquid Propane When Involved in a Fire	39, 51, 52, 77, 164, 170
INTERNATIONAL/ACADEMIC	
Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation (CIRRELT)	
174. A bi-level representational model of hazardous material supply chains	80, 175

Organization & Project Title	Related Projects
175. A lead-time approach to rail-truck intermodal transportation of dangerous goods	174
176. A Tactical Planning Model for Railroad Transportation of Dangerous Goods	46, 43, 71, 81, 161
177. Cross-analysis of hazmat road accidents using multiple databases	15, 18, 27, 74
178. Safety management in hazardous materials logistics	
179. Toll policies for mitigating hazardous materials transport risk	
SHIPPERS	
Center for Chemical Process Safety	
180. Definitions for Inherently Safer Technology in Production, Transportation, Storage and Use	22, 48
Chlorine Institute	
181. Chlorine Industry Liquid Pumping Methods	
DuPont	
182. GPS Hazmat Shipment Tracking	22, 41, 48
183. Ride-Tight	
184. Standardized Program for Loading and Unloading Operator Training and Certification	167
Institute of Makers of Explosives (IME)	
185. Continuous development of standards and best practices	41, 46, 43, 71, 80, 84, 81, 111
186. Shipment and Truck Tracking	22, 41, 48
187. Institute of Makers of Explosives Safety Analysis for Risk (IMESAFR)	
STATE	
National Conference of State Legislatures	
188. Alliance for Uniform Hazmat Transportation Procedures	

Appendix C

Research Project Scoring

Rank (Excl. Cost)	Project	Research Priority	Significance of Expected Outcome	Practical Implementation Potential	Clarity of Deliverables	Primary Stakeholder Focus	Modal Applicability	Material Focus	Project Budget
1	Identifying Sources and Types of Undeclared Hazmat	100	100	80	100	60	100	70	$200K
2	Human Factors Issues for Hazardous Cargo Handling	100	100	80	70	60	100	70	$250K
3	Improving Local Emergency Planning Committees	100	100	80	100	40	30	40	$200K
4	Develop Guidelines for Testing, Maintaining, and Operating Chemical Transfer Hoses	50	100	100	100	60	30	40	$300K
5	Initial Actions by Hazmat First Responders	100	60	80	100	20	30	40	$300K
6	Addressing Acquisition of Proprietary Hazmat Commodity Flow Data	100	60	40	70	60	100	70	$150K
7	Travel Times of Hazmat in Waterways	50	100	40	100	60	100	40	$200K
8	Development of Guidance Documents for State and Local Pipeline Oversight and Response	50	100	80	70	40	10	40	$200K
9	Chemical-Based Risk Assessment Model	50	60	80	70	60	100	70	$300K
10	Distribution Facility Risk Assessment	50	60	80	70	40	100	70	$300K
11	Changes in Public Perception of Risk in Hazmat	50	60	80	70	60	60	70	$200K
12	Systematic Approach for the Development and Use of Hazmat Commodity Flow Data in Emergency Response Planning	100	30	40	70	40	60	70	$200K

Rank (Excl. Cost)	Project	Research Priority	Significance of Expected Outcome	Practical Implementation Potential	Clarity of Deliverables	Primary Stakeholder Focus	Modal Applicability	Material Focus	Project Budget
13	Assessing the Impact of Global Warming on Hazmat Commodity Flow	20	100	40	100	80	100	40	$200K
14	Effects of Multiple Regulatory Schemes on Pipeline Operations	50	100	40	70	40	10	40	$200K
15	Commercial Explosives Testing	50	60	40	70	100	60	70	$100K
15	Comparative Hazmat Risk Assessment across Modes	50	60	40	70	60	100	70	$300K
17	Improved Hazmat Placarding Technologies	50	60	40	70	80	60	70	$200K
18	Impact of Hazmat Transportation Research on Public Policy	20	60	80	70	60	100	70	$200K
19	Measuring the Potential Benefit of Hazmat Risk Mitigation Strategies	50	30	80	30	100	100	70	$150K
20	Risk-Based Analysis of High-Strength Pipeline Steel	50	30	40	70	60	100	100	$200K
21	Estimating the Costs of Hazmat Incidents	50	60	40	70	60	10	40	$150K
22	Rural Hazmat Emergency Response	20	30	80	70	80	100	70	$200K

Acronyms and Abbreviations

AAR – Association of American Railroads

ABS – American Bureau of Shipping

ACC – American Chemistry Council

AEI – automatic equipment identification

AFFTAC – Analysis of Fire Effects on Tank Cars

AHRM – all-hazards risk management

ASME – American Society of Mechanical Engineers

ARA – Applied Research Associates, Inc.

ATA – Air Transportation Association

ATA – American Trucking Association

ATCCRP – Advanced Tank Car Collaborative Research Program

ATRI – American Transportation Research Institute

BAA – broad agency announcement

BLEVE – boiling liquid expanding vapor explosion

BMT – BMT Fleet Technology, Ltd.

BP – British Petroleum

BTS – Bureau of Transportation Statistics

CalEMA – California Emergency Management Agency

CCPS – Center for Chemical Process Safety

CDC – Certain Dangerous Cargo

CEESI – Colorado Engineering Experiment Station, Inc.

CFATS – Chemical Facility Anti-Terrorism Standards

CFR – Code of Federal Regulations

CGA – Compressed Gas Association

CHARM – Coordinated Hazardous Atmospheric Release Modeling

CIRA – Chemical Infrastructure Risk Assessment

CIRRELT – Interuniversity Research Centre on Enterprise Networks, Logistics and Transportation

COSTHA – Council on the Safe Transportation of Hazardous Articles

CPR – conditional release probability

CREATE – National Center for Risk and Economic Analysis of Terrorism Events

CSAC – Chemical Security Analysis Center

CTRA – Chemical Terrorism Risk Assessment

CVSA – Commercial Vehicle Safety Alliance

DCPD – Domestic Chemical Defense Policy

DGAC – Dangerous Goods Advisory Council

DHS – Department of Homeland Security

DNDO – Domestic Nuclear Detection Office

DNV – Det Norske Veritas

DOD – Department of Defense

DOT – Department of Transportation

EEBA – emergency escape breathing apparatus

EMC^2 – Engineering Mechanics Corporation of Columbus

EPA – Environmental Protection Agency

ERW – electric resistance weld

ESI – Engineering Systems, Inc.

FAA – Federal Aviation Administration

FEMA – Federal Emergency Management Agency

FGE – fuel grade ethanol

FMCSA – Federal Motor Carrier Safety Administration

FRA – Federal Railroad Administration

GIS – geographic information system

GMAW – gas metal arc welding

GPS – Global Positioning System

GTI – Gas Technology Institute

HAS – HAS Engineers and Scientists

HE – hydrogen embrittlement

HM-ACCESS – Hazardous Materials - Automated Cargo Communications for Efficient and Safe Shipments Initiative

HMCFS – Hazardous Materials Commodity Flow Study

HMCRP – Hazardous Materials Cooperative Research Program

HPAC – Hazard Prediction and Assessment Capability

IAFC – International Association of Fire Chiefs

IAPC – International Chiefs of Police

IGSCC – intergranular stress corrosion cracking

IME – Institute of Makers of Explosives

IMESAFR – Institute of Makers of Explosives Safety Analysis for Risk

IRVMC – US Coast Guard Inland River Vessel Movement Center

ISHA – Increasing Safety of Hazardous Chemicals

IST – inherently safer technology

ITS JPO – Intelligent Transportation Systems Joint Program Office

IVODGA – International Vessel Operations Dangerous Goods Association

JHU APL – Johns Hopkins University Applied Physics Laboratory

KTC – Kentucky Transportation Center

LEPC – local emergency planning committee

LNAPL – light non-aqueous phase liquid

LPG – liquid petroleum gas

LRFD – load and resistance factor design

MARAD – Maritime Administration

MWM – meandering winding magnetometer

NAERG – North American Emergency Response Guidebook

NAPL – non-aqueous phase liquid

NAR – non-accident release

NCFRP – National Cooperative Freight Research Program

NCSL – National Council of State Legislatures

NDE – nondestructive examination

NHTSA – National Highway Traffic Safety Administration

NITL – The National Industrial Transportation League

NPSORC – National Pipeline Safety and Operations Research Center

NRC – Nuclear Regulatory Commission

NTSB – National Transportation Safety Board

NTTC – National Tank Truck Carriers, Inc.

OHMS – PHMSA Office of Hazardous Materials Safety

OPS – PHMSA Office of Pipeline Safety

ORNL CTA – Oak Ridge National Laboratory Center for Transportation Analysis

OSHA – Occupational Safety and Health Administration

PCC – Post Construction Committee

PHMSA – Pipeline and Hazardous Materials Safety Administration

PIGPEN – Proactive Infrasonic Pipeline Evaluation Network

POC – point of contact

QMS – quality management systems

RDT – Office of Research, Development, and Technology

RFA – Renewable Fuels Association

RFID – radio frequency identification

RITA – Research and Innovative Technology Administration

RNG – renewable natural gas

RRF – Railroad Research Foundation

RSI – Railway Supply Institute

S&T – Science and Technology Directorate

SAIC – Science Applications International Corporation

SARMA – Security Analysis and Risk Management Association

SBD – strain-based design

SBIR – Small Business Innovation Research Program

SCC – stress corrosion cracking

SDDC – Surface Deployment and Distribution Command

SNF – spent nuclear fuel

SSWG – Stub Sill Working Group

TCOE-TF – Tank Car Operating Environment Task Force

TDG – Transport Canada Transport Dangerous Goods Directorate

TRANSCAER – Transportation Community Awareness and Emergency Response

TRB – Transportation Research Board of the National Academies

TSA – Transportation Security Administration

TTCI – Transportation Technology Center, Inc.

USCG – US Coast Guard

USPS – US Postal Service

USTRANSCOM – United States Transportation Command

VaR – value at risk

VOHMA – Vessel Operators Hazardous Materials Association

Volpe – John A. Volpe National Transportation Systems Center

VRT – Visual Risk Technologies, Inc.

Index