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John A. Volpe National Transportation Systems Center
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13. ABSTRACT (Maximum 200 words)

This report documents a study of the application of information technology to emergency response for hazardous materials incidents. The focus of the study is on the information needs of first responders (i.e., those responders who are typically first on the site of a hazardous materials incident.) Chapter 1 is an introduction to the project containing a discussion of background and objectives. Chapters 2 through 5 provide summaries on information requirements of first responders, relevant technologies, existing or pending projects of potential relevance, and candidate test scenarios and information architectures, respectively. In Chapter 6 there is a detailed discussion of the key issues identified in the study regarding hazardous materials information systems pilot testing. Chapter 7 is a summary of the report based on stakeholder inputs, related projects, and evolving technology applications.

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PREFACE

This report examines the application of information technology to emergency response for hazardous materials incidents, with a focus on the needs and requirements of first responders. The report implements Recommendation 3 in Special Report 239, *Hazardous Materials Shipment Information for Emergency Response,* prepared by the Transportation Research Board for the U.S. Department of Transportation (U.S. DOT), which suggests that the U.S. DOT "...systematically investigate opportunities for application of information technology to aid emergency responders and reduce the costs of hazardous materials incidents."

This report was prepared by Alberto B. Calvo, Alan V. Fullerton, Jr., and Michael F. Vetter of TASC under Contract Number DTRS-57-93-00101, Technical Support Services (ORA), OMNI TTD Task No. RA 3026 with the Volpe National Transportation Systems Center (Volpe Center).

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METRIC/ENGLISH CONVERSION FACTORS

ENGLISH TO METRIC

LENGTH (APPROXIMATE)

1 inch (in) = 2.5 centimeters (cm)
1 foot (ft) = 30 centimeters (cm)
1 yard (yd) = 0.9 meter (m)
1 mile (mi) = 1.6 kilometers (km)

AREA (APPROXIMATE)

1 square inch (sq in, in^2) = 6.5 square centimeters (cm^2)
1 square foot (sq ft, ft^2) = 0.09 square meter (m^2)
1 square yard (sq yd, yd^2) = 0.8 square meter (m^2)
1 square mile (sq mi, mi^2) = 2.6 square kilometers (km^2)
1 acre = 0.4 hectare (ha) = 4,000 square meters (m^2)

MASS - WEIGHT (APPROXIMATE)

1 ounce (oz) = 28 grams (gm)
1 pound (lb) = .45 kilogram (kg)
1 short ton = 2,000 pounds (lb) = 0.9 tonne (t)

VOLUME (APPROXIMATE)

1 teaspoon (tsp) = 5 milliliters (ml)
1 tablespoon (tbsp) = 15 milliliters (ml)
1 fluid ounce (fl oz) = 30 milliliters (ml)
1 cup (c) = 0.24 liter (l)
1 pint (pt) = 0.47 liter (l)
1 quart (qt) = 0.96 liter (l)
1 gallon (gal) = 3.8 liters (l)
1 cubic foot (cu ft, ft^3) = 0.03 cubic meter (m^3)
1 cubic yard (cu yd, yd^3) = 0.76 cubic meter (m^3)

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°C=5/9(°F - 32)

METRIC TO ENGLISH

LENGTH (APPROXIMATE)

1 millimeter (mm) = 0.04 inch (in)
1 centimeter (cm) = 0.4 inch (in)
1 meter (m) = 3.3 feet (ft)
1 meter (m) = 1.1 yards (yd)
1 kilometer (km) = 0.6 mile (mi)

AREA (APPROXIMATE)

1 square centimeter (cm^2) = 0.16 square inch (sq in, in^2)
1 square meter (m^2) = 1.2 square yards (sq yd, yd^2)
1 square kilometer (km^2) = 0.4 square mile (sq mi, mi^2)
10,000 square meters (m^2) = 1 hectare (ha) = 2.5 acres

MASS - WEIGHT (APPROXIMATE)

1 gram (gm) = 0.036 ounce (oz)
1 kilogram (kg) = 2.2 pounds (lb)
1 tonne (t) = 1,000 kilograms (kg) = 1.1 short tons

VOLUME (APPROXIMATE)

1 milliliter (ml) = 0.03 fluid ounce (fl oz)
1 liter (l) = 2.1 pints (pt)
1 liter (l) = 1.06 quarts (qt)
1 liter (l) = 0.26 gallon (gal)
1 cubic meter (m^3) = 36 cubic feet (cu ft, ft^3)
1 cubic meter (m^3) = 1.3 cubic yards (cu yd, yd^3)

TEMPERATURE (EXACT)

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QUICK INCH-CENTIMETER LENGTH CONVERSION

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CENTIMETERS	0	1	2	3	4	5	6	7	8	9	10	11	12	13

QUICK FAHRENHEIT-CELSIUS TEMPERATURE CONVERSION

°F	-40°	-22°	-4°	14°	32°	50°	68°	86°	104°	122°	140°	158°	176°	194°	212°
°C	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°

For more exact and or other conversion factors, see NIST Miscellaneous Publication 286, Units of Weights and Measures. Price $2.50. SD Catalog No. C13 10286.

Updated 8/1/96

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EXECUTIVE SUMMARY

IMPETUS FOR STUDY. The 1990 Hazardous Materials Transportation Uniform Safety Act (HMTUSA) called for, among other things, a study of *hazardous materials shipment information*, with particular focus on the needs of emergency response (ER) personnel. The National Research Council's Transportation Research Board conducted the study for the Research and Special Programs Administration of the U.S. Department of Transportation (U.S. DOT) and prepared Special Report 239, *Hazardous Materials Shipment Information for Emergency Response.* One of that report's recommendations was that the U.S. DOT

> "...should, on an ongoing basis and in conjunction with the shipper and carrier industries and emergency responders, systematically investigate opportunities for application of information technology to aid emergency responders and reduce the costs of hazardous materials incidents." (Recommendation 3, pp. 2-3)

This current report documents the first such information technology study based on the Special Report 239 recommendation.

STUDY CONTEXT: Changing Technology; Widespread ER Efforts. Because information and telecommunications technologies continue to evolve extremely rapidly, some technologies covered in this report have been superseded by recent developments, or will be in the near future. Despite potential obsolescence, however, this report remains timely and relevant in several important ways. First, most technologies covered by the report remain current and could serve as deployment candidates in today's emergency response environment. Second, the discussions of the technologies identify companies, projects, or products that augment the report's role as an information compendium. Third, the report delineates the variety of ways in which emergency responders use different kinds of hazardous material (HAZMAT) information, with the technology requirements varying considerably among different uses.

As a further contextual note, a number of information technology and emergency response activities are currently underway in the United States. Many of these are supported by the U.S. DOT. For example, the DOT's Intelligent Transportation Systems Joint Program Office oversees more than 300 projects, tests, and studies investigating ways to apply information and telecommunications technology to numerous U.S. transport sector needs. Many of these projects, such as those dealing with incident detection, position location, and improved wireless voice/data communications, have emergency response applicability.

STUDY APPROACH. This information technology study encompassed three broad task areas: (1) a survey of response officials to identify their perceptions of what kinds of information are most needed and when, given a HAZMAT transport accident, (2) a comprehensive review of information/communication technologies that have potential applicability to emergency response situations, and (3) an analysis of which hardware-software configurations appear best suited to meeting response officials' needs in the case of an accident. The coverage of this study may be summarized as addressing: *what is needed*, *what is possible*, and *what is practical*.

KEY FINDINGS. Information Needs Fit Several Categories. After interviewing 13 nationally recognized emergency response experts, and conducting a workshop with another 16 active response community officials, the project team was able to categorize first responder information needs as fitting three general categories: (1) identification of the HAZMAT-related transportation incident, an example of which might be characterized by a dispatch communication such as "HAZMAT truck with Class 6 poison placard overturned near the school on Elm Street--leakage feared but not confirmed," (2) identification of the specific commodity (or commodities) and other manifest-related information, and (3) identification of the shipment's specific risks, including multiple product chemical reactions, possible worst case results and likely ways of avoiding them, and similar kinds of precaution considerations, given the specific product/shipment at hand. Responders may have other information needs as hazmat incidents are brought under control, but these are generally less critical than first response requirements.

Technology Use Varies With Information Needs. Although it is possible to apply advanced technology to almost any aspect of emergency response procedures, the need and practicality of doing so vary considerably from situation to situation. For example, the technology presently exists to outfit a truck or shipment with a self-activating alarm device (e.g., a two-inch square radio transponder tag) and even with a position location device that could directly inform local emergency response officials of an unfolding incident. Tagging all vehicles or shipments and equipping all response officials to receive tag-released data from a threatened vehicle, however, is not presently practical and would not necessarily improve the overall response. Helping first responders quickly identify a HAZMAT-related situation through good training, knowledge of placards, and a reliable two-way radio system may be the most appropriate application of technology for dealing with early stages of incidents involving highway vehicles.

In contrast, once an incident situation has been identified and a first responder is on the scene, some of today's information/communication technology is very relevant and practical. For example, it is not only plausible but increasingly affordable for an on-scene commander to use a laptop computer with wireless data communication links to either the local public safety dispatch center or even a national emergency response center (e.g., CHEMTREC). Depending upon such factors as a locality's financial resources, the experience of its responders, the extent of its communications infrastructure, the extent of hazardous materials traffic in or near the community, and so forth, it may be advantageous to deploy this kind of information technology even today.

Improvements In Accessing Centralized, *Non-Shipment Specific* Response Information Still Most Practical Measure At This Time. Finally, this study considered six different scenarios applying improved information technology to an emergency response incident involving truck transport of hazardous materials. One scenario involved a carrier with automated vehicle location technology contacting the local public safety dispatch center when an accident/incident occurs; a second involved improved first responder and public safety dispatcher access to large, centralized databases that provide response advice for handling chemical emergencies; and the other four involved giving first responders or public safety dispatchers direct or indirect electronic access to shipment specific/vehicle specific data.

The scenarios indicate that, given costs, confidentiality considerations, and current levels of responder training, access to centralized response data is the most practical technology application at this time for most communities. The number of situations where the local response community and hazmat carriers pre-arrange automated links to carriers' shipment-specific data may continue to increase, particularly in localities with large rail freight handling facilities. Access to product information and response guidance of a more generalized nature, however, will continue to be the more common technology application.

LIST OF ACRONYMS

ft	Feet
m	Meter
nm	Nanometer
AEI	Automatic Electronic Identification
AGPS	Augmented Global Positioning System
ALOHA	Area Locations of Hazardous Atmospheres
AMSC	American Mobile Satellite Corporation
ATSDR	Agency for Toxic Substores and Disease Registry
AVC	Automatic Vehicle Classification
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
CAD	Computer-Aided Dispatch
CDMA	Code Division Multiple Access
CDPD	Cellular Digital Packet Data
CHEMTREC	Chemical Transportation Emergency Center
CLS	Collecte et Localisation par Satellites (France)
CMA	Chemical Manufacturers Association
CMC	Canadian Marconi Company
CVO	Commercial Vehicle Operations
DEA/U.S.DEA	United States Drug Enforcement Agency
DOD/U.S.DOD	United States Department of Defense
DOT/U.S.DOT	United States Department of Transportation
E&E	Ecology and Environment
EDI	Electronic Data Interchange
EMS	Emergency Medical Service
EPA/U.S.EPA	United States Environmental Protection Agency

LIST OF ACRONYMS (cont.)

ERG	U.S. DOT Emergency Response Guidebook
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
FET	Field Effect Transistor
FHWA	Federal Highway Administration
FIRA	First Responder Awareness
FIRO	First Responder Operations
FOSC	Federal On-Scene Coordinator
FR	First Responder
FTP	File Transfer Protocol
GIS	Geographic Information System
GPS	Global Positioning System
HELP	Heavy Vehicle Electronic License Plate
HMTC	Hazardous Materials Technical Center
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Site Operations and Emergency Response
HMIX	Hazardous Materials Information Exchange
ITS	Intelligent Transport Systems
IVHS	Intelligent Vehicle Highway Systems
LAN	Local Area Network
LEO	Low Earth Orbit
LTL	Less Than Truckload
MCMIS	Motor Carrier Management Information System
MDT	Mobile Data Terminal
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MSDSs	Material Safety Data Sheets
NAS	National Academy of Sciences

LIST OF ACRONYMS (cont.)

NFPA	National Fire Protection Association
NOAA	U.S. National Oceanic and Atmospheric Administration
NPTN	National Pesticide Telecommunications Network
PC	Personal Computer
PCS	Personal Communications Services
PDA	Personal Digital Assistant
PINS	Position, Information and Navigation System
PPP	Point-to-Point Protocol
QASPR	QUALCOMM Automatic Satellite Position Reporting
RSPA	Research and Special Programs Administration
SLIP	Serial Line Internet Protocol
TAT	Technical Assistant Team
TCCS	Transportation Computing and Communications System
TCP/IP	Transmission Control Protocol/Internet Protocol
TDMA	Time Division Multiple Access
TDOA	Time Difference Of Arrival
UN/NA	United Nations/North American
USCG	United States Coast Guard
VIS	Vehicle Information Systems
WIM	Weigh-In-Motion

1. INTRODUCTION

This final report summarizes a year-long study of pilot testing issues related to the first response of public safety agencies to road transportation hazardous material (HAZMAT) emergencies. The study focused on first responders (typically police, fire, and emergency medical services) to the scene of a potential HAZMAT release usually associated with a traffic accident. This report details the work done in an initial review of issues associated with first response and summarizes stakeholder inputs, related projects, and evolving technology applications.

1.1 BACKGROUND

This study project was motivated by a 1993 National Academy of Sciences (NAS) report [NAS]* on HAZMAT and emergency response and the U.S. Department of Transportation (DOT) report [RSPA] to Congress responding to the NAS report. As a direct result of these reports, the Department of Transportation, through the Research and Special Programs Administration (RSPA), funded a project at the Volpe National Transportation Systems Center (Volpe Center) to make an initial examination of issues involved in conducting a pilot test of information systems to meet the needs of first responders.

1.1.1 NAS Report on Hazardous Materials Shipment Information for Emergency Response and the U.S. Department of Transportation Report to Congress

In the NAS report, two recommendations under the heading "Implementing New Information Systems" identifiably led to the establishment of this initial planning study:

> *DOT should immediately undertake one or more limited start–ups of automated information systems.* [NAS, p. 15]

* References (bibliographic citations) are shown in brackets and listed at the end of the report.

DOT should, on an ongoing basis and in conjunction with the shipper and carrier industries and emergency responders, systematically investigate opportunities for application of information technology to aid emergency responders and reduce the costs of hazardous materials incidents. [NAS, p. 16]

In DOT's report to Congress, they identified a number of actions taken by them to improve the hazardous materials communication requirements. One action DOT highlighted was the initiation of a pilot program, now known as Operation Respond, to demonstrate the value of an automated information system in the rail industry.

With the NAS and DOT reports as motivating background documents, a project was funded by RSPA for the Volpe Center to lay out the initial groundwork for one or more HAZMAT emergency response automated information system demonstrations.

1.1.2 Volpe Center Study of a Pilot Project in Hazardous Materials Transportation

The initial tasking for this project was for a Phase I study to develop one or more specific pilot demonstrations that would satisfy emergency response requirements, use current information technology applications, and involve a range of interested stakeholders. The later implementation of the Phase I study would be a full–scale Phase II demonstration in 1996. A refinement in the focus of this project resulted in a more conservative Phase 0 examination of the issues and a survey of the applicable requirements, stakeholders, and technologies. Both the DOT and TASC agreed that an aggressive push now (late 1994 — early 1995) toward a full–scale demonstration in 1996, without thoughtful examination of the issues and implications for all involved, was premature and probably unproductive. As a result, the current study aims to document each of the component sub–studies that went into identifying the issues relevant for a later, more detailed, planning phase prior to the actual demonstrations.

The Phase 0 study does not, therefore, recommend specific test scenarios. Rather this phase examines a limited range of scenarios (all of which involve reasonable uses of modern commercial information technology and address documented information needs) and the issues these scenarios raise with emergency first responders and shippers and carriers. Issues surfaced during the Phase 0 study by emergency first responders and shippers and carriers have been identified. These issues are summarized for consideration in planning of Phase 1 of the pilot project.

1.2 STUDY OBJECTIVES AND APPROACH

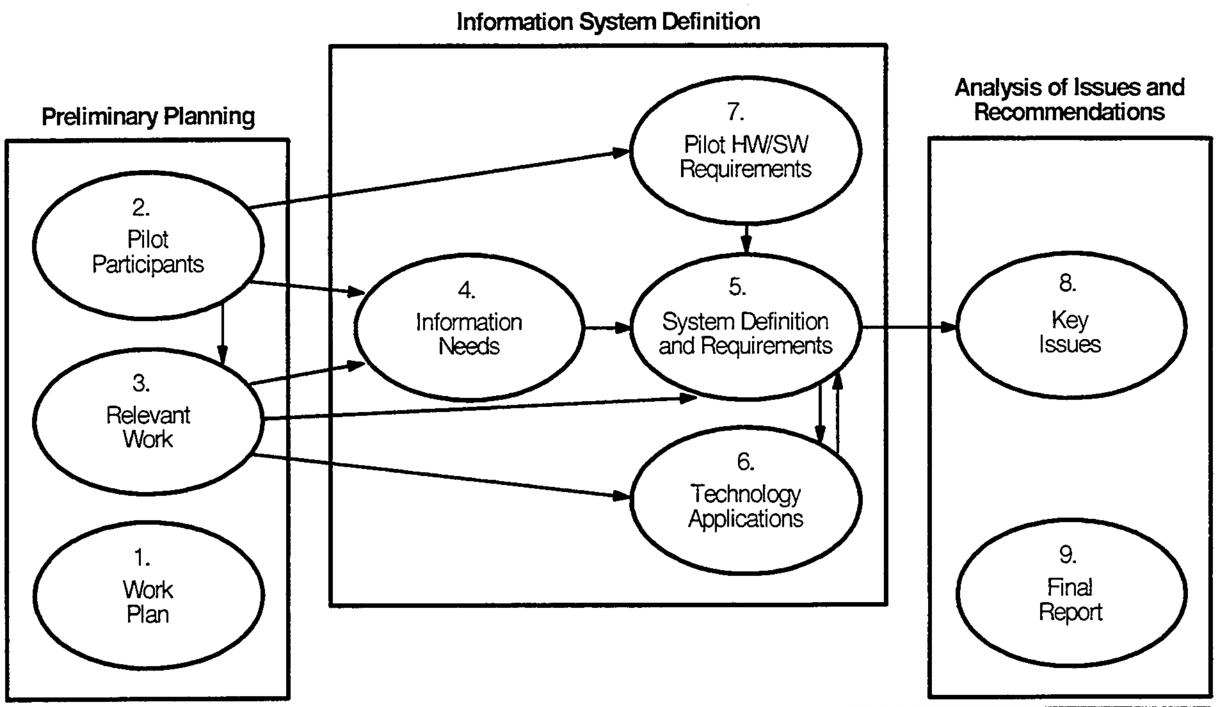
A summary of the study's objectives and approach is shown in Table 1–1. Figure 1–1 shows the relationship among the various project subtasks.

1.3 REPORT OUTLINE

Chapters 2 through 5 summarize milestone reports prepared during the analysis on the topics of information requirements of first responders, relevant technologies, relevant pilot participants, and candidate test scenarios and information architectures, respectively. Chapter 6 discusses in detail the key issues identified in the study regarding HAZMAT information systems pilot testing. Chapter 7 is a summary of the report.

Table 1-1 Summary of Project Objectives and Approach

STUDY SUB–TASK	OBJECTIVE(S)	APPROACH
1. Study Work Plan	Lay out process for one–year study. Define activities and responsibilities of subcontractors.	Used project management approach to divide work according to subtasks.
2. Potential Pilot Participants	Identify at least one carrier and several emergency response organizations in an area as candidate participants.	Focused on western New York State due to amount of HAZMAT traffic and familiarity with area participants.
3. Relevant Work by Others	Find other Government or private industry test projects of relevance to the study that could be used to leverage resources.	Contacted E&E and TASC resources; used Internet postings.
4. Information Needs of First Responders	Identify information needed or desired by emergency responders.	Telephone and in–person interviews with first responders.
5. Pilot Project Scenario Candidates	Develop sample test scenarios to meet information needs of first responders and exercise technology applications.	Formulated pilot scenarios based on modifications to existing test projects and to test promising concepts.
6. Information Technology Applications	Identify a range of technologies that could be used to enhance emergency response capabilities.	Survey key enabling technologies and identify specific transportation–related or emergency–related applications.
7. Pilot HW/SW Requirements	Identify specific hardware and software to be acquired for limited pilot projects.	Not performed due to lack of information on final pilot scenarios.
8. Identification of Key Issues	Identify, discuss, and evaluate important relevant issues relating to the use of new technologies for emergency first response.	Conducted a First Responders Workshop and a Carrier/Shipper survey to obtain balanced inputs and comments.
9. Final Report and Summary	Document and summarize prior subtasks and examine a limited range of test scenarios.	Compile prior technical reports and memorandum; summarize findings of the workshop and survey.



Deliverable Project Outputs

- Phase 1 Work Plan
- List of Potential Participants and Discussion
- Report of Past and Current Relevant work

- Documentation of HAZMAT Emergency Information Requirements
- System Definition and Functional Requirements for Potential Pilot Projects
- Report on Emerging Technologies Applicable to the Pilot Project
- Pilot Hardware/Software Requirements

- Report Discussing Key Issues in Pilot Project Implementation
- Final Report on Contract Activities and Summary

Figure 1-1 Study Subtask Relationships

2. INFORMATION REQUIREMENTS OF FIRST RESPONDERS

2.1 INTRODUCTION

Senior members of various first response organizations and HAZMAT teams were interviewed and their comments on information requirements summarized. Ecology and Environment (E&E), under subcontract to TASC, was the principal author of this chapter.

The goals of the interview were to:

- Establish a baseline of information needed by on-scene first responders;
- Coordinate this baseline of information with the participants in the project; and
- Correlate the discovered relevant work with the information requirements.

This chapter deals with the information provided by first emergency responders who were interviewed by telephone and in person. These interviews provided the basis for refinement of the problem prior to conducting the operational evaluation at the First Responders Workshop. This workshop was conducted on November 1, 1994, held in conjunction with the 1994 International Hazardous Material Spills Conference at Buffalo, NY, where first emergency responders (police, firefighters, etc.) from across the nation gathered.

2.1.1 Interview Participants

The Team interviewed emergency response experts within E&E (Table 2-1). Following refinement of the results of these interviews, E&E interviewed several national authorities on first response to hazardous materials incidents (Table 2-2). The interviewees were chosen because of their experience as first responders or their experience with first responders and their participation in the higher echelons of HAZMAT response.

2.1.2 Interview Approach

In preparation for the interviews, participants were provided with a brief outline of the project and a copy of the general topics to be covered in the interview so that they might be better prepared. An overview of the format used during the interview is included in Appendix 2-A. Every attempt was made to conduct face-to-face interviews; however, in the interests of cost control, four of the thirteen were telephone interviews. Figure 2-1 summarizes the rationale involved prior to conducting the interviews and anticipated as a result of refining the interview. This chapter deals with the information provided by the 13 national respondents and focused on the refinement of the problem prior to conducting the operational evaluation at the November workshop.

Table 2-1 E&E Emergency Response Experts Interviewed

NAME	BIOGRAPHIC SUMMARY
Donald Zelazny	Mr. Zelazny has 13 years of experience as a member of the U.S. EPA Technical Assistance Team (TAT) providing emergency response support services during hazardous materials incidents of national significance. He is currently directing these efforts for EPA Region 5 through Region 10, an area that covers approximately 70% of the United States.
Louis Adams	A retired career Army colonel with over twenty years in the chemical corps explosives ordnance disposal, Mr. Adams established the U.S. EPA TAT program for the entire United States under a contract with the EPA. For ten years Mr. Adams has directed E&E's nationwide corporate chemical emergency response team.
James Jackson	Mr. Jackson has 11 years of experience directing EPA's Region 7 TAT program (Midwest). He has significant experience providing training and emergency response support services to over 10,000 first responders in the Midwest.
William Carberry	Mr. Carberry has directed the U.S. EPA Region 10 TAT program (Seattle-Northwest) for seven years. He has worked with first responders in numerous significant HAZMAT incidents.

Table 2-2 National Authorities in Emergency Response Interviewed

NAME	BIOGRAPHIC SUMMARY
Gene Carlson	As a fire fighter and educator, Mr. Carlson is the Editor of Fire Protection Publications, Oklahoma State University. He is also a member of the National Fire Protection Association Hazardous Materials Technical Committee.
John Hess	While at the U.S. DOT, Mr. Hess participated in the development of the Emergency Response Guidebook in the Office of Hazardous Materials Transportation. Mr. Hess was Associate Director, National Response Center (USCG), and is now employed at the Office of Pipeline Safety providing emergency response planning services.
William Keffer	Mr. Keffer is a leading EPA HAZMAT emergency response expert with over twenty years of experience, including on-site first responder support services and first responder HAZMAT training. He serves on the NFPA HAZMAT Technical Committee.
R. Bickum	Captain Bickum is a career emergency service professional in the Montgomery County (MD) Department of Fire and Rescue. He currently serves as Assistant to the Chief for Emergency Medical Services.
Dennis Barmore	Mr. Barmore is the Deputy Commander (EMS) of the Chautauqua County (NY) office of Emergency Services. He is an experienced fire fighter and a founder of the county's nationally known HAZMAT team.
Lawrence Blair	Chief Blair is Past Chief of the Townline (NY) Fire Department, and founder and Past Chief of the Town of Lancaster (NY) HAZMAT Team. He is a paid fire and HAZMAT inspector for the town of Lancaster. He continues as a volunteer fire fighter and HAZMAT specialist. He is also a founder of HAZWEST, the Regional Hazardous Materials Consortium.
Virginia Hens	Ms. Hens is the Executive Director of the Western New York Regional Emergency Medical Services Agency. She is the founder of the International Emergency Nurses Association and is intimately familiar with fire, HAZMAT, and EMS issues surrounding first responders.
David Beach	CDR Beach served for four years as Director of the USCG's National Response Center. He has recently been transferred to the National Pollution Funds Center.
Michael Mazurowski	Chief Mazurowski has risen through the ranks to the position of Department Chief, Doyle Fire Department, Cheektowaga, NY. He has been an active policy maker in his region on fire, EMS, and HAZMAT issues.

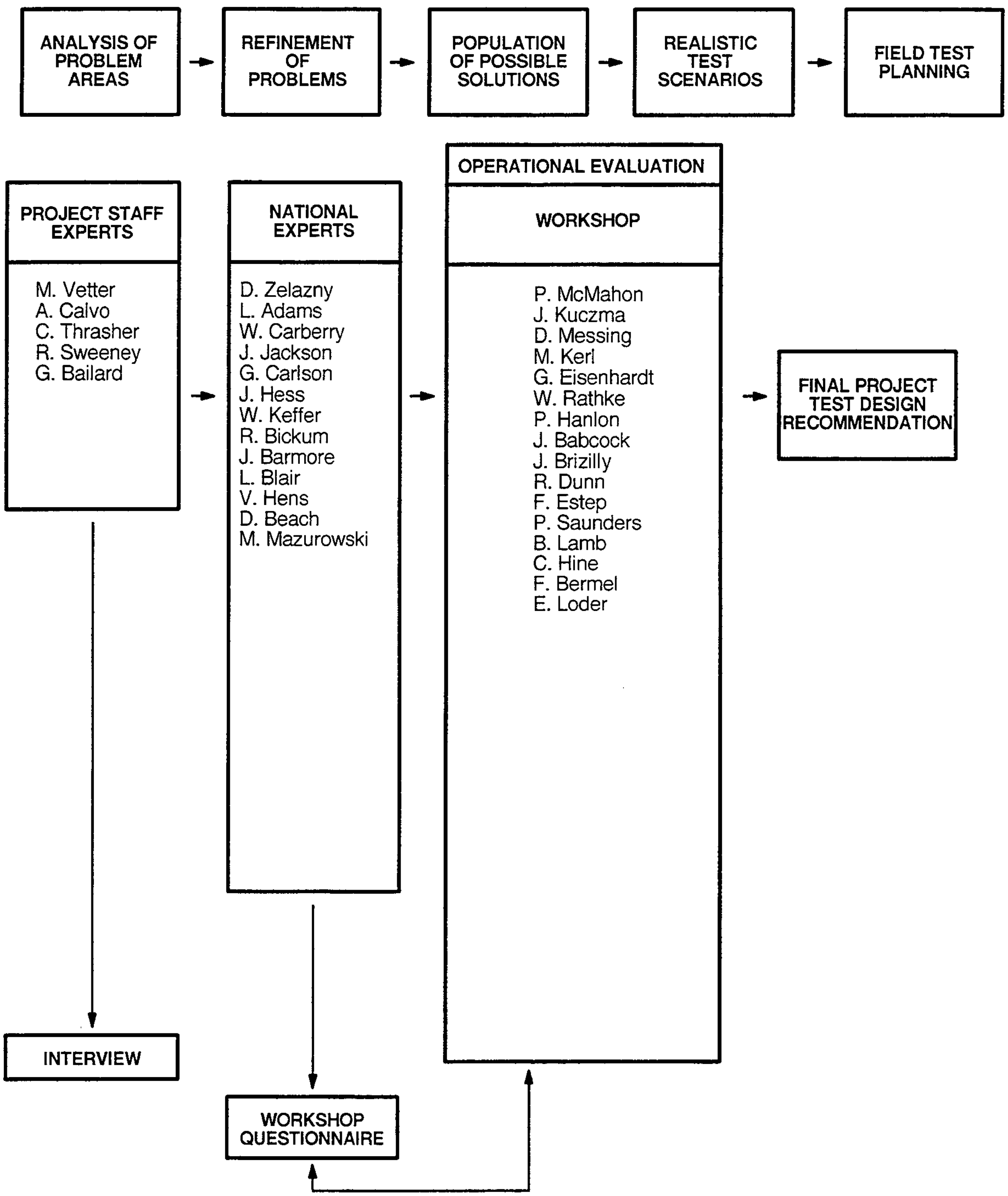


Figure 2-1 Pilot Project Phase 1 Validation Rationale

Respondents were diverse in their opinions and ideas. As the interviews progressed, the interviewer generated preliminary conclusions that were then tested during follow-on questions and follow-on interviews. The interview first focused upon operational problems that each individual has had during actual response experiences. When possible, these operations problems were related to the adequacy of available information about the involved hazardous materials. Next, the interviewer discussed information that was considered, by first responders during the event, to be of marginal use. Questions were asked about how the information could be improved. Finally, emphasis was placed upon the first responders' perception of the ideal type and amount of information surrounding an unfolding HAZMAT event.

2.1.3 Response Summary

The consensus among the interview participants is that truck content information is of utmost importance in responding to HAZMAT incidents. However, given the technological implications of this requirement, the interviewees placed timing priorities in their request for contents information.

The priorities are a strong short-term demand for better placarding of HAZMAT cargo information, a mid-term need for better chemical database and remediation guidance, and a long-term need for more detailed load list information. Most respondents were skeptical of the value of "high tech" tools and wanted simple, reliable, accurate information on HAZMAT commodities. Accuracy of information was seen as more beneficial than instant availability of information. A thorough understanding of the management of real emergencies at the first responder level leads to one overriding conclusion — any information available to an incident commander to support a tactical decision will be used if it *provides concise information, is easy to use at remote sites, and is reliable.* It was also shown that if on just one occasion the information source provides false or incomplete information and exacerbates responder risks, the source will be tainted, resulting in reduced dependence upon it.

2.2 DISCUSSION OF HAZMAT INFORMATION REQUIREMENTS

This section contains a discussion of the content of comments obtained from first responder interviews. It concludes with a brief discussion of the interests of chemical shippers, transporters and users in satisfying the information needs of first responders.

2.3 INITIAL REQUIREMENTS FROM EMERGENCY FIRST RESPONDERS

Any project to improve the availability and quality of critical hazardous materials information to the first responding emergency personnel at the scene of a hazardous materials accident must be firmly based upon input from those same responders. To sample this input, either face-to-face or telephone interviews were conducted with HAZMAT emergency response personnel (as explained in Section 2.1.1).

2.3.1 Interview Scope

The initial scope of the interview was defined using the appropriate sections of the OSHA HAZWOPER regulations (29 CFR 1910.120), and the Incident Analysis sections of the National Fire Protection Association's (NFPA) Standard 472, Standard for Professional Competence of Responders to Hazardous Materials Incidents and NFPA Standard 473, Standard for Professional Competencies for EMS Personnel Responding to Hazardous Materials Incidents, for First Responder Awareness (FIRA) and First Responder Operations (FIRO) incident analysis roles.

The FIRA's incident analysis role is defined by the above references as:

- Detect the presence of HAZMAT
- Perform a distant survey to catalog chemicals, problems, hazards, and risks
- Use the U.S. DOT Emergency Response Guidebook (ERG) to implement:
  - Protective actions (Isolate/Evacuate)
  - Notification of HAZMAT experts.

The FIRA role requires familiarity with DOT hazard classes, UN/NA Identification Numbers, NFPA 704 hazardous materials marking schemes, and military, pipeline, and special hazard markings. The FIRA role is defensive in nature.

The FIRO incident analysis role expands the FIRA role to include active accident site surveys and interpretations of chemical markers and chemical container shapes and configuration. Further, the FIRO have the capability and the training to begin active operations, therefore, their information requirements are greater than the FIRA.

2.3.2 Interview Format

All of the interviews focused upon three considerations. The first consideration is operations problems encountered during actual first response experiences that could relate to the adequacy of available information about the involved hazardous materials. The second is information considered during the first response phase of the event to be of marginal value. Participants were asked, "How can the quality of that information be improved?" Finally, each first responder was asked for their perception of the ideal chemical information surrounding an unfolding HAZMAT event. That is, "What do you think would constitute ideal, though realistic, information about an unfolding hazardous materials event during the first response phase?"

2.3.3 Respondents' Qualifications

Those interviewed were experienced in first response to hazardous materials accidents. They included individuals drawn from the EPA, the Coast Guard, commercial response specialists, and actual first responders at the First Responder Awareness, First Responder Operations, and Hazardous Materials Technician levels, as defined by OSHA and the NFPA. The results of the interviews were distilled to yield a baseline of information needed by on-scene first responders to

HAZMAT events. Table 2-3 provides a categorization of the organizations and areas of expertise of the respondents.

2.3.4 Interview Findings

The interviews identified two key steps that must be taken. First, *the first responder (FIRA or FIRO), when first approaching the accident site, needs to differentially diagnose the event within a broad spectrum of emergency scenarios that he or she might be expecting to encounter.* Is this a hazardous materials emergency or a simple accident with injury? Is fire involved? The outcome of this first diagnosis will have significant impact on accident victims, the first responders, and the public.

Table 2-3 Interview Respondent Categories

GOVERNMENT RESPONDERS	CORPORATE RESPONDERS	FIRST RESPONDERS	
EPA	E&E	Fire	
USCG/DOT		EMS	
Oklahoma State University (OSU)		Police	
W. Keffer (EPA)	L. Adams	R. Bickum	(Fire–Paid)
D . Beach[1] (USCG/DOT)	D. Zelazny	D. Barmore	(EMS–Paid) (HAZMAT–Volunteer)
J. Hess[2] (USCG/DOT)	J. Jackson	L. Blair	(Fire–Volunteer)
G. Carlson (OSU)	W. Carberry	V. Hens	(EMS–Paid)
		M. Mazurowski	(EMS–Paid) (Fire–Volunteer)

1 = Reassigned USCG - Pollution Funds Center.
2 = Now with U.S. DOT - Office of Pipeline Safety.

The first responder must balance needless delays in rescues when there is no HAZMAT present versus the unwise risk to rescue personnel when there is. Having established that the accident is in the hazardous materials accident category, the responder should initiate a stepwise chemical evaluation plan.

The second key step is that *the first responder needs to identify and characterize all of the chemicals involved or potentially involved* (see Figure 2-2).

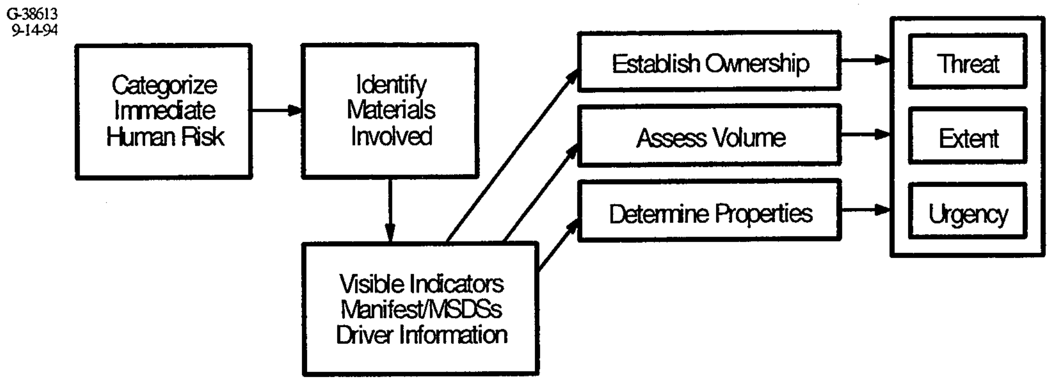


Figure 2-2 HAZMAT Identification Decision Flow

This is sometimes a very difficult task. For example, frequently only the largest volume chemical in a mixed load is identified by a DOT placard or standardized classification number (e.g., UN/NA number).

Placards are intended to be the principal indicator of hazard type, primarily through symbols keyed to the hazard class, coded colors, and hazard number displayed on the placard. Except for the Dangerous placard, all placards contain this information. For instance, the skull and crossbones indicates poison, an orange color indicates explosive, and the hazard number 8 (located at the bottom of the placard) indicates corrosive material. Other potential indicators of hazard type are descriptive company emblems and markings on the vehicle and labels on exposed packages (also, some bulk materials have the proper shipping name marked on the package). Views concerning the value of placards are mixed. Some regard them as a good visible indication of hazards, others *regard the placards as incomplete information at best*. The placards are small, selective, often obscured or destroyed during an accident; many times they indicate only chemicals present in quantities greater than the regulatory threshold levels. Ideally, first responders want a method of identification that will reflect the complete manifest.

2.3.5 Respondent Recommendations

The interview respondents made three general suggestions to improve the safety of first responders. First, understanding the functionality of the first response system and the roles of First Responder Awareness and First Responder Operations personnel, *all vehicles transporting hazardous materials in quantities that pose any potential hazards to first responders should be marked with a new, larger DOT placard that indicates "Hazardous Materials."* In fact, emergency responders on the NAS committee [NAS] expressed concern that certain Table 2 materials (in accordance with 49 CFR 172.500), when transported in any quantity, may be sufficiently hazardous to warrant placarding and reclassification to Table 1. However, a lower threshold for placarding could affect hundreds of thousands of small shipments thus diminishing the significance of placards [NAS, pp. 128-129]. A delicate balance needs to be reached to ensure the value of the placard.

Second, the respondents indicated the need to *improve the mechanism for maintaining an accurate inventory of hazardous commodities being transported on board a vehicle* that is immediately accessible by first responding organizations.

The third suggestion is the *availability of a single HAZMAT response center*, accessed by telephone, that would be able to provide complete chemical standardized database references with download capability, and response consultation services including the ability to predict or estimate the effects of the interaction of multiple chemicals.

2.4 HAZMAT INFORMATION REQUIREMENTS

2.4.1 Primary Information Requirements for the First Responder

Based on the interviews conducted, the following categories of information are needed by HAZMAT incident first responders:

Identification of the Scenario

- Before or upon arriving on the scene, immediate recognition of the potential for a hazardous materials incident
- Accurate location of the accident.

Identification of the Hazards

- Direct, immediate, real-time access to commodity manifest information; manifest; driver's information; remote manifest database; on-site data retrieval.

Identification of the Risks

- Real-time access to a single chemical database capable of cross referencing a full spectrum of complete and fragmented markers to provide useful information about the properties of target chemicals to field personnel
- Real-time access to response consultation services that include ability to predict or estimate the effects of the interaction of multiple chemicals.

2.4.2 Information System Characteristics

The system that provides this information should be user-friendly, responsive, cost effective, and exhibit the following characteristics:

- Minimal initial and recurring expenditure for the first responder unit
- Training and retraining levels must be appropriate to the role and responsibilities of the first responders
- Support the evolving standardized procedures for hazardous materials response
- Easy integration into existing computerized command and control systems, and potential system upgrades.

2.5 REQUIREMENTS OF THE TRANSPORTATION INDUSTRY

The chemical shipper, transporter, and ultimate users also have a fundamental interest in the safe and efficient transportation of hazardous materials. Each accident results in a wide spectrum of expenses that directly and indirectly affect profit; however these expenditures need to be balanced by the additional up-front investments on safety. Often the efficient management of hazardous materials information contributes to a reduction of accidents. However, the most important value of overall hazardous materials information management is to reduce the response time of first responders, and spill containment and cleanup specialists, if an incident occurs. The reduction of this response time will appreciably reduce the long-term industry costs associated with every accident.

Commodity transportation by highway and rail must be especially efficient and cost effective if the transporter is to be profitable. The profit margin in this industry is very small, suggesting that new local, state, federal and private initiatives to provide improved information to the first responders must also be designed to enhance business profit rather than erode it. Any increased costs resulting from information technology applications will be passed on to the shipper, recipient, and, ultimately, to the consumer. Therefore, characteristics of an effective HAZMAT information management system for industry should include:

- Business function enhancement to encourage shipper, transporter, and recipient to provide system inputs and to maintain both equipment and quality of information
- Non-interference with day-to-day business operations
- Minimal net capital investment and recurring costs
- Reduced time between an accident and the notification of first responders thereby reducing damage, cleanup, and other business expenses
- Benefit-cost payoffs.

A proper balance should be achieved between the information technology requirements for first responders and the added burden and costs that the emerging technology may place on the shippers/carriers. A basic tradeoff between safety and cost needs to be explored when considering the enabling technologies for HAZMAT transportation, and particularly for first responders. The relevant technologies are addressed in the next chapter.

3. RELEVANT TECHNOLOGIES

In this chapter, the applicability of technologies to HAZMAT emergency response is evaluated with respect to various HAZMAT case studies. Identified technologies are categorized into vehicle information systems, HAZMAT/chemical sensors, communications, information resources, and computer-human interfaces. The chapter concludes with discussions of systems that integrate various technologies and the potential impact of the identified technologies on HAZMAT information issues.

3.1 OVERVIEW

Information technology in a HAZMAT first response situation can affect the users of information, the providers of information, and the communication of information. Technologies are addressed along the lines of:

- **First responders** — computer and human interfaces
- **Information Providers** — vehicle information systems, chemical sensors, and information resources
- **Communications** — wireless, landline, or computer networks.

Figure 3.1 illustrates communications between information resources/providers, vehicle information systems and the first responders. Technologies from five areas are applicable to improving information for first responders to HAZMAT incidents:

1. Vehicle information systems (VIS)
2. Chemical sensors for HAZMAT detection and identification
3. Communications
4. Information resources
5. Computer and human interfaces.

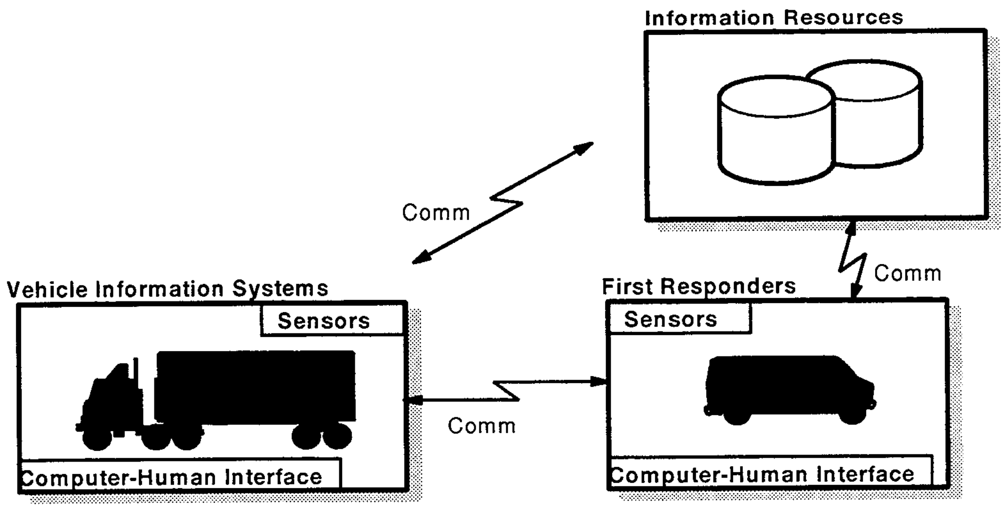


Figure 3-1 Communication Between Information Users and Providers

VIS is discussed in terms of tracking and location technologies and on-vehicle sensors. Chemical sensors are discussed regarding their ability to determine the presence of HAZMAT and identify the material. Communications covers a variety of technologies applicable to incident reporting, carrier and shipper notification, data retrieval, and conferencing. Database technologies and information resources applicable to Material Safety Data Sheet (MSDS) information management and retrieval and shipping paper management and retrieval are identified. Computer-human interface technologies for communications and data retrieval are discussed in terms of capabilities and availability. Technologies and products that integrate functionality from subsets of the five technology areas are discussed, as are HAZMAT incident case studies and the potential benefits of information technology.

The *proactive response* generally illustrated in Table 3-1 is a useful model or structure for evaluating the value added by each technology area versus a traditional response scenario. In many case studies [NAS], first responders were found to be unaware of the information sources available to them. A "push" approach addresses this lack of awareness by proactively providing critical information to first responders. A technology or resource that notifies first responders of the presence of HAZMAT *before* or *immediately upon* arrival at the scene is more effective than one that notifies them only *sometime after* their arrival.

For example, "on-board documents, such as shipping papers, do not function as early warning devices, because they must be retrieved from the vehicle and are not readily observable" [NAS, p. 64]. Beyond warning of the presence of HAZMAT, a proactive response attempts to provide information about the materials and safety precautions.

Table 3-1 Traditional, Proactive, and Possible Future/Proactive HAZMAT Emergency Response Scenarios

Incident
Traditional: Driver detects problem visually, pulls over, and notifies carrier and 911.
Proactive: Automatic sensors detect problem, notify driver, and carrier. VIS indicates position and presence of HAZMAT to 911 system.
Future: Public notifies 911 and GPS-enabled cellular technology or enhanced 911 service automatically relays caller location.
Alert Response
Traditional: Carrier contacts shipper, identified through internal electronic database, by telephone.
Proactive: Carrier broadcasts HAZMAT data and initial recommendations from MSDSs to likely first responders, identified through a GIS.
First Responders' Actions
Traditional: At the scene, first responders identify and contact carrier, shipment information and MSDSs sent by FAX or voice.
Proactive: Enroute, first responders receive/download information from carrier and on-line material database.
Future: At the scene, first responders interrogate an on-board transponder for electronic placard information — including HAZMAT MSDS information.

As examples, BMW in Germany and Ford in England are currently testing accident detection and reporting technologies for private vehicles. BMW is testing roadside posts and on-vehicle transponders, and Ford is testing GPS-based positioning. Each system allows a proactive alert for emergency response to be initiated either by the driver or a crash sensor. The Ford system will communicate, via satellite, vehicle information such as license plate number, and vehicle make and model as well as GPS position [Law Enforcement, p. 56]. These systems, along with current "alert-capable" tracking and vehicle information systems, enable a proactive response to an emergency situation. The Ford system could be adapted to warn first responders of the presence of HAZMAT cargo.

The essential components of the proactive response are:

- The carrier identifies itself using vehicle tracking and alert communication and determines the nature of the cargo. The carrier contacts the shippers (if necessary) and electronically sends shipping papers and MSDSs to (likely) first responders, or clearly notifies them of non-hazardous cargo.

- If there is any potential ambiguity about the hazardous or non-hazardous nature of cargo (from the point of view of first responders), the carrier notifies the shipper and possibly CHEMTREC®.

These components of the proactive response illustrate the goal of providing information to first responders *before* they arrive at the scene. For the purpose of this technology assessment, the descriptions of incident, alert response, and first responders' actions in Table 3-1 are used as the paradigm for *proactive response* in describing the benefits of technologies and do not describe any particular agreed-upon vision of HAZMAT response. This assessment also discusses technologies that would improve the first responders' awareness of HAZMAT immediately upon arriving at the scene (e.g., electronic placards). The general situation in which the presence of (or lack of) HAZMAT has not been determined will be referred to as a *potential HAZMAT incident*.

3.2 VEHICLE INFORMATION SYSTEMS (VIS)

VIS covers a range of technologies from sensors to navigation and communication. Some VIS systems report information to the driver only, while others integrate communications hardware that relays information to a dispatcher. These systems may help mitigate the severity of an incident by quickly notifying the driver of a problem. In terms of proactive response, a VIS system that enables communication with the carrier and emergency responders (perhaps even indirectly) may enable notification of the presence of HAZMAT to take place before the first responders arrive at the scene. For less-than-truckload (LTL) vehicles, determining the presence of HAZMAT can be complicated by package deliveries and pickups. VIS with communications enables shipment tracking, which can be useful in reconstructing the deliveries and pickups in an LTL vehicle. VIS is not necessary for shipment tracking (e.g., smart packages can enable tracking); however, it can substitute for it when tracking information is not available.

The Global Positioning System (GPS) is an important enabling technology for vehicle and shipment positioning and tracking. For details on GPS, see [Wu, p. 1443].

If the first responders are to be notified of the presence of HAZMAT *before* arriving at the scene, one of the following must occur:

- The driver or observer calling 911 must report the information
- The carrier or shipper must provide the information
- An automatic alert from the vehicle to 911 must include the information.

Otherwise, first responders will not know of the presence of HAZMAT until after they arrive at the scene. For the carrier or shipper to provide the information, they must be notified of the (potential) incident as soon as possible. In most cases with information problems, the carrier or shipper is not notified until well after the first responders arrive at the scene [NAS]. VIS can enable early notification of the carrier and shipper.

VIS can be broken down by component functions into:

- Automatic Vehicle Location (AVL)
- Sensors
- Communication.

The next two sections describe AVL and sensor technologies. Communications technologies are covered in detail in a separate section due to their wider applicability to HAZMAT response.

3.3 AUTOMATIC VEHICLE LOCATION (AVL) AND TRACKING

Increasingly integrated into modern fleet management systems, tracking capabilities serve a number of business purposes related to delivery service quality. Shipment tracking provides carriers with the capability to redirect shipments in response to customer demands, to provide accurate estimates of the delivery time, and to accommodate advantageous "switching" of trailers, which minimizes driver time on the road and wear and tear on the vehicles [QUALCOMM Literature].

One benefit of AVL to HAZMAT response is in alerting the carrier of the incident. The carrier may be alerted through using its shipment tracking capability to identify itself as the owner of a vehicle involved in an accident. The carrier may be notified by an alert initiated by the driver of the vehicle; many AVL systems contain this "panic button" capability. There may be an improved reporting time to emergency response personnel, as well. Improved shipment tracking may improve response to requests for cargo information from LTL carriers. Two components of AVL systems contribute to a proactive HAZMAT response:

- Positioning (for shipment tracking)
- Communication (of incident to carrier).

Most AVL systems are integrated with a communication system to enable direct communication between the vehicle and the carrier. Communication capabilities vary by the type (voice and/or data), one-way or two-way, and the delay in relaying information. Messaging systems typically provide two-way data communication. Paging systems provide one-way data communication, with limited two-way data communication, using preprogrammed responses from the pager, becoming available.

This section provides an overview of the current and planned technologies applicable to AVL. While not comprehensive in describing the industry, this section covers the major technology areas and describes example applications and products from each.

AVL Enabling Technologies — In a 1990 review of technologies applicable to HAZMAT response [Boghani], AVL systems are divided into:

1. Dead-reckoning systems
2. Ground-based radio determination systems
3. Low-earth orbit (LEO) satellite-based system
4. Radio determination satellite systems (geosynchronous)
5. Proximity systems.

In addition to these technology areas, companies such as KSI Inc. (Annandale, VA) are promoting the use of cellular networks in positioning. Enhanced 911 services for cellular networks may enable positioning through cellular technology. Commercial FM radio broadcasts may enable positioning by triangulation [Driscoll, Survey]. Consequently, for a complete listing there are two more types of AVL systems that should be added to the five given above:

6. Network Systems: cellular networks, paging technology, and Enhanced 911 (E911)
7. Commercial FM radio.

The descriptions of the seven types of AVL systems are as follows:

1. *Dead-reckoning systems* — Systems that provide position information independent of external reference sources are called dead-reckoning systems. For increased accuracy, occasional position updates are used. Since they do not inherently depend on a communications link, dead-reckoning systems do not necessarily provide any improvement in HAZMAT response.

2. *Ground-based radio determination systems* — These systems use LORAN signals or other dedicated ground-based radio systems to compute position by triangulation on the estimated distances to known transmitters. Distance is estimated using Time Difference of Arrival (TDOA) techniques to determine the propagation time of the radio signals, and therefore the distance the signals traveled. These systems do not depend on the vehicle emitting a signal and calculations are done on-board. While location alone is not a HAZMAT concern, these technologies are likely to be integrated with modern communication equipment, providing a tracking capability [ARRAY].

3. *Low-earth orbit (LEO) satellite-based systems* — Little LEO and Big LEO satellite networks are proposed systems based on constellations of small (Little LEO) and large (Big LEO) communication satellites in orbit near 1000 km above the earth's surface. The networks will provide positioning, data messaging and, in

the case of Big LEO, voice communication, paging and facsimile transmission (see communications section).

4. *Radio determination satellite systems* — Specialized geosynchronous satellites enable positioning over a wide geographic area. QUALCOMM currently uses two such satellites to provide coverage over the continental U.S. [QUALCOMM Literature] [APL, pp. 4-5].

5. *Proximity systems* — Automatic Vehicle Identification (AVI) technologies, such as those being tested in the ADVANTAGE I-75 and Heavy Vehicle Electronic License Plate (H.E.L.P.) initiatives, are examples of proximity systems. If implemented, they would "allow vehicles to be identified at State borders without having to stop" [Allen, p. 1]. Initially, ADVANTAGE I-75 will "facilitate motor-carrier operations by allowing transponder-equipped and properly documented trucks to travel any segment along the entire length of I-75 and Canadian Highway 401 . . . with minimal stopping at enforcement stations" [ADVANTAGE I-75]. Combined with Automatic Vehicle Classification (AVC), providing shipment type, AVI represents "the beginning of a 'transparent border' between States" [Allen, p. 1].

The Companion Warning and Information System under development and testing by Germany's BMW uses roadside posts with small radio transmitters and receivers to communicate with on-vehicle transmitters. Vehicle location is easily estimated to the nearest roadside post. This system will be integrated with traffic management and emergency response systems [Law Enforcement].

These systems could be used to communicate the presence of HAZMAT to first responders. A central statewide database of vehicles carrying hazardous material enroute through the state (a tracking function) could be accessed, as could the on-vehicle transponder (a communication function). As tracking technologies, AVI and AVC could enable first responders to download cargo information from a central statewide database while enroute to the scene. The statewide database would also serve as a second information resource to the carrier's information.

6. *Network Systems: cellular networks, paging technology and Enhanced 911* — Many carriers provide their drivers with cellular phones. For many of the [NAS] HAZMAT incident cases, this technology would apparently have enabled communication with the carrier and shipper(s), who could have then taken further action, such as proactively providing or verifying shipping papers.

KSI Inc. (Annandale, VA) is promoting the use of its Direction Finding Localization system (DFLS) for determining the position of vehicles using cellular phones. Directionally sensitive receiving antennas capture signals (voice or control) from cellular phones and compute a bearing angle. A central station processes the bearing information from the receiving antennas to compute location. KSI intends to pursue applications to routing and fleet management. The company claims potential location accuracy of 150 ft [Driscoll, Survey, p. 13].

Paging technology is used to provide location information in AirTouch's Teletrac systems. Upon request, a control signal is transmitted to the vehicle, which then relays it through receiving antennas to a centralized processing center. The centralized processing center calculates position based on the delays in receiving the control signal from the receiving antennas.

The increasing use of cellular phones raises concerns about the efficacy of Enhanced 911 (E911) services [Driscoll, Survey]. Currently, many areas have invested in E911 capability, which provides emergency dispatchers with location information based on the caller's telephone number. With cellular phones, E911 type service is not currently possible. An investment in location technologies for cellular transmissions would enable positioning information to be sent to emergency responders in a HAZMAT incident. While positioning information has been identified as a low priority in HAZMAT response, expansion of this service to non-emergency calls would provide the positioning component of a shipment tracking system (e.g., TrackMobile) [Driscoll, Survey, p. 22]. Some components of an envisioned cellular E911 system are related to locating the caller's position from a moving platform (e.g., police car) using specialized hardware that would not contribute to a shipment tracking system [Driscoll, Survey].

Spectrum Associates, Inc., is designing a cellular-based E911 system for the Greater Harris County of Houston, TX. "Up to 22 percent of emergency calls to the [current system] are made by cellular telephone, making traffic difficult or impossible when the caller cannot describe his location" [Law Enforcement, p. 23]. The system will integrate GIS technology with cellular tracking based on cell location. Landmarks will be identified so that the caller can report relative position even if unfamiliar with the area.

Motorola is introducing its Cellular Positioning and Emergency Messaging Unit that provides reliable voice communication and dynamic GPS positioning during emergency situations. The technology is applicable to vehicle tracking and fleet management [PR Newswire, Motorola].

7. *Commercial FM radio* — Using FM radio signals as the basis for triangulation of position differs from the ground-based radio determination systems in the number of transmitters: a number of pilot signals from commercial FM radio stations plus one special "Fixed Observer" transmitter per metro area, rather than a number of specialized transmitters. The Fixed Observer transmitter would, as envisioned by Terrapin Corporation [Driscoll, Survey, p. 43], provide synchronizing information about the phase of the commercial FM stations' pilot tone sine waves. This information would be broadcast to Terrapin's PINS (for Position, Information and Navigation System) receivers, enabling location triangulation. FM radio broadcasts are less affected by urban environments than GPS signals, which may give an edge to the technology in shipment tracking in those areas. Thirty-meter accuracy is predicted by Terrapin [Driscoll, Survey, p. 44].

3.3.1 Current Use of Tracking Technology

Current use of tracking technology is split between large, long-haul fleets, which tend to use systems by QUALCOMM, and smaller, local fleets, which tend to use systems by AirTouch. AirTouch has 29,000 units installed in 1000 fleets, while

QUALCOMM has more than 100,000 units installed in over 250 fleets [Driscoll, Vehicle Tracking, 1994] [Space News].

QUALCOMM's OmniTRACS system provides real-time data messaging and positioning for shipment tracking through geostationary satellite technology. This system has been effective in improving emergency response in accident situations through faster emergency notification and response. Positioning is provided through satellite-based triangulation to within one-quarter of a mile, using QUALCOMM's Automatic Satellite Position Reporting (QASPR) service, or, optionally, through GPS [QUALCOMM Literature]. The QASPR service, based on two geostationary satellites, replaced LORAN-C as QUALCOMM's navigation enabling technology [GPS World, April 1994]. QUALCOMM has about a 13 percent market share in the long-haul market, or about 100,000 out of 800,000 long-haul trucks [Space News].

AirTouch's (formerly Pac Tel) Teletrac AVL system offers low-cost positioning through paging technology. The driver initiates a request for location information using a portable computer workstation. The computer, using standard telephone technology, notifies the Teletrac transmitting antennas, which respond by transmitting a short code. The Teletrac equipment on the vehicle transmits the received data to a Teletrac control center, which calculates the vehicle's location and transmits it to the workstation. The response time from position request to the time vehicle location is displayed on the vehicle workstation is typically three to five seconds. The company also offers optional messaging services and emergency button capability [AUTOMOTIVE FLEET]. Teletrac is currently available in Los Angeles, Chicago, Detroit, Miami, Dallas/Fort Worth and Houston. It is the "largest supplier of AVL for local trucking and other metropolitan fleets" [Driscoll, Vehicle Tracking].

American Mobile Satellite Corporation (AMSC) and Rockwell International compete with QUALCOMM for the long-haul trucking market. Both AMSC and Rockwell currently use GPS for location and Inmarsat-C service for data communication. AMSC's system currently enables messaging and AVL, the company plans to launch its own satellite in March 1995 which will enable voice communication [Driscoll, Vehicle Tracking]. Rockwell's Tripmaster® system enables messaging, AVL and emergency alert capabilities. Norand Corporation will be providing its PEN*KEY™ pen-based hand-held computers as the computer-human interface for the Tripmaster system [PR Newswire, Rockwell].

AUTO-TRAC in Dallas has deployed an AVL system using the cellular digital packet data (CDPD) standard [AUTOMOTIVE FLEET].

HighwayMaster provides two-way data and voice communication, using cellular technology, along with positioning based on LORAN-C (optionally GPS) [Driscoll, Vehicle Tracking].

Other currently operational tracking systems include: Pinpoint, ETAK, and Differential GPS-based systems.

3.3.2 Future Tracking Technologies

Along with the expansion of service planned for current systems, tracking technology will grow as a result of the deployment of new systems. Many small companies are working on communication and tracking technologies. The combination of GPS with cellular telephone communications may enable new tracking capabilities, especially in rural areas where GPS signals are unaffected by the clutter of cities. Enhanced 911 services, which rely on the ability to determine caller location, may lead to location-inferring technologies for cellular phones, with applications to tracking. Broadcasts from commercial radio stations can be used to triangulate position [Driscoll, Survey]. According to NAVSYS Corporation, raw GPS data can be transmitted from a vehicle to a centralized processor, rather than processed on the vehicle, reducing equipment cost [Driscoll, Survey].

The North American CLS's ARGOS system currently provides tracking and messaging capability over much of the world using two low-earth orbit NOAA satellites. In North America, messages are typically processed within 20 minutes [ARGOS]. According to promotional literature, this delay will decrease to real-time rates as the number of satellites in the constellation increases to the planned 24.

Due to the intermittent availability of the communications link, this system is currently used for tracking cargo on ships rather than trucks.

Terrapin Corporation is developing a tracking system, called PINS, based on triangulation using FM pilot tones broadcast from commercial FM radio stations [Driscoll, Survey]. The company plans commercial availability in a number of major cities beginning in 1995.

In 1995, Canadian Marconi Company (CMC) plans to introduce a GPS-based, turnkey AVL system, initially targeting long-distance operators [GPS World, October 1994].

TrackMobile, Inc. is developing technology that will enable "location enhanced 911 response, stolen vehicle recovery, medical emergency response, roadside assistance, personal security response and street and address finding" [Driscoll, Survey, p. 22]. These capabilities are planned through a modification of cellular phones that will allow them to transmit signal strength measurements of control signals. Position will be computed by a centralized data processing center.

According to promotional information, PinPoint Communications' ARRAY system will, by the late 1990s, provide tracking and messaging in more than 300 major metropolitan areas in the U.S. via a ground-based radio network. Measuring the time difference of arrival (TDOA), the ARRAY system will reportedly be able to estimate position to within 20 to 50 feet [ARRAY, p. 7]. The system is planned to be available in Dallas by the end of 1995. Pinpoint plans a network in 50 major cities within the next two years [Law Enforcement].

The Federal Aviation Administration (FAA) has backed a plan for an Augmented GPS (AGPS) system that would, through five geostationary satellites, provide global corrections enabling sub-five-meter accuracy [GPS World, October 1994, p. 12]. Wilcox Electric (Kansas City, MO), TRW and Hughes Aircraft submitted a proposal for the system with Wilcox as the prime contractor. On August 3, 1995, FAA awarded this consortium a $475 million contract for development of the Wide Area Augmentation System (WAAS) to develop and build a network of ground stations across the U.S.

Table 3-2 summarizes key technologies in enabling AVL.

Table 3-2 Summary of AVL Enabling Technologies

SYSTEM	VENDOR(S) (PRODUCTS)	FUNCTIONAL DESCRIPTION	STATUS/AVAILABILITY	APPLICABILITY TO HAZMAT
GPS receivers	Trimble, Motorola, many others	Satellite positioning	Current	Positioning to100m (95%)
Raw GPS data	NAVSYS (TIDGET)	Communicates raw GPS data. GPS sensor, no processor.	Planned availability in 1995	Positioning to 100m, alert system
Differential GPS	Canadian Marconi, many others	GPS with corrections	Current in major U.S. metro areas	Positioning to <5m, orientation
Dead reckoning	ETAK	Vehicle sensors update position via a GIS computer	Current	Positioning
Commercial FM radio	Terrapin (PINS)	Triangulation on commercial radio broadcasts	In development, planned availability in 1995	Positioning to 30m
Paging	AirTouch	Centralized computing of position	Current	Positioning to 1300 ft. cellular communications
Ground-based radio	PinPoint	Triangulation by TDOA of radio signals	Some current systems	Enables tracking, positioning to 50ft
LEOSAT	North American CLS	Low-earth orbit satellite	Large growth in coverage predicted by 1996	Enables tracking
Enhanced 911	TrackMobile (Help Express)	Cellular network based positioning	Initial availability 1995	Enables tracking, positioning to 500ft
LORAN-C	Highway Master	Ground-based radio	Current	Positioning

3.4 INCIDENT DETECTION AND IDENTIFICATION

Incident detection and identification involves detecting a *potential* HAZMAT incident (an incident that *may* involve hazardous material) and identifying the particular HAZMAT involved, if any. Detection can be accomplished through human observation or automatic sensors. Identification can be accomplished from information on the scene through placards, paper manifest, electronic manifests, or chemical sensor technology, or through communication with the carrier/shipper. This section describes technologies that fall under VIS and apply to detection and identification.

3.4.1 Accident Sensors

With the proper communication equipment, accident sensors such as those used in airbag systems, could be used to trigger an alert, as could strain gauges or accelerometers. Orientation sensors, based on accelerometers or differential GPS, can detect a rollover [APL]. Table 3-3 summarizes technologies applicable to accident and incident detection.

Table 3-3 Summary of Accident/Incident Detection Technologies

SYSTEM/PRODUCT	VENDOR(S)	FUNCTIONAL DESCRIPTION	STATUS/AVAILABILITY	APPLICABILITY TO HAZMAT
Impact sensor	Various	Airbag switch, strain gauges, accelerometers	Current	Detection of potential impact
Differential GPS	Canadian Marconi	Attitude information	Current, not widely used	Orientation / rollover detection
Smart packaging	Various possible	Package monitors	Current, not used	Detect package failure
Trailer monitors	QUALCOMM	Detect changes in trailer/ cargo state	Some current	Alert driver of potential problem

Currently-In-Use Accident Sensors — Currently, air-bag triggers are the most ubiquitous accident sensors. "Inertial switches are the primary instruments employed in SRSs [Supplemental Restraint Systems, or airbags] today" [APL, p. 3-1]. An inertial switch consists of an inertial mass that must overcome a force (e.g., from a magnet, spring, or chemical bond) to physically activate a switch. Reliability is achieved through multiple, redundant sensors with a voting logic. Most current systems are designed to detect head-on collisions.

The Applied Physics Laboratory (APL) concluded in January 1994 that "due to reliability, cost or inability to measure g forces that could provide supplemental crash data (assists in determining appropriate EMS response), both strain gauges and inertial switches were not as appropriate for crash sensing as accelerometers" [APL, p. ES-1]. In APL's analysis, there was a strong emphasis on a technology's value in determining the severity of the accident. Since inertial switches give no indication of crash severity, they were discounted in the comparison with other technologies. However, the essential purpose of sensors in the proactive response scenario is to enable automatic notification of the carrier. In an accident in which the driver is incapacitated, inertial switch technology could enable carrier notification.

Future Accident Sensor Technology — A wide range of accelerometer technology could be applied to impact detection. The type and number of accelerometers would depend on the level of information required (e.g., acceleration profile range and bandwidth, orientation sensitivity, error limits and cost) [APL, p. 3-3].

Strain gauges, which measure chassis deformation, could be useful in detecting a crash or in detecting problems with cargo containers. One disadvantage is that multiple sensors would be required, since strain gauges only measure local deformation. Crash severity is not directly measured by strain gauges [APL, p. 3-9].

Differential GPS, with accuracy sufficient to determine vehicle attitude, could be used to detect rollover. Other technologies for detecting rollover include a strain gauge on the roof of the vehicle, gyroscopes ("prohibitively expensive" [APL, p. 3-10]), and accelerometers oriented vertically to measure vertical acceleration.

3.4.2 Incident Detection

Some HAZMAT incidents are coincident with a collision, while others are not. Improved detection of non-accident related incidents can be accomplished through automatic sensors. Technologies that warn a driver of a cargo problem may shorten reaction time, mitigating incident consequences and improving response time. Inexpensive thermometers, pressure sensors, chemical, smoke and fire detectors can provide cargo-state information to a driver. Electronic switches on valves, as well as on the trailer hook-up, can act as monitors. QUALCOMM's OmniTRACS systems has an optional trailer monitoring system. QUALCOMM is developing and implementing systems that detect and monitor open trailer doors, fire, chemical vapors, jack-knife controls, and other trailer subsystems [QUALCOMM Literature].

Sandia National Laboratories has developed smart sensor technology with application to detecting package container failure on trains and notifying the operators. In an accident, it would send a distress signal to authorities, notifying them of the location and condition of the cargo. The "Green Box [smart sensor] would be capable of surviving most typical railroad accidents . . . [It] could be attached to any railroad car or cargo container" [Hogan, p. 147]. Plans have been developed for testing the hardware in accident conditions. Smart packaging has been identified as an ITS technology with application to HAZMAT response. Currently, there are very few users of smart packaging other than the government [Allen].

3.5 HAZMAT IDENTIFICATION

Once a potential HAZMAT incident has been detected, that is, a crash alert signal has been sent to the dispatcher and police, fire, medical have been notified, the presence of HAZMAT has to be determined and the particular materials involved identified. A number of technologies can provide backup for placards and paper manifests.

In a study conducted for the FHWA [Russell, p. 48], 30 panel members with state and local responsibility for HAZMAT transportation policy and engineering were asked to produce a list of 11 extreme risk HAZMAT transportation-related scenarios and to evaluate proposed protective measures. Remote sensing capability (Table 3-4) was generally rated as more desirable than non-remote sensing (Table 3-5).

An analysis of emergency response decision making in 70 chemical accident situations (not necessarily transportation related) found that "the decision to warn the public took an average of 79 min, ranging from less than a minute to more than 16 h" [Rogers, p. 361]. Most of the decisions to warn the public were made "rapidly, 50% [were] made within about 30 min, . . . about 90% [were] made within the first 2 h" [Rogers, p. 363]. Safe-side decisions were found to be made more rapidly than decisions that place people at risk. One source of delayed decision making was identified as: "decisions in chemical emergencies often involve information seeking"

[Rogers, p. 371]. The study also reported that "decisions using standard operating procedures are made more quickly than decisions without benefit of SOPs" [Rogers, p. 364].

Current Sensor Technology — Allen identified smart packaging as a technology with potential application to HAZMAT transportation. The technology monitors the physical condition (e.g., temperature, pressure, etc.) of containers. Allen notes that the "sensor and communication technology now exists to develop smart packages. Key question is whether benefits exceed the costs at this point" [Allen, p. 4].

Table 3-4 Technologies Applicable to Remote Sensing

TECHNOLOGY	RATING*
Gaseous-measuring laser radar systems	6.7
Haze Analyzer	6.5
U.S. Army's remote sensing XM 21	6.5
Correlation Spectrometer	6.0

Table 3-5 Technologies Applicable to Non-Remote Sensing

TECHNOLOGY	RATING*
Explosimeters	5.9
Colorimetric Indicators	5.8
TLV Sniffers	5.4

*(Partial) Scale:

5.0 — *Possible merit as practical and implementable protective system; worth further thought or development*

6.0 — *Clear cut merit as practical and implementable protective system*

7.0 — *Highly feasible, very practical, useful and efficient, i.e., excellent and very desirable.*

Source: [Russell, pp. 48]

Future Chemical Sensor Technology — Chemical sensors that can detect chemical changes in the atmosphere within a trailer could provide an early warning to the driver. Many of the potential technologies are hampered by "large irreproducibility of performance and important drifts and degradation with time" [Madou, p. 3].

The U.S. Army has indicated a willingness to transfer technology related to standoff detection of chemical vapors. A tripod-mounted passive infrared device as well as new generations of hand-held sensors may become available to the commercial market and to first responders [Aberdeen].

Research in metal oxide silicon field effect transistors (MOSFETs) has indicated their effectiveness in detecting hydrogen containing gases, such as ammonia, hydrogen gas, and hydrogen sulfide, as well as carbon monoxide. Robins indicated that "the devices [are] small, rugged and easily interfaced to control equipment. However, the most important advantage of the MOS-based sensors is that they should be easily mass-produced using conventional silicon microelectronic techniques and should, therefore, have a relatively low cost" [Robins, p. 234]. The major advantages of solid state sensors over more classical analysis techniques, such as gas chromatography, ion mobility spectroscopy, and mass spectroscopy, are their simplicity in function, small size, and projected low cost [Madou, p. 1].

Sandia National Laboratories has developed microsensors based on chemical and radiation sensing field effect transistors (FETs). A microelectronic chemical-sensor array capable of selectively sensing several gasses has been fabricated. [Sandia] Many thin-film solid-state sensors are "still [1989] in the development phase, but sensors for hydrogen sulfide have been commercially available for years" [Madou, p. 431]. Applicability of a solid state sensor to a particular environment depends on details of the design; that is "satisfactory performance is obtained only when all these different design factors are considered" [McGeehin, p. 783].

In 1988, Harmer and Narayanaswamy identified chemical sensing with optical fibers as "one of the most interesting of the emerging sensor technologies. . . . [The optical fiber] bestows total electrical isolation at the transducing end, thus making the device safe for use in explosive environments" [Edmonds, Ch. 13, Sec. 1]. Sandia National Laboratory, in 1990, wrote about a "new class of chemical sensors based on the change of reflectivity of thin metal and/or polymer films on the end of an optical fiber" [Sandia, p. 10]. These monitors could give low-cost, real-time measurements of toxic wastes around a waste site.

Ultrathin film composite membranes have been recently identified as a potential sensor technology with a "promising and versatile approach for sensor design" [Martin, p. 12]. Such composites consist of an ultrathin [less than 100nm thick] chemically-selective 'skin' bonded to the surface of a microporous support membrane" [Martin, p. 2]. The chemical separation occurs within the "skin," whose thinness increases the rate of permeation of the chemical(s) of interest. These membranes can provide "high chemical selectivity, high permeate flux, and good mechanical strength" [Martin, p. 2].

Table 3-6 summarizes current research in chemical sensors applicable to HAZMAT sensing and identification.

Table 3-6 Summary of HAZMAT Sensing and Identification Technologies

SYSTEM	VENDOR(S)	FUNCTIONAL DESCRIPTION	STATUS/AVAILABILITY	APPLICABILITY TO HAZMAT
Solid State sensors, thin film-sensors	Various potential	Chemically sensitive transistors, chemically permeable membranes	Research	Personnel badges on-vehicle detection chemical identification
Fiber-optic sensors	Eli Lilly	Optic transmission properties dependent on ambient chemicals	Research, current biomed application	Chemical identification, some stand-off capability

3.6 COMMUNICATIONS

In the project survey (Chapter 2), first responders identified the lack of information on the cargo as a constraint on their effectiveness. They indicated the need to determine *if* hazardous material is present and, if so, then which material(s). Other surveys [NAS, p. 81] have indicated that in about 25% of potential HAZMAT incidents, the information from the driver, shipping papers, and placards is insufficient in communicating the nature of the cargo (this includes cases in which HAZMAT was suspected to be present but, in fact, was not; and cases in which shipping papers were destroyed or made unretrievable by a crash or fire). Although Federal regulations require that "emergency response information accompany or be included on hazardous materials shipping papers, [in several of the case studies examined by the NAS] the required information was incorrect or missing, and some of the responders noted that the shipping papers do not always contain a working emergency telephone number" [NAS, p. 138]. A failure in any component of the information provided by the driver, shipping papers, or placards can cast doubt on the validity of the available cargo information, leading to lengthy precautionary delays.

The three most critical information needs of first responders, as identified by the Transportation Research Board [NAS, p. 64], are:

1. Forewarning of the presence of hazardous materials
2. Basic description of the types of hazards present
3. Technical names, quantity, and packaging of materials.

In the pilot project survey, the following actions were identified as key steps in emergency response:

1. Differentially diagnose the event within the broad spectrum of emergency scenarios
2. Identify and characterize all chemicals involved.

In order to be relevant, a communication technology should have the potential to address at least one of these concerns. Communications provide the links between the components of an effective HAZMAT incident response system. Communication needs include accessing computer networks and databases maintained by carriers for shipment information, accessing MSDS information from public and private information resources, and "pushing" shipping paper and MSDS information to first responders. Table 3-7 provides an overview of applicable communication technologies and protocols.

Table 3-7 Communication Enabling Technologies

SYSTEM/PRODUCT	VENDOR(S)	FUNCTIONAL DESCRIPTION	STATUS/AVAILABILITY	APPLICABILITY TO HAZMAT
EDI	Industry standard: many vendors	Electronic data interchange	Current internal use in larger shipping companies	Electronic manifests could be downloaded by responders
CDMA	Industry standard: QUALCOMM is primary developer	Code Division Multiple Access, standard for improved use of bandwidth	Planned general availability on LEO in 1st quarter 1996	PCS method, real time voice/ data
Radio Packet Data	RAM, Ardis	Radio/Cellular technology	Current	Real-time data, 2-way messaging
Smart Cards, Transponders	Micron Communications, others	Data storage on small cards – radio transponders	Currently security, banking, aircraft, military-related applications	Cargo description, truck ID, HAZMAT information
Little LEO	Orbcomm	Small LEO satellites	Awarded the first FCC LEO license Oct., 1994.	Real-time data, 2-way messaging via pocket-sized communicators
Big LEO	Iridium, Globalstar L.P., others	LEOSAT, > 1 GHz	FCC plans to begin issuing licenses in Jan., 1995	Real-time voice and data
ARGOS	North American CLS	LEOSAT	Some current capability, planned expansion	Enables tracking – currently large delays due to satellite availability
Broadband PCS	AT&T/McCaw Cellular	FCC regulated, Large capacity, ~30MHz	Bid for FCC licenses Dec. 1994	Real-time data and voice across U.S.
Narrowband PCS	Mtel, PageNet, KDM Messaging	FCC regulated narrow (~50 KHz) frequency bands	Begin availability late 1995	Real-time data across U.S.
Satellite Cellular Phones	Motorola	LEOSAT	Under development	Real-time voice/data
ARRAY	PinPoint	Ground-based radio	Under development	Real-time data and positioning, tracking/alert

3.6.1 Current Communication Technologies

A number of current applications enable communication between the vehicle and the carrier. Many vehicles carry cellular phones, which enable quicker notification and could enable automatic notification through integration with an accident detector. An alert-capable QUALCOMM system can, when the panic button is pushed, immediately generate a position report and alert message to dispatch. In one incident, a tanker was hit and began leaking fuel. The panic button capability enabled the police to respond in 15 minutes, reducing spillage at the scene and decreasing exposure to liability [QUALCOMM, Shippers on Trac].

The Transportation Computing and Communications System (TCCS) from Itronix currently provides wireless data communication from a portable PC platform, using any of the Cellular Digital Packet Data (CDPD) wireless networks provided by major cellular phone companies in the United States [Itronix]. CDPD is a system for transmitting data files over idle channels in cellular networks.

Communication applications such as TCCS provide the capability to track vehicle position through a data communication version of a "phone check-in" system, while other systems, such as QUALCOMM's OmniTRACS, provide AVL technology and automatic periodic position reporting. Package deliveries can be reported and tracked, improving data on the cargo in the event of an incident. An alert signal can be sent advising the carrier of a problem, improving the emergency response time. QUALCOMM is a primary developer of the Code Division Multiple Access (CDMA) technology, which enables wireless voice transmission over a broad band spectrum. Each transmission is encoded such that it can only be identified and retrieved by the intended receiver. CDMA modulation allows more calls to occupy the same bandwidth in a communications channel. It "is expected to become one of the standards for digital cellular and Personal Communications Services (PCS) networks" [Driscoll, Survey, p. 3]. QUALCOMM reports that this technology could be used in positioning, but that there has been little customer interest.

Two-way paging services are enabled through packet radio providers, such as RAM Mobile Data and Ardis. These tend to be more expensive than one-way numeric display services [S&P report], though less expensive than cellular telephones [APL, p. 4-20]. RAM Mobile Data and Ardis currently offer packet radio data communication services in most U.S. metropolitan areas [APL, p. 4-20].

3.6.2 Future Communication Technologies

The NAS report highlights automatic electronic identification (AEI) of vehicles, containers, or packages as one technology area with application to HAZMAT response. AEI systems are suitable for remote and automatic reading [ADVANTAGE I-75]. The I-75 initiative includes on-board transponders that could provide information on hazardous material in the shipment. These electronic placards could be used to communicate shipping papers and HAZMAT information to first responders as a stand-off technology.

Smart cards, such as the MicroStamp™ produced by Micron Communications, are miniaturized (approximately one inch square and the thickness of a dime) radio receiver/transmitters and CPU/memory chips. MicroStamp capacity is available in 48, 264, and 528 bytes. Manifest and MSDS information can be encoded on a smart card and carried on a vehicle or with a driver. Micron Communications estimates the MicroStamp will be commercially available after January 1995 [E&E].

Mobile Telecommunication Technologies Corporation (Mtel) expects to begin commercial operation of its *Destineer* network in 300 U.S. metro areas during the second half of 1995 [S&P]. This wireless two-way paging network, utilizing narrowband PCS, should "provide an effective communication link for AVL and other mobile data applications" [Driscoll, Vehicle Tracking, p. 8]. Mtel envisions enabling business travelers and consumers to "send and receive messages using a small, user-friendly device or via an ordinary laptop or palmtop computer" [S&P, p. 259]. Initially, the technology will support only a few, scripted replies to acknowledge receipt of a message. Later, Mtel plans to introduce a device which allows users to create their own messages.

Of the six Big LEO applicants, five propose using code division multiple access (CDMA) and one — Iridium — proposes Time Division Multiple Access (TDMA). These communication standards enable efficient use of available bandwidth.

Orbcomm plans a 36-satellite "Little LEO" system for data relay and position determination [AW&ST, p. 12].

PageNet is the largest provider of paging services in the U.S. It plans to use its narrowband PCS licenses to create a nationwide voice messaging product dubbed VoiceNow. The system will allow limited data response to a voice message as an acknowledgement or receipt [S&P].

The NAS study notes that electronic data interchange (EDI) can enable on-demand communication of cargo, shipper and MSDS information [NAS]. EDI technology improves internal communication and record keeping within a carrier company and speeds its billing process. According to NAS, a "1991 American Trucking Associations survey found 176 trucking companies using EDI, up from 86 in 1988" [p. 192]. The NAS also noted that "EDI is used today [1993] by all major railroads and large shippers. All the larger trucking companies also use EDI, but it has not yet been extensively adopted among the tens of thousands of small trucking companies and the millions of small trucking customers in the country" [NAS, p. 192]. In terms of HAZMAT response, EDI technologies improve the system of data retrieval. In the event of an incident and with the proper equipment, local government emergency response officials could be given access to a shipper's EDI system.

In January 1995, CDPD carriers, Ardis and RAM Mobile Data L.P., are expected to ratify a standard allowing applications to be ported easily from one wireless network to another [PC WEEK, November 21, 1994].

Three current cellular/wireless network standards are summarized in Table 3-8. Some applications (e.g., Tech-Net by Service Systems International) already make use of a variety of protocols, including these three [Service Systems].

Table 3-8 Communications: Cellular/Wireless Network "Standards"

SYSTEM/PRODUCT	VENDOR(S)	FUNCTIONAL DESCRIPTION	STATUS/AVAILABILITY	APPLICABILITY TO HAZMAT
RAM	RAM Mobile Data L.P.	Wireless network, proprietary	Current	Wireless network, data messaging
Ardis	Ardis	Wireless network, proprietary	Current	Wireless network, data messaging
CDPD	Industry standard: Bell Atlantic Mobile, others	Cellular digital packet data, uses SLIP drivers	Current, under development by consortium of major cellular carriers	Standard for low-cost data messaging

3.7 INFORMATION RESOURCES

Information resources related to HAZMAT transportation incidents can be divided into cargo information sources, HAZMAT databases, and services such as

CHEMTREC. Cargo data may be provided by the driver, carrier or shipper, in paper or electronic forms. Hazardous material data, such as that found on an MSDS, may be provided by the shipping papers, the carrier, the shipper, government sources, CHEMTREC, or other private chemical information companies. Table 3-9 summarizes information resources applicable to HAZMAT transportation incidents.

Table 3-9 Summary of Information Resources

SYSTEM/PRODUCT	VENDOR(S)	FUNCTIONAL DESCRIPTION	STATUS/AVAILABILITY	APPLICABILITY TO HAZMAT
Cargo Manifest Data (Onboard)	I-75 initiative	Transponders signaling presence/type of HAZMAT	Experimental	On-site standoff determination of HAZMAT by equipped first-responders
Cargo Manifest Data (Dispatch)	Encompass	Electronic document databases of HAZMAT cargo	Current for some ship carriers; highway carriers being considered	Faster response from carriers / shippers in providing shipping papers
Chemical Reference Database	CHEMTREC, CAMEO, HMIX, U.S. DoD	MSDS databases	Current, not widely available	Identification of toxicity, precautions to take with chemicals
Medical/Toxicology Reference Database	U.S. National Library of Medicine, NPTN (EPA)	National toxicology/ pesticides information	Currently research oriented	Currently non-emergency oriented

3.7.1 Current Management of Cargo Information

In the U.S., DOT regulations require that most shipments of HAZMAT by truck must carry shipping papers that describe the hazardous material and contain certification by the shipper that the shipment conforms with all DOT HAZMAT regulations and requirements. In addition, placards warning of the presence of hazardous cargo and identifying the class of hazard present (e.g., flammable, corrosive, and poison) are required by DOT to be placed on the ends and sides of trailers. The information provided by these measures has been demonstrated to be insufficient in a significant percent of case studies of HAZMAT incidents [NAS]. First responders in the project survey (Chapter 2) identified the need to maintain an accurate inventory of hazardous commodities being transported on a vehicle and to make this information immediately accessible by first responding organizations.

The NAS interviewed a major chemical manufacturer regarding shipping. One conclusion was that "the circumstances at this company, which are typical of many shippers, suggest that the most efficient arrangement for maintaining real-time records relating vehicle identification to contents would be to place record-keeping responsibility with the carriers, rather than sharing it among carriers, shippers, and receivers" [NAS, p. 212].

For the past six years, a central tracking system run by Encompass, Inc. (Cary, NC) has been providing companies shipping goods, some of which are specially marked as HAZMAT, with an electronic view of where their goods are located at any point in the shipping process. The system "allows suppliers, warehousers, manufacturers, and carriers to transmit [manifest] information to its central data clearinghouse . . . in Dallas" [Encompass, p. 22]. Encompass uses a client-server-based distributed architecture that allows recipients of maritime shipments from a range of carriers to see where their materials are and estimate when they will arrive at their destinations. According to a company vice president, Encompass will be expanding its central manifest clearinghouse services to support air and land shipments in the U.S. Encompass is also willing to participate in any tests involving HAZMAT tracking when they begin work with truck carriers [Encompass].

3.7.2 <u>Current Management of Material Safety Data</u>

The Hazardous Materials Information Exchange (HMIX) system is a dial-up service of the Department of Transportation and the Federal Emergency Management Agency providing a variety of information on chemical materials, regulations and literature. The service is not emergency-oriented.

CHEMTREC is a service provided by the Chemical Manufacturers Association (CMA). CHEMTREC maintains the largest electronic database of MSDSs in the United States, with "over one million documents available for immediate access in an emergency" [CHEMTREC, p. 2]. CHEMTREC can access medical and poison control specialists who can provide expert advice in the event of an emergency.

Through the CERT program, Ecology and Environment, Inc. offers a comprehensive range of services. Private subscribers support a 24-hour Operations

Center complete with computerized databases, HAZMAT library, spill modeling capability, and experienced emergency management staff. Other firms provide services similar to these provided by E&E.

The Emergency Response function for the Center for Disease Control is coordinated by the Emergency Response Office of the Agency for Toxic Substances and Disease Registry (ATSDR), based in Atlanta, GA. ATSDR funnels all requests for support during HAZMAT incidents through one telephone access number, (404) 639-0615. This access is afforded to any organization with a bona fide unfolding HAZMAT emergency.

When calling this number, the caller will be routed to either the office responsible for EPA Superfund Sites or to the office responsible for all other response action. ATSDR experts provide the caller with detailed chemical information and treatment recommendations and serve as a resource for in-hospital medical personnel during chemical emergencies. Within ten minutes of the receipt of a call for assistance, ATSDR staff will make available specific expert consultations with toxicologists, chemists, physicians and, in a less timely fashion, health physicists for radiation associated problems. If the incident is of national significance, then ATSDR will assemble a special on-site assistance team to travel to the emergency and support the response operations. This service is only provided when the event's Federal On-Scene Coordinator (FOSC) requests it. The Emergency Response Office also provides technical advice and guidance to callers during non-emergency situations as their workloads permit.

CAMEO is a software application that helps emergency responders identify the chemicals involved in an incident and select the appropriate protective gear. It is used by the Los Angeles hazardous materials team [NAS, p. 215]. While this information is not typically available to first responders, an early notification of the presence of HAZMAT may enable the information to be communicated before, or soon after, first responders arrive at the scene.

Currently, on-line public MSDS databases are becoming available. The University of Utah Chemistry Department maintains public domain MSDSs on an on-line Internet Gopher server at gopher://atlas.chem.utah.edu/70/11/MSDS. A wider variety of MSDSs (including proprietary) are available on CD-ROM from commercial and government sources [Gale].

3.7.3 Future Database Technologies

In the future, currently available, though not widely used, database applications such as CAMEO are likely to become more widely employed. The expanding capabilities and decreasing cost of data storage and retrieval and computer hardware will likely increase the use of CD-ROM and on-line chemical and medical databases.

Chemical reference database — The U.S. Department of Defense, through the U.S. Navy, provides MSDS data on over 100,000 chemical substances bought and used by the DoD. A proprietary version is restricted to U.S. government agencies, while a nonproprietary version is publicly available. Information on the Hazardous Material Information System is available from the Defense General Supply Center, Richmond, VA.

Medical/toxicological reference databases — The U.S. National Library of Medicine provides data on the toxicity of over 100,000 chemicals through commercial vendors. CCINFOdisk markets the data in CD-ROM format. This is currently oriented towards researchers and literature searches. TOXLINE and MEDLINE provide researchers with CD-ROM based information on toxicological research. TOXLINE contains information from the Hazardous Materials Technical Center (HMTC), part of the U.S. Defense Logistics Agency. HMTC reports on transportation, disposal, and storage of hazardous materials [Gale].

The National Pesticide Telecommunications Network (NPTN) provides toxicological information on pesticides, sponsored cooperatively by the U.S. Environmental Protection Agency and Texas Tech University Health Sciences Center. Currently, it is not oriented to providing emergency response information (e.g., no 24-hour hotline) [NPTN].

3.8 COMPUTER-HUMAN INTERFACES

Computer-human interface technologies can improve the level of communication between first responders, emergency dispatch, the shipper, carrier and chemical information providers. Table 3-10 summarizes the following technologies:

Table 3-10 Summary of Computer-Human Interface Technologies

SYSTEM/PRODUCT	VENDOR(S) (PRODUCTS)	FUNCTIONAL DESCRIPTION	STATUS/ AVAILABILITY	APPLICABILITY TO HAZMAT
CAD Workstation	Pamet	Computer-aided dispatch	Current, some use	MSDSs to first responders
Mobile Data Term (MDT)	Itronix, DataMaxx, others	Mobile computer with messaging capability	Current	2-way messaging. Electronic shipping papers
Personal Digital Assistant (PDA)	Apple (Newton), Motorola (Envoy)	Hand-held computer, often with pen entry	Current	2-way messaging. Electronic shipping papers
Personal Communicator	IBM (Simon)	Hand-held computer. paging, fax and e-mail	Current	2-way messaging Electronic shipping papers
Smart Pager	Notable Technologies (AirNote)	One-way (receiver) for data messaging, e-mail	Current	Communicate MSDS data to first responders, shipping papers
Smart Card Programmer/ Reader	Centennial Technologies, Citibank N.A. Micron MicroStamp	Encryption cards, security, "cash" cards	Currently available as security-pass cards	Store shipping papers, contact information
Geographic Info Systems (GIS)	Strategic Mapping (Atlas GIS)	Geographically organized database	Currently available, little use	Enable carriers to notify likely first responders
Internet Access Applications	Spry (AIR NFS)	SLIP, PPP, etc. connection software	Currently available	Connect emergency dispatchers, first responders, carriers, shippers
AVL, VIS Systems	QUALCOMM	Vehicle location and information systems	Current	Enable tracking, early notification to carrier and first responders

Computer Aided Dispatch (CAD) Workstation — Pamet Systems' FireServer computer-aided dispatch software provides a number of services related to fire service dispatch, including access to the CAMEO Hazardous Materials Database [Pamet].

Mobile Data Terminal (MDT) — MDT technology is available for both carriers and emergency responders. Itronix currently provides vehicles with PC-based messaging via its Transportation Computing and Communications System (TCCS) [Itronix].

Personal Digital Assistant (PDA) — A PDA is essentially a handheld computer. Motorola's soon-to-be released Envoy PDA provides two-way personal wireless communication through the Ardis nationwide wireless data network and RadioMail Inc.'s wireless e-mail gateway. Envoy weighs 1.68 pounds. Sony Electronics recently announced its Magic Link PDA, which supports pen-entry (handwriting) and will send handwritten e-mail as images without attempting handwriting recognition.

Personal Communicator — Two-way data messaging (e-mail) based on little LEO or cellular technology. Little LEO technology should become available in 1995-1996. BellSouth Corp. and IBM teamed to produce Simon, a cellular based personal communicator providing wireless e-mail, pager and fax capabilities [PC WEEK, August 22, 1994]. Simon weighs 18 ounces, measures 8 by 2.5 by 1.5 inches and is available in 190 cities covered by BellSouth's cellular network.

Smart Pager — One-way paging services providing e-mail include AirNote by Notable Technologies [Information Week], an alphanumeric pager that accepts e-mail transmitted via satellite communications. AirNote can be linked to voicemail or 800 numbers.

Smart Card Programmers — Smart card technology development is oriented towards banking [Information Week, 1994] and security applications such as encryption cards [Edge, 1994]; however, it has applications to HAZMAT in enabling electronic shipping papers. A smart card programmer would be used to store shipping papers, chemical warnings, and other information on a smart card.

Geographic Information System (GIS) — The increasing use and quality of GIS technology improves carriers' tracking capabilities. GIS is also useful in planning emergency response and locating emergency responders near the incident. QUALCOMM provides GIS technology with its tracking software [QUALCOMM Literature]. There is wide variety in the qualities of available GIS software.

Internet Access Applications — Many products bundle the necessary software for Internet connectivity and use. Fundamentally, a TCP/IP stack is necessary to provide Transmission Control Protocol and Internet Protocol compliance. Interfacing software allowing SLIP (Serial Line Interface Protocol) or PPP (Point-to-Point Protocol) connection may also be necessary. The well-known browsers Mosaic and Netscape are available in different versions from a number of commercial providers, as well as free on-line. These web clients enable database browsing and data retrieval, via File Transfer Protocol (FTP), over the Internet, along with hypertext-based browsing.

3.9 TECHNOLOGY INTEGRATION

Many of today's vehicle information systems combine navigation and communication functions to support fleet management. Messaging capabilities allow alphanumeric communication between a carrier and its trucking fleet. Different systems provide different levels of capability, as measured by the time required for communication and bandwidth (data/voice/size of messages). Use of these systems, while motivated by quality improvement, enables carriers to respond more quickly to HAZMAT incidents through alert capabilities.

Positioning information has not been identified as an important bottleneck in HAZMAT response. However, the combination of positioning and communication in tracking technologies allows for a proactive response in incident management.

Table 3-11 summarizes VIS-based tracking systems. These AVL/VIS systems, by providing tracking and emergency alert capabilities, enable a proactive response from the carrier.

Table 3-11 Summary of Vehicle Information System Products

PRODUCT	VENDOR(S)	FUNCTIONAL DESCRIPTION	STATUS/AVAILABILITY	APPLICABILITY TO HAZMAT
OmniTRACS	QUALCOMM	Geostationary satellite based messaging with optional VIS	Current – 100,000 units sold	1000 ft positioning, vehicle monitoring, tracking, alert
Tripmaster	Rockwell	AVL through GPS, messaging, route analysis	Current – 2,000 installed, 4,000 units sold	Tracking, alert
Highway-Master	Highway-Master	Cellular, LORAN-C, or GPS based positioning. 2-way data, location and voice.	Current – 3,000 units installed	Tracking, alert.
AirTouch Teletrac	Teletrac	Land-based radio positioning. 2-way data messaging, location.	Current – 29,000 installed	Location to 150 ft. tracking, alert.
ARGOS	North American CLS	LEOSAT	Very limited current capability	Tracking, alert
ARRAY	PinPoint	Ground-based radio	Under development	Tracking, alert

3.9.1 Intelligent Transportation Systems (ITS)

The ITS, formerly Intelligent Vehicle Highway Systems (IVHS), initiative currently includes a number of technologies being tested for their applicability to routing, fare collection, and Weigh-in-Motion (WIM) [H.E.L.P.] [Advantage I-75]. These technologies could enable a statewide tracking system for HAZMAT shipments. The on-board transponders could be programmed with HAZMAT information.

Allen discusses the following four ITS technologies applicable to HAZMAT transportation [Allen]:

- Electronic Placard
- Real Time Tracking
- Electronic Manifest
- Smart Package.

Electronic placards, discussed in the communications section, would enable a stand-off capability to access manifest information at the scene, including, potentially, emergency instructions (e.g., MSDSs). Allen notes that the technology exists to develop smart cards and identifies the need to test their performance in an accident environment. As discussed earlier, real-time tracking may be useful in piecing together the shipment information for LTL shipments, but precise position information alone does not appear to be a primary need of first responders. Checkpoints [H.E.L.P.] for weigh-in-motion and automatic toll collection, combined with statewide databases, could track HAZMAT shipments. Electronic manifests, provided either through smart cards or on-line databases, may improve the availability of shipping papers to first responders. Smart package technologies that alert operators of problems and broadcast their position (as an anti-theft capability) also enable tracking.

The State of Florida is initiating a statewide digital public safety radio system that will eventually link 4,989 officers in five agencies. Motorola is handling the implementation and testing of the system. The system combines computer and radio technology. "Computer Aided Dispatch," another part of the network, will also allow agencies to collect information in real time. Information will be available at a mobile data terminal in trooper's cars" [Edge, 1993, p. 18].

3.10 IMPROVING HAZMAT RESPONSE WITH INFORMATION TECHNOLOGY

If proactive response capabilities had been in place, what effects would they have had on the incidents in the case studies in the DOT response to the National Academy of Sciences (NAS) study? [NAS] How could the technologies identified above have improved the emergency responses? The HAZMAT cases in which information problems were detected were determined to have one of six information-related problems. [NAS] The six information problem categories described by NAS are cited below, along with comments on the information problems and technology implications.

1. Required sources of information are missing or inaccurate.

2. Placards, shipping papers or other information sources are obscured, destroyed, or inaccessible because of crash or fire, explosion, toxic exposure, or other impediments.

The lack of required information at the scene (items 1 and 2 above) can be compensated for by proactive technologies that provide information to the first responders before arrival. Missing placards indicate, presumably, that electronic placarding might not have been effective in those cases. The driver may be unavailable, or there may be a lack of knowledge of the cargo at the scene. The driver may also unintentionally mislead first responders into thinking the cargo is more/less hazardous than it actually is. Additional information sources, such as verification of the shipping papers might help.

3. Information sources are in compliance with regulations and accessible, but they fail to efficiently convey important information to responders.

Most importantly, the "dangerous placard" was not descriptive of hazards; shipping papers were cumbersome to review; and responders did not trust all information sources available and therefore did not use them. For mixed loads, identifying cargo tends to complicate the response. Even with the required information, determining potential chemical interactions is beyond the capabilities of first responders. A proactive response would notify first responders of the mixed load, but would not necessarily be helpful in identifying what part of the shipment is involved (e.g., has caught fire). Chemical sensors may be useful in identifying the HAZMAT involved. The shipper or a professional HAZMAT team might be contacted for support in identifying the materials. Confusion over shipping papers at the scene might be mitigated by a proactive response that communicates shipping papers to first responders. Such a system would have to communicate papers for all potentially ambiguous incidents in order to prevent confusion over non-hazardous cargo.

4. *Information is insufficient because the material or shipment is exempt from some federal hazardous materials transportation regulation.*

Some potentially harmful materials on shipments are not covered by DOT regulations governing placarding, labeling, and shipping papers because they are not designated as hazardous, do not meet minimum weight/quantity thresholds, or are not involved in a clearly transportation activity. First responders cannot readily confirm that a material is not hazardous. In some cases, material that appeared to first responders to be hazardous was not covered by DOT regulations. In many cases, the material was misidentified as hazardous by the driver or had characteristics of hazardous material (e.g., caused dizziness or fumes). First responders typically reacted with extreme caution, assuming the cargo was an unmarked hazardous shipment. A proactive response would have identified the cargo before the driver could provide misinformation. Unregulated material, showing evidence of toxicity, may have been treated as hazardous material even with a proactive response. In cases in which the cargo had characteristics of HAZMAT, it was treated as HAZMAT, even after the shipper insisted it was not.

5. *Vehicle operator is unprepared to provide information.*

Without shipping papers or other cargo information (lost in accident), vehicle operators (i.e., truck driver or train crew) were unable to identify basic hazards of cargo. In many instances, the vehicle operator did not take proper actions to assist first responders, such as identifying themselves and providing on-board documentation.

6. *Responders fail to obtain or properly use available information.*

In some cases, the first responders were apparently unaware of the shipper's phone number on the shipping papers, of CHEMTREC services or of other sources of information and assistance. By "pushing" information to them, the proactive response does not assume the first responders are aware of all information sources.

Evaluation

Using information inadequacies from the case studies as the basis for evaluating the general technology areas, the following observations are made:

Automatic Vehicle Location/Tracking. In many cases, the carrier was not contacted for information until well into the response. Most AVL systems contain a "panic button" or other instant communications capability that would allow the driver to contact the carrier as part of requesting emergency service. AVL is important to improving HAZMAT response by providing [NAS]:

- Alert notification to the carrier
- Tracking capabilities for carrier self-identification, shipper identification.

Sensors on vehicle/cargo. More general than AVL, Vehicle Information Systems (VIS) may also contain technology that monitors the vehicle and cargo state. In the future, sophisticated chemical sensors may be able to determine what part of the cargo is involved in an LTL incident. Smart packaging with communication capability (e.g., transponder) would enable identification of open containers that are not in view of first responders.

Chemical sensors for HAZMAT detection and identification. A first response team equipped with chemical identification equipment could determine the presence of HAZMAT and the material involved independent of shipping papers, placards or driver information. Lack of compliance with placarding or shipping papers would not affect sensor capabilities the way it might with electronic placarding. A stand-off chemical sensor was identified [Russell] as the most valuable of the potential technologies in responding to a potentially catastrophic HAZMAT incident.

Communications. The lack of communication between first responders and information providers (shipper, carrier, CHEMTREC) indicates that communication technologies are the most valuable in assisting first responders. With the proper communications equipment, a 911 dispatcher could quickly be in touch with carriers, a first response team could download the MSDSs from a remote computer database, and the shipper or carrier could verify shipping papers and identify possible ambiguities in the hazardous nature of the cargo. Automatic Vehicle Identification (AVI) technology and other ITS technologies may also provide transponder-communicated information about the cargo.

Information resources. The increasing use of electronic file management systems could, with the proper communications equipment, lead to a proactive response in verifying shipping papers and identifying ambiguities. Databases containing MSDS information are available on CD-ROM, and some MSDS information is available on-line. Increasing access to this information would improve HAZMAT response.

Computer and human interfaces. Interfaces with electronic placarding systems and other on-vehicle identifiers must assist in assuring a sufficient level of compliance. Computers hosting MSDS information have been identified as useful to first responders. Computer and human interfaces are enabling technologies for improved communications and are rapidly becoming commercially available.

3.11 SUMMARY

This chapter has identified areas of technology applicable to improving emergency HAZMAT first response. Specific products and systems were identified as examples of the current and possible future capabilities of the carrier, shipper and responder communities. Conditions for a proactive response lead to the following observations:

- To overcome information problems regarding the hazardous nature of the cargo, the carrier should be notified as soon as possible. The carrier can be identified through vehicle position/tracking, vehicle markings or driver "alert." It is generally unfeasible to directly notify the shipper before the first responders arrive at the scene. The carrier is in the best position to quickly review shipping papers and determine if there is any potential ambiguity about the nature of the cargo.

- The carrier must have fast access to shipping papers and the first responders must have the communications equipment to receive the information. The carrier should contact the emergency response telephone number on the shipping papers, which is required by DOT, if the cargo is determined to be hazardous, or if its nature is ambiguous.

4. PROJECTS OF POTENTIAL RELEVANCE

This chapter provides a list of projects that may be relevant to a potential pilot project. The first section provides background to the subtask and the second section contains a categorized list of relevant projects and/or products.

This chapter discusses projects related to the subject potential pilot project in order to leverage the technologies or resources of other companies or agencies. The expectation is that other projects could be modified or adapted to accomplish HAZMAT information system pilot test objectives.

The approach of this subtask was to use the personal contacts of team members in government and industry to identify likely candidates.

4.1 APPROACH

Typically, only breakthrough technologies or applications find their way into scientific or professional publications. There were few of these discovered in standard literature databases. The lack of publishing interest made surveying the total population of innovative projects very difficult. Ongoing and proposed projects were discovered by informally surveying the responder community.

In addition, a posting was made to a number of Internet news and discussion groups during December 1994 to solicit relevant information. Postings were made to the newsgroups and discussion groups shown in Table 4-1. More information about Internet postings and responses appears in TASC Technical Information Memorandum TIM-07568-OA-1, 15 March 1995.

4.2 IDENTIFICATION OF WORK OF RELEVANCE TO THE PILOT PROJECT

The application of emerging information systems to improve the first response to hazardous materials accidents encompasses a broad range of new technologies and applications. It is also important to not overlook the value of existing information technologies and applications that may evolve without new technology infusion to be equally as effective. The input from experienced first responders has broadly suggested that a mix of modifications to existing information systems together with the application of new technologies will provide the total solution.

Table 4-1 Internet Newsgroups and Discussion Groups

NEWSGROUPS	DISCUSSION GROUPS
alt.law-enforcement	Disaster Research – Natural Disasters and Public Planning
alt.law-enforcement.traffic	Dispatch – Public Safety Dispatchers
comp.dcom.telcom	DOT – State and Federal DOT
comp.dcom.telcom.tech	HAZMATMED – HAZMAT Medicine
comp.std.wireless	IVHS-L – ITS Forum
misc.emerg-services	NETS – Public Emergency Response
misc.transport.urban-transit	OCC-ENV-MED-L – Occupational Medicine
sci.chem	SAFETY – Public Safety
sci.eng.chem	TRANSP-L – State and Federal DOT
sci.med.occupational	WirelessNOW/OverNET – Wireless Technologies
sci.med.telemedicine	

Throughout all of the existing, developmental, and proposed work that might impact upon the first responders information problem, no single initiative focused upon the problem as defined by first responders. Many provided parts of the solution, such as communications, database information, positioning, and response coordination. But few attempted to provide an integrated package. Of interest is the omnipresent reference to solving the problems caused by hazardous materials accidents to improve the marketability of a particular technology. They are solutions in search of a problem.

The development work relevant to a potential pilot project has been clustered into five groups:

- Communications, monitoring, and tracking
- Computer-based emergency response software
- Emergency response consultation services
- Regional agency emergency response programs
- Computer-based emergency response networks.

Each item in the following sections is denoted as **currently operational** (O) or **under development** (D) as of December 1, 1994.

4.3 COMMUNICATIONS, MONITORING, AND TRACKING PROJECTS

The following are representative of projects having the potential for gathering information about vehicles and possibly capturing commodity data.

Defense Transportation Tracking System (DTTS) (O)

The Defense Transportation Tracking System (DTTS) is an operational vehicle tracking system used by the Department of Defense to track shipments of munitions. One technology used by DTTS is the QUALCOMM OmniTRACS satellite communications and vehicle tracking system. While DTTS carriers do not have to use OmniTRACS (some use armed guards in chase cars), they have found it to be very cost-effective in meeting the strict tracking standards set by DTTS. There are 1,100 OmniTRACS systems installed with DTTS carriers and 50,000 DTTS shipments per year that use OmniTRACS.

Contacts: DTTS, Gary Henning, Naval Ordnance Center, Indian Head, MD, (301) 743-6057; Mark Bauckman, QUALCOMM, Inc., San Diego, CA (619) 597-5142, bauckman@ QUALCOMM.com

TRS (Tracking and Report System) (D)

TRS is a technology that is being jointly developed by Torrey Science and Technology and Orbital Communications Corporation. TRS is an autonomous global geopositional system using Torrey's receiver-transmitters inherent positioning receivers and Orbital Communication Corporation's (Orbcomm) LEO network. TRS intends to provide information on the location of trucks, trains and barges, and to have the capacity for remote messaging.

Contacts: Torrey Science and Technology, Thomas Seay, San Diego, CA, (619) 552-1052;
Orbital Communications Corporation, Alan Parker, Dulles, VA, (703) 406-5300

Material Tracking Technologies/Emergency Response System (MATTERS) (D)

Proposed by the Ktech Corporation, MATTERS focuses upon the trans-border movement of hazardous waste and hazardous substances between Mexico and the United States.

From an operations center in New Mexico, MATTERS will coordinate the monitoring and tracking of vehicles known to be carrying hazardous waste or materials that cross the border. Management of shipping manifest information gathered at the ports of entry will be coordinated with vehicle tracking services. The action of the vehicle or indication that the vehicle has been involved in an accident will be immediately transmitted to the local authorities having jurisdiction for action. According to Ktech Corporation, the system is easily linked with chemical emergency response information to support the actions of the first responders during HAZMAT accidents.

Contact: Ktech Corporation, Richard Blose, Albuquerque, NM, (505) 268-3379

Intransit (O)

Intransit (International Transport Information Tracking) is a unit within the Volpe National Transportation System Center (Volpe Center). Intransit, under contract from the U.S. Department of Defense (DOD), has been involved in the tracking and monitoring of sensitive cargo shipments requiring tight security. The Intransit concept also has been made available to the U.S. Drug Enforcement Agency (DEA).

Intransit uses existing geostationary satellites to communicate between tagged cargo and the Intransit operation center in Cambridge, MA. Intransit projects also include the fusing of other data and information sources to the tracking and monitoring applications.

Contacts: Volpe Center, Mohammed Avani, Cambridge, MA, (617) 494-3724; Savi Technologies, Vic Verma or Alan Bien, Mountain View, CA, (415) 428-0550

ARRAY™ Intelligent Mobile Data Network (D)

Pinpoint™ Communications of Dallas, TX will be testing its proprietary radio-location based mobile data network in the Dallas metropolitan area beginning in August 1995. Pinpoint is in the process of signing on the Dallas Police Department as a test user and are looking for other public safety applications, such as HAZMAT response. The test in Dallas will transition to an operational system in April 1996. It will then expand in late 1996 to include Houston and the area between the two cities.

The ARRAY system is a digital radio packet data communications system (similar to RAM Mobile Data or ARDIS) that also accurately locates the source of a digital data transmission through surface-based triangulation and includes source location as a "free" data value in the communications packet. Pinpoint's proprietary algorithms compute accurate locations in real time and tag message packets with fixed base equipment at a relatively low cost. The source of the digital transmission can share its location with any set of users on the network.

It is conceivable that the major providers of digital radio packet data networks (RAM and ARDIS) could modify their existing equipment to also compute source location, in which case the value of tracking by existing surface-based radio networks could be greatly enhanced over vehicle location and tracking systems that use satellite technology. Pinpoint's ARRAY system is a technology that is worth following for potential applications in HAZMAT incident emergency response because it promises to be inexpensive, can be customized to accommodate many different applications, and easily allows location and data sharing among many different users. The down side is that the technology is still in its infancy, the company is a start-up whose future depends on successfully breaking into a market already dominated by two very aggressive companies (RAM Mobile Data/Bell South and ARDIS/Motorola), and its expansion outside of the Dallas-Houston area is still years away.

Contact: Pinpoint, Susan Paul, Dallas, TX, (214) 789-8900

MicroStamp (D)

MicroStamp is a sophisticated smart card produced by Micron Communications, a division of Micron Technology. MicroStamps are miniaturized (dimensions approximately one inch square and the thickness of a dime) radio receiver-transmitter and CPU memory computer chip with a lithium battery power source having an estimated life of seven years.

The capacity of the MicroStamp depends on the manufactured size of the chip (e.g., 48, 264, or 528 bytes). The MicroStamp can be used to encode manifest information, such as the name of the product being shipped, shipper's name, address, phone number, destination, and in the case of HAZMAT, the United Nations number and material data safety sheets (MSDSs). Micron Communications estimates that MicroStamps will be commercially available after January 1995.

Contact: Micron Communications, John Tuttle, Boise, ID, (208) 368-3398

4.4 COMPUTER-BASED EMERGENCY RESPONSE SOFTWARE

Many software packages have the potential to provide first responders with valuable information about unfolding incidents. They are, however, dependent upon a chemical identifier: some number or name (fragment or whole) with which to extract the correct chemical characteristics from the database. Their resident information could play a significant part in any emergency response information system, once the chemical is identified.

Computer Aided Management of Emergency Operations (CAMEO) (O)

The Computer Aided Management of Emergency Operations (CAMEO) program was designed by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Environmental Protection Agency (EPA) to help emergency planners, facility operators, and first responders plan for, and safely handle chemical accidents. CAMEO includes databases as well as applications. CAMEO's chemical database files contain names, synonyms, formulas, and regulatory and response information for about 4,000 chemicals in common use. CAMEO also includes an air dispersion model to help in the evaluation of hazardous chemical release scenarios, a mapping application, and fields to help maintain records and information useful for emergency planning and response. The first responder can use functions in CAMEO to search for specific information in its databases, and can readily import and export information. CAMEO's interrelated databases and programs can help the first responder meet the emergency planning and reporting requirements of Title III of SARA, the Superfund Amendments and Reauthorization Act of 1986.

The Area Locations of Hazardous Atmospheres (ALOHA) model is a tool for estimating the movement and dispersion of gases. The air model estimates pollutant concentrations downwind from the source of a spill, taking into consideration the toxicological and physical characteristics of the spilled material. ALOHA also considers the physical characteristics of the spill site, the atmospheric conditions, and the circumstances of the release.

Contact: NOAA/GENWEST, Washington, DC, (202) 293-2270

Chemical Hazard Response Information System (CHRIS) (O)

This PC-based system originated in the U.S. Coast Guard. CHRIS is intended for use by USCG port safety personnel and others who may be the first to arrive at the site of an accidental discharge or fire who need readily available and easily understood information about the hazardous properties of the chemical(s) involved. CHRIS can be used to determine the proper actions required immediately to safeguard life and property and prevent contamination of the environment.

CHRIS briefly describes the chemical and biological hazards of various materials so that personnel at the scene of an accident can assess the danger and consider the appropriate large-scale response. It also lists the on-scene information needed for the proper use of the Hazardous Assessment Handbook. Selected information on each chemical covered by CHRIS is summarized from the extensive material in the Hazardous Chemical Database. For each substance, CHRIS lists the specific chemical, physical, and biological data needed for the preparation and use of the other components of the system. CHRIS can also be used after the initial response action when there is sufficient time to use more detailed information.

Contact: USCG / HAZMAT America, Boston, MA, (617) 867-3660

Automated Resource for Chemical Hazard Incident Evaluation (ARCHIE) (O)

With the wide proliferation of personal computers through the United States in recent years, it is now possible to provide emergency preparedness personnel at all levels of government and industry with relatively sophisticated computational tools to evaluate the nature and magnitude of threats facing individual jurisdictions. To facilitate what would otherwise be a difficult, time-consuming, and expensive (if not impossible) task in many cases, the majority of accident hazard assessment and consequence analysis procedures required for a comprehensive hazard analysis have been incorporated into a single software program titled Automatic Resource for Chemical Hazard Incident Evaluation (ARCHIE).

The primary purpose of ARCHIE is to provide emergency preparedness personnel with several integrated estimation methods that may be used to assess the vapor dispersion, fire, and explosion impacts associated with episodic discharges of hazardous materials into the terrestrial (i.e., land) environment. The program is also intended to facilitate a better understanding of the nature and sequence of events that may follow an accident and the resultant consequences.

The core of the ARCHIE computer program is a set of hazard assessment procedures and models that can be sequentially utilized to evaluate consequences of potential discharges of hazardous materials and, thereby, assist in the development of a basis for emergency planning. In other words, ARCHIE can help emergency planning personnel understand the nature and magnitude of hazards posing a threat to their jurisdictions, the sequence of events that lead to an emergency, and ultimately, the nature of response actions that may be necessary in the event of an emergency to mitigate adverse impacts upon the public and its property.

Contact: DOT / HAZMAT America, Boston, MA, (617) 876-3660

CHEMTOX Chemical and Toxiologic Database (O)

The CHEMTOX database is a collection of information on hazardous chemicals that resides on a hard disk on the first responder's personal computer. On a quarterly basis (March, June, September, and December), the database owner will receive one or more update diskettes that, when used with a program supplied with the CHEMTOX database software, will update various records in the CHEMTOX database. These updates add new records as well as information regarding regulatory status, toxicity, etc., to records already in the database. In this way, the first responder can be assured that the data in the CHEMTOX database will be as up-to-date and accurate as possible. The CHEMTOX database is also compatible with most PC local area networks (LANs). A special license agreement allows the CHEMTOX database to be used on networked PCs.

Contact: Resource Consultants, Inc., Brentwood, TN, (615) 373-5040

4.5 EMERGENCY RESPONSE CONSULTATION SERVICES

These services afford the first responder with some form of active human expert contact to assist in the decision making. The first three, for reasons of liability, tend to give information only — without providing any scenario-specific interpretation or suggestions for first responder action. The last service is only available by pre-arranged subscription. Immediate consultative services should be part of any pilot project.

Center for Disease Control (CDC-ATSDR) (O)
Agency for Toxic Substances and Disease Registry Emergency Response

The Emergency Response function for the Center for Disease Control is coordinated by the Emergency Response Office of the Agency for Toxic Substances and Disease Registry based in Atlanta, Georgia. Access to services is afforded to any agency with a bona fide unfolding HAZMAT emergency. When calling this number the caller will be routed to either the office responsible for EPA Superfund Sites or to the office responsible for all other response action.

Using their database of chemical information, ATSDR experts provide the caller with detailed chemical information and treatment recommendations. In addition, the agency serves as a resource for in-hospital medical personnel during chemical emergencies. Within ten minutes of the receipt of a call for assistance, ATSDR staff will make available specific expert consultations with toxicologists, chemists, physicians and, in a less timely fashion, health physicians for radiation-association problems.

If the incident is one of national significance, then ATSDR will assemble a special on-site assistance team to travel to the emergency and support the response operations. This service is only provided when the event's Federal On-Scene Coordinator (FOSC) requests it.

The Emergency Response Office also provides technical advice and guidance to callers during non-emergency situations as their workloads permit.

Contact: Agency for Toxic Substances and Disease Registry Emergency Response Office, CDC, Atlanta, GA, (404) 639-0615

Chemical Transportation Emergency Center (CHEMTREC) (O)

The Chemical Manufacturers Association operates CHEMTREC 24 hours a day in Washington, DC. By calling the appropriate telephone number listed below, a first responder can consult technicians experienced in data retrieval for chemical and spill responses. The most important services CHEMTREC provides is real-time fax or voice access to any chemical Material Safety Data Sheet (MSDSs) on file. Although CHEMTREC provides information on multiple chemical shipments, they will not provide advice or recommendations beyond the contents of each individual MSDSs.

Contact: CHEMTREC, (800) 424-9300;
in Alaska, Hawaii, District of Columbia: (202) 483-7616

National Pesticide Telecommunications Network (NPTN) (O)

The National Pesticide Telecommunications Network is jointly sponsored by the U.S. Environmental Protection Agency (EPA) and Texas Technical University's Health Sciences Center. It is managed by the university's Department of Preventive Medicine. NPTN operates a toll-free hotline and fax service, staffed by pesticide specialists, providing health and environmental information on the 600+ active ingredients incorporated into over 50,000 different pesticide products in use in the United States since 1974.

NPTN is able to assist callers in the interpretation and understanding of toxicological information on pesticides and to access over 300 different resources containing pesticide information. The network also is able to make referrals to laboratories that conduct pesticide testing. Additional services include gaining access to label information on EPA-registered pesticides and locating general information on U.S. pesticide regulations.

Contact: NPTN, Lubbock, TX, (800) 858-PEST (7378)

Canadian Transportation Emergency Center (CANUTEC) (O)

Canadian Transportation Emergency Center (CANUTEC) has been implemented by the Canadian Ministry of the Environment to support first responders to hazardous materials accidents ("dangerous goods") throughout Canada. The center maintains chemical databases and MSDSs files and responds to requests for information from on-site personnel.

Typically, CANUTEC provides only the information that it has on file and does not offer advice or recommendations for action beyond which is contained in their approved databases or MSDSs files. Chemical synergy assessments are not offered. The office will take immediate action to contact shipper, transporter, and/or consignee to support the needs of the first responding agencies.

Contact: Canadian Ministry of the Environment, Toronto, Canada, (613) 996-6666

Chemical Emergency Response Team (CERT) (O)

CERT is a registered service of Ecology and Environment, Inc., an environmental consulting firm based in Buffalo, NY, which is representative of services available from similar firms. Through the CERT program, a comprehensive range of services is provided to private subscribers. For example, the 24-hour Operations Center is complete with computerized databases, HAZMAT library, spill modeling capability, and experienced emergency management staff. Upon receiving notification of a spill, the CERT program provides all site personnel, including first responders, with all available chemical information, interpretation of toxicological information and assessment of any chemical synergy that might be present. On-site personnel are provided with recommendations and direction to enhance the containment and cleanup of the spilled material. Direction is also provided to medical personnel while they are providing health services to chemically injured persons.

The CERT personnel also access LOCATOR, the firm's Decision Support System family of databases to facilitate the time and cost effective mobilization and deployment of critical resources. As necessary, and when requested, the CERT program also provides on-site teams of experts to support unusually complex HAZMAT problems.

Contact: Ecology and Environment, Inc., Louis Adams, Buffalo, NY (716) 684-8060

4.6 REGIONAL AGENCY EMERGENCY MANAGEMENT PROGRAMS

These programs are region-specific and have begun to develop the capability to handle regional emergencies through coordination of follow-on resources. They suggest that part of the solution may be two-tiered: real-time load information gathering and dissemination and localized support services. While their immediate value to the true first responder is not yet clear, their potential for helping appears substantial.

Operation Respond Institute, Inc. (O)

Operation Respond is a research and demonstration project designed to improve the information available to first responders at hazardous materials incident sites. It began in November 1992 as a cooperative arrangement between the Federal Railroad Administration (FRA) and the Port Terminal Railroad Association (PTRA) of Houston, TX. In April 1995, the Operation Respond Institute (ORI), Inc., was established as a non-profit organization, furthering the project's research while continuing to receive public, as well as private, funding.

Operation Respond combines several aspects of emergency preparedness and information technology: training of local officials, design and customization of proprietary software, and cooperation from participating carriers to expedite identification of shipment-specific contents. ORI's Emergency Information System (OREIS) is designed to improve information available to both first responders (at the scene) and to officials operating from local emergency dispatch centers. Computerized access to generalized emergency response procedures, such as those contained in the *North American Emergency Response Guidebook*, is available, but emphasis is also placed on access to computerized databases that provide shipment-specific information. To assist with fire- or accident-related emergencies involving rail passenger cars (e.g., those operated by AMTRAK), car-specific information--such as design and location of emergency exits--is also being computerized for on-scene responders and local dispatchers.

Operation Respond's computerized information systems continue to evolve. It is expected that in some communities, the local emergency dispatch center would house the requisite software and initiate access to centralized databases, while on-scene responders would access the dispatch center via cellular phones. In other communities, response officials may choose to equip emergency vehicles to serve as on-scene, electronic command centers. In still other communities, on-scene commanders equipped with laptop computers and two-way voice and data communications are expected to eventually achieve enough direct access to computerized information that they can essentially manage incidents at the scene, with minimal reliance on a dispatch center.

Following development and operational testing in Houston, OREIS software has since been installed in communities in California, Georgia, Louisiana, Maryland, New York, and elsewhere in Texas, as well as at locations along the US/Mexican border. The Georgia installations included some undertaken as part of the preparations for the 1996 Olympic Games, with more 100 dispatchers, fire and law enforcement officials receiving training on OREIS software use. Currently, participating freight carriers throughout the country include some 10 railroads--passenger carriers, as well as freight--and 2 trucking companies, with the near-term prospect of 5 to 10 more trucking companies becoming participants.

Guidance for Operation Respond is provided by a management-labor steering committee with members from government (FRA, FHWA, and RSPA), industry (Shell, Dow Chemical, Union Pacific, Southern Pacific, AMTRAK, Chemical Leaman Tank Lines, Yellow Freight, and the American Trucking Association), and the public sector response community (fire/police agencies, the IAFF, and local EMSs).

Contact: Operation Respond Institute, Inc., Daniel Collins, Executive Director, Washington, D.C., (202) 906-2770.

Advantage I-75 (D)

This ITS project is sponsored by the Federal Highway Administration, and includes states in the Interstate 75 corridor, two Canadian provinces, the U.S. motor carrier industry, and Transport Canada. With program costs of $10M through the spring of 1995, the project will first focus on implementing AVI, WIM, and AVC technologies. The project will allow transponder-equipped and properly documented commercial vehicles to travel any segment along the entire length of I-75 and Canadian Highway 401 at mainline speeds with minimal stopping at enforcement stations.

This project could serve as a platform for testing technologies to inform emergency first responders of required credentials. The information may include a detailed description of all HAZMAT aboard participating trucks. Properly equipped first responders could interrogate a participating vehicle to determine its cargo using handheld devices similar to those being placed at fixed sites along I-75 to identify and track participating vehicles.

Contact: Advantage I-75, Lexington, KY, (606) 257-4513

Heavy Vehicle Electronic License Plate (H.E.L.P.), Inc. (D)

The Heavy Vehicle Electronic License Plate (H.E.L.P.) project is a nonprofit corporation that is implementing AVI, WIM, and AVC technologies in support of both the motor carrier industry and state revenue agencies. H.E.L.P. operates along the west coast of the U.S. from the Canadian to Mexican borders and includes some western inland states. Its mission is to develop and deploy advanced technology systems to create a cooperative operating and regulatory environment that improves the safe and efficient movement of commercial vehicles within the federal highway system. Its use of a central clearinghouse of long-haul manifests, on-vehicle identifying transponders, and roadside transponder interrogators is almost identical to that planned for the Advantage I-75 project.

Should the H.E.L.P. project be identified as a possible candidate for a later demonstration of first responder information strategies and technologies, the H.E.L.P. project manager has indicated that modifications could be readily made to the current database configuration to add detailed HAZMAT information. The current format only includes HAZMAT category codes for registered, participating vehicles. A feasibility test could be ready as early as mid-1995.

Contacts: H.E.L.P., Jim Gentner, Phoenix, AZ, (602) 254-2708 FHWA/ITS/Motor Carrier Division, Doug McKelvey, Washington, DC, (202) 366-0950

On Scene Coordinators Area Response System (OSCARS) (O)

Region 6 of the United States Environmental Protection Agency (U.S. EPA) tasked the Region 6 Technical Assistance Team (TAT) to develop a field-deployable computer-based system that On Scene Coordinators (OSCs) from EPA Region 6 could use as a decision making tool during an emergency response. TAT developed the On Scene Coordinators Area Response System (OSCARS), which is a GIS application. OSCARS is fully field deployable and provides the OSC with a computer-based system that links spatial data with geographic information. The data can be queried or sorted, and the results displayed graphically on a map or viewed in a tabular format. These functions provide the OSC with tools to answer the basic questions of "What if at ...?, Where is it?, What spatial patterns exist?, and What if ...?."

The geographical area covered by OSCARS is U.S. EPA Region 6 (Arkansas, Louisiana, New Mexico, Oklahoma, and Texas). Sites contained in the OSCARS application include Oil Pollution Act (OPA) regulated facilities, such as refineries, bulk storage units, crude and product pipelines, and wellhead locations. Wildlife and land resource management coverage in OSCARS include information on endangered species, wildlife refuges, bird rookeries, fisheries, wetlands, Federal and state parks, location of water intakes, dams, and recreational boating facilities. OSCARS also contains coverage with information on cleanup contractors, hazardous waste disposal facilities, agency rosters (federal, state and local), hospitals, airports (private and public), digital imagery (satellite photos, low-level orthophotos, digital camera photography), census data, and major land features (e.g., roads, rivers, major lakes). In the future, OSCARS will provide the OSC with plume and spill modeling tools.

In Region 6, 116 counties have been determined by the U.S. EPA to exhibit "high risk" elements. These counties contain industries that either have a history of high spill rates or have the potential, if a large spill occurs, to cause significant and substantial harm to the environment or public health. The development of OSCARS has thus been geared towards obtaining, or in some cases digitizing, data, in these "high risk" counties.

OSCARS was developed on a UNIX workstation using Arc/Info™. It is deployed in the field on notebook computers running ArcView™ to display the information. Due to the enormous amount of data contained in the OSCARS application, Region 6 has been divided into sections. Each section contains all the data in the OSCARS application for the area of concern. If the OSC need information concerning surrounding sections, data can be transmitted via modem from the complete OSCARS application stored in the office at OSC and TAT field staff on-site. If, for example, a spill occurs in a designated county, those TAT's responding can retrieve the section of interest from a library of removable hard disk and CD-ROMs. The hard drive is inserted in the notebook and the portable CD player is attached to the computer. While mobilizing to the site, the OSC can review all the data surrounding the spill site, contact the various federal, state, and local agencies affected, and if necessary locate and contact cleanup crews and determine what materials the clean-up contractor will need. Once on-site, the OSC can use OSCARS to help evaluate different scenarios.

Contact: U.S. EPA Region 6, Michael Williams, Dallas, TX, (214) 220-0318

OHM-TADS (EPA) (O)

The Oil and Hazardous Materials Technical Assistance Data System (OHM-TADS) has been developed by the EPA to provide information on physical and chemical properties, hazards, pollution characteristics, and shipping information for over 1200 hazardous materials. OHM-TADS consists of a computerized database that can be accessed from terminals at the 10 EPA Regional Offices, from EPA Headquarters in Washington, DC, and from Coast Guard Marine Safety Offices. The system can provide either information on specifically requested properties of a material, or it can print all the information in its files for that material.

Contact: Not available

4.7 COMPUTER-BASED EMERGENCY RESPONSE NETWORKS

The value of computer networks for gathering information is low when compared to the information available from other sources during an emergency. Specific load information from the driver, or standoff chemical identification through placarding or container identification, together with on-site chemical data software, can easily take the place of the capabilities of computer networks. While computer networks can provide assistance during the planning phases, during an unfolding incident, they are of very limited use.

Hazardous Material Information Exchange (HMIX) (O)

The Hazardous Material Information Exchange (HMIX) is a computerized bulletin board designed especially for the distribution and exchange of hazardous materials information. The HMIX provides a centralized database for sharing information pertaining to hazardous materials emergency management, training, resources, technical assistance, and regulations. With the HMIX, the user can retrieve information, provide information to other users, or interact with peers.

To serve the hazardous materials community, the HMIX is available 24 hours a day, seven days a week. Each user is allowed thirty minutes of free access time per session on the system. The three primary features of HMIX are the HMIX Bulletins, Electronic Mail, and File Transfer. The HMIX is *not* intended to provide assistance during an actual emergency.

Contact: HMIX, Argonne National Laboratory, Chicago, IL, (800) 752-6367

Connect EnviroNet (D)

A consortium of private companies and government agencies are being formed under the leadership of the University of Phoenix at San Diego (UPSD) to explore the application of wireless and internetworking technologies to environmental damage prevention and remediation. Connect EnviroNet will test making environmental and HAZMAT data publicly available on an Internet server and accessible to a variety of users who would not normally have direct, real-time access to this data. Current plans are to put environmental, geographic, regulatory, and technical data on-line and test its usefulness. Members of the consortium are:

- *Connect (UPSD)* — Executive agent and manager of Connect EnviroNet consortium; focus on growth of enterprises; look at commercialization of EnviroNet.
- *U.S. Navy R&D Center/San Diego (formerly NOSC)* — Provider of environmental data about Northern San Diego Bay; user of air and water data.
- *San Diego Supercomputing (run by General Atomics for UCSD)* — Internet services and firewall to protect proprietary data; payback accounting for on-line commercial databases that charge a fee for usage.
- *City of San Diego* — Departments of Water Quality and San Diego Fire Department.
- *San Diego County Air Pollution Control District* — County/state rules, regulating, forms.
- *QUALCOMM, Inc.* — Truck location/tracking information.
- *Titan Corp.* — Environmental and water remediation data; software prototyping; multiple access software and demonstration testbed.
- *PSCI (subsidiary of Cirrus Logic)* — Wireless access from notebook and laptop computers within San Diego area; starting with wireline access, then going to cellular and then CDPD.

QUALCOMM has proposed a use for EnviroNet that involves one or more of their clients who track their vehicles with the OmniTRACs satellite communications and location system. Their concept is for client companies to notify emergency response agencies of an accident involving one of their vehicles carrying HAZMAT cargo and for the responding agency to access EnviroNet for data on the material, information on the accident scene (topography, demographics, watershed, traffic, etc.), and related reporting forms, applicable regulations, and other administrative materials. EnviroNet would serve as the common information infrastructure for responders, HAZMAT clean-up contractors, and public service and regulatory agencies.

Contacts: Connect EnviroNet, Susan Peterson, San Diego, CA, (619) 576-7392, Mark Bauckman, QUALCOMM, Inc., San Diego, CA, (619) 597-5142

On-line Material Safety Data Sheets (MSDSs) (D)

MSDSs in the public domain are available on the Internet from the University of Utah (UT) Chemistry Department. UT will scan and edit any non-proprietary/non-copyrighted data sheets received in paper form. However, the preferred method is to allow posting of new data sheets by ftp (see below) to the MSDSs server at the university.

Access the Internet MSDSs at gopher://atlas.chem.utah.edu:70/11/MSDS. You can also gain access via anonymous ftp at ftp.chem.utah.edu in the MSDSs sub-directory.

An MSDSs listserver is also available for an MSDSs discussion group. To subscribe send an e-mail message to listserv@listserv.chem.utah.edu with a blank subject and only the words "subscribe msds-project Your Name" (no quotes) in the body of the message. Messages sent to msds-project@listserv.chem.utah.edu will be posted to all participants.

The MSDSs Project at the University of Utah can be contacted through the Internet by sending e-mail to msds@msds.chem.utah.edu.

The Chemistry Department at Utah State University does not have their MSDSs data on the Internet, but they do have it on a local server and available to users on their campus network. They have an arrangement with local fire departments to query their database and provide data by voice or fax when requested. The University of California, Santa Cruz and the University of Illinois also have MSDSs on Internet servers for access by telnet, but they are limited to authorized users, because they contain proprietary, licensed data. Other schools may also have limited access or publicly available MSDSs files on the Internet.

Contacts: University of Utah, Department of Chemistry, Steven Fetherston, (801) 581-4696; Utah State University, Carolyn Stahl, Department of Chemistry, Provo, UT, (801) 797-1053

SAFETYNET (MCMIS) (O)

SAFETYNET is an information network that is part of the FHWA MCMIS (Motor Carrier Management Information System). SAFETYNET is the part of the PC-based system that resides at state motor carrier inspection and regulation offices and at DOT/FHWA roadside inspection stations. It is the gateway that allows access to the following three database segments within the MCMIS:

- *Microcensus* — This database is made up primarily of the information provided when a carrier applies for a DOT # on a Form 170. It also contains information about the carrier that is provided by the carrier at roadside inspections. Information about a carrier can be retrieved by querying a variety of data fields.
- *Accidents* — This information is provided by both state law enforcement agencies and voluntarily by carriers. It is the least up-to-date of the files (some states do not participate) and many carriers do not report their accidents. Data goes back about six years.
- *Inspections* — This is the most up-to-date of the files, since many roadside inspection sites have SAFETYNET terminals. When inspected, the vehicle is identified very accurately and the contents (especially if HAZMAT) are identified by category and quantity. FHWA has focused on this area the most and has several ITS/CVO projects under way to improve the timeliness of data through use of wireless input devices, personal digital assistants (PDAs), pen-based computers, and voice-recognition devices. FHWA has begun the SAFER Project to explore these and other roadside inspection technologies.

Areas of applicability to this project include access to the motor carrier census file to obtain contact information on less well-known carriers and to check for recent roadside inspections. Carrier information is easily searchable by DOT #, ICC #, Doing Business As (DBA) name, registered name, etc. Information is also available on what HAZMAT, if any, the carrier is allowed to handle. Roadside inspection information will eventually be available on-line 5 to 15 minutes after an inspection has been completed. Of special interest to first responders would be if violations were discovered and if the vehicle had continued on its route without correcting the violations.

Access to SAFETYNET and the MCMIS is restricted to the U.S. DOT and states. It is not accessible by private individuals or companies. There has been some discussion of setting up Internet access, and it may be one of the areas to be investigated by the SAFER Project. Individuals and companies can request MCMIS profile reports on any company in the databases under the Freedom of Information Act.

Contact: Federal Highway Administration, FHWA/OMC/HTA-10, Lori Seacrist, Washington, DC, (202) 366-6086

5. CANDIDATE TEST SCENARIOS AND INFORMATION ARCHITECTURES

This chapter discusses possible test scenarios for demonstrating relevant technologies designed to meet the needs of first responders. The scenarios were used in two separate instances to solicit comments from both HAZMAT first response officials and executives with HAZMAT shipper and carrier companies.

5.1 DEVELOPMENT OF CANDIDATE TEST SCENARIOS

The candidate test scenarios were derived mainly from the specific information requirements of the HAZMAT first response community discussed in Chapter 2. In Chapter 3 we surveyed current technologies that could meet these requirements and applied selected technologies to the information problem. We identified ongoing or contemplated ITS projects in Chapter 4 and used some of these as a framework for the final scenarios.

A thorough synthesis of these three components (first responder needs, current technologies, existing or planned projects) could have yielded dozens of possible test scenarios. However, the funding and time schedule of this effort precluded us from systematically exploring all of the possibilities. Instead, we limited ourselves to six candidates that, together, met most of the following criteria:

- Meets priority information need(s) of first responders by providing high payoff information items
- Capitalizes on existing DOT projects, demonstrating leverage and reuse
- Addresses issue(s) raised in the NAS Study
- Uses existing information technology, not research technology
- Contains simple and useful technology applications.

5.2 OVERVIEW OF SIX SUGGESTED SCENARIOS

Six suggested scenarios were selected for the reasons presented in Table 5-1.

Table 5-1 Overview of Suggested Scenarios

SCENARIO	REASONS FOR SELECTION AS CANDIDATE
A – Public Safety Dispatchers Notified Directly by the Carrier of a HAZMAT Incident	• Meets highest need of first responders to immediately know what HAZMAT is inside the vehicle (*pushes* initial critical information to first responders) • Test does not require an elaborate DOT test infrastructure; can be performed by grant to a participating trucking company • Addresses need of forewarning of the presence of HAZMAT [NAS] • Uses existing commercial technologies • Workable within a company's existing vehicle tracking and dispatch infrastructure • Requires no new technology for first responders
B – Direct Computer Access by First Responders to Vehicle HAZMAT Contents Information and Material and Environmental Reference Information	• Meets highest need of first responders to immediately know what HAZMAT is inside the vehicle and how to handle it, once identified (they *pull* information from a data network as needed) • Uses existing commercial technologies • Addresses need of basic description of HAZMAT present plus technical names, quantity and packaging in vehicle [NAS] • Addresses lack of material-specific information and remediation guidance [NAS] • Workable within a company's existing manifest database and vehicle tracking and dispatch infrastructure; uses public domain information • Requires limited new technology for first responders • Test infrastructure is not geographically limited and can overlay the existing Internet
C – A HAZMAT Carrier Cross-Index Locator	• Meets an immediate first responder need of being able to find and contact a carrier to identify vehicle contents (they *pull* information from a catalog or CD-ROM as needed) • Combines information that is already available from public and private sources • Requires no new technology for first responders • Has no impact on shippers or carriers • Test infrastructure is not expensive and can be developed and executed regionally or nationwide
D – On-line Computer Access to Material Safety Data Sheet (MSDSs) Information (Limited subset of Scenario B)	• Meets secondary need of first responders to know how to handle identified HAZMAT (they *pull* information from a data network as needed) • Uses existing commercial, public domain technologies • Addresses lack of material-specific information and remediation guidance [NAS] • Requires limited new technology for first responders • Test infrastructure is not expensive or geographically limited and can overlay the existing Internet
E – Access by First Responders to Vehicle Identification from Vehicle Transponder and HAZMAT Contents from Real-Time Information	• Meets highest need of first responders to immediately know what HAZMAT is inside the vehicle (they *pull* information from a data network or read it from an on-vehicle transponder as needed) • Builds upon existing DOT ITS test infrastructures • Addresses need of basic description of HAZMAT present plus technical names, quantity and packaging in vehicle (identified by NAS) • Uses existing commercial technologies • Requires limited new technology for first responders

Table 5-1 Overview of Suggested Scenarios (Continued)

SCENARIO	REASONS FOR SELECTION AS CANDIDATE
F – On-line Access by First Responders to Vehicle HAZMAT Contents Information	• Meets highest need of first responders to immediately know what HAZMAT is inside the vehicle (they *pull* information from a data network as needed) • Builds upon existing DOT ITS test infrastructure • Addresses need of basic description of HAZMAT present plus technical names, quantity and packaging in vehicle (identified by NAS) • Uses existing commercial technologies • Requires limited new technology for first responders

5.3 DETAILED DESCRIPTION OF SIX SUGGESTED TEST SCENARIOS

Table 5-2 describes the format of the detailed information on the six scenarios presented in Tables 5-3 through Table 5-8. The information architecture for each scenario is shown graphically in Figure 5-1.

Table 5-2 Scenario Format Description

Title: Scenarios A-F outlined in Table 5-1.

First Responder Information Requirement: The basis for defining the scenario using information supplied by first responders and documented in Chapter 2.

Issue or Concern to be Tested: The principal item of information to be tested or question to be answered.

Objective(s): Test objectives to be accomplished.

Description: Overview of the test and how it is to be conducted.

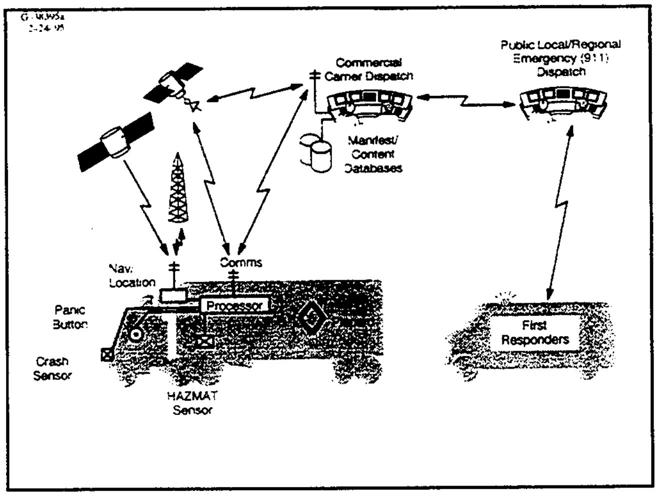
Participants: Principal stakeholders in the test.

Data Collection/Measurements: Items of information to be collected and measured in order to meet the test objectives.

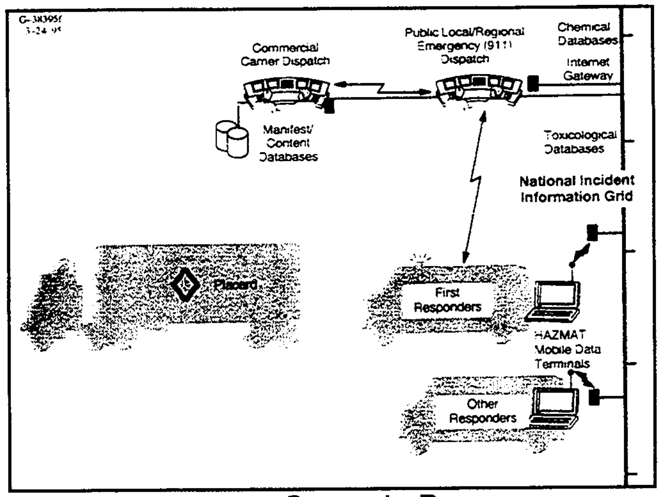
Problems and Concerns: Some of the problems and concerns that may arise during the pilot test that will need to be addressed in the pilot test set-up or in the report discussing the results of the pilot test.

Cost Effectiveness: Measures of the benefits, costs, and cost-effectiveness of the proposed information technology and processes to be tested. Projection of the additional costs to impacted stakeholders (e.g., First Responders, Carrier/Shippers and Federal Government).

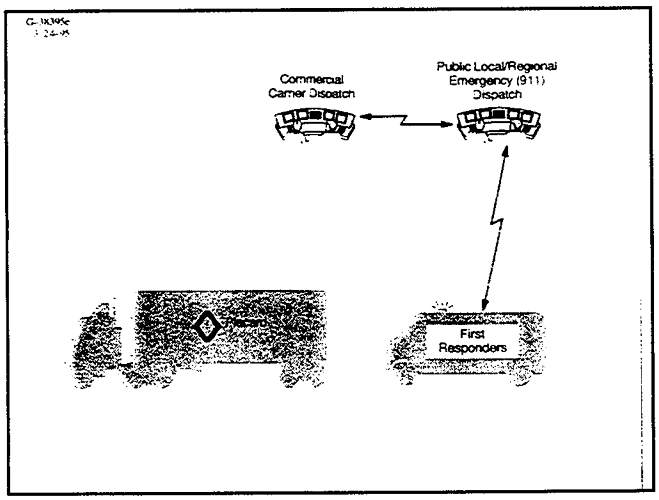
Output Products: Specific documents and/or data to result from the test scenario.



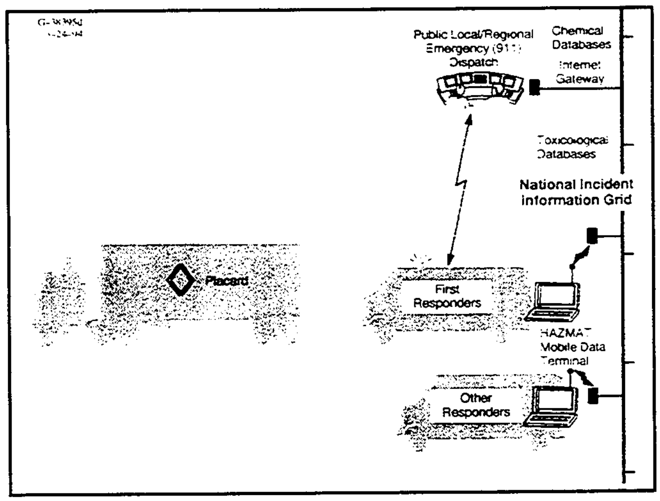
Scenario A
Public Safety Dispatchers Notified Directly by Carrier



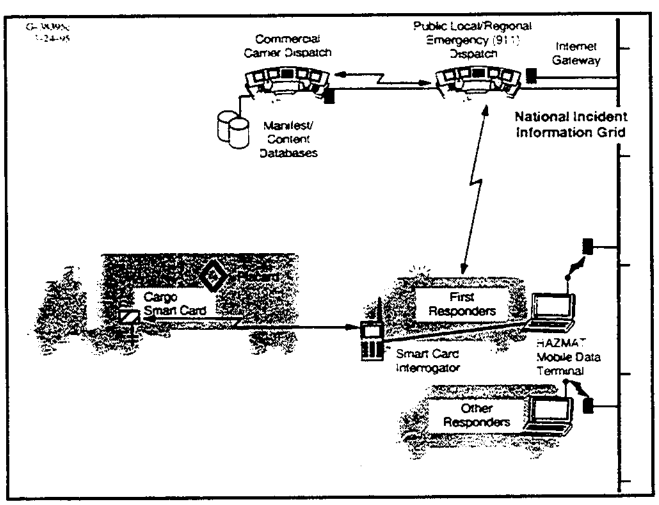
Scenario B
Direct Computer Access by First Responders of Vehicle Contents



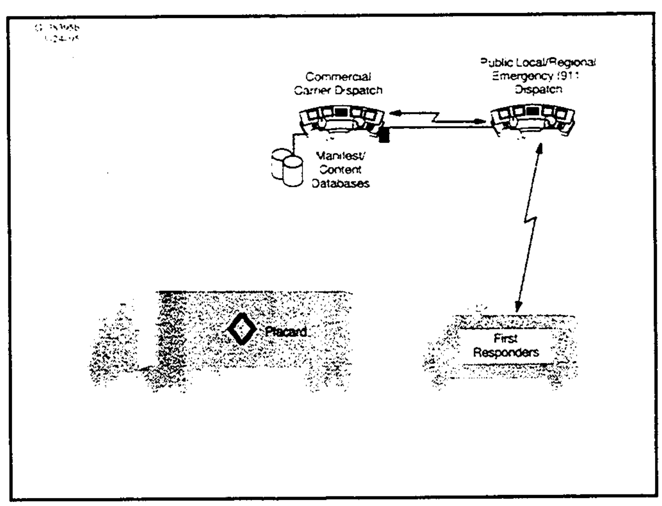
Scenario C
HAZMAT Carrier Cross-Index Locator



Scenario D
On Line Computer Access to MSDS



Scenario E
Accessed by First Responders to Vehicle ID from Transponder and Contents from Real Time Information



Scenario F
On Line Computer Access to Vehicle Contents

Figure 5-1 Candidate Pilot Test Scenarios

Table 5-3 Scenario A – Public Safety Dispatchers Are Notified Directly by the Carrier of a HAZMAT Incident

Title: Scenario A - Public Safety Dispatchers Are Notified Directly by the Carrier of a HAZMAT Incident

First Responder Information Requirement: First responders now rely almost entirely on information from a placard, load manifest, or a vehicle driver to locate and identify the contents of a highway vehicle involved in a HAZMAT incident. In some instances, this information may be incomplete, ambiguous, or even erroneous. In addition, a hazardous materials incident resulting from a vehicle accident may go undetected for an hour or more.

Issue or Concern to be Tested: What is the benefit to emergency first responders of a proactive information system where a carrier first becomes aware that a HAZMAT-related incident has taken place, knows accurately where it is located, knows what materials are involved, and can immediately notify public safety officials with this information?

Objective(s): Measure the benefits to first responders of direct, instantaneous, electronic communications between a vehicle with HAZMAT cargo and its parent carrier company that makes possible the immediate notification of public safety dispatch authorities of a HAZMAT-related incident. To assess the scope of these technologies, document instances when a commercial vehicle accident (regardless of its HAZMAT implications) is first reported by a participating carrier and determine how this unique information helped public safety agencies.

Description: One or more commercial carrier companies that already have automatic vehicle location (AVL) and vehicle-to-carrier communications would be engaged by the pilot test contractor to document instances when one of their vehicles is involved in an accident or HAZMAT-related incident in a defined test area. Whether HAZMAT-related or not, participating carriers would agree to immediately provide the responsible public safety dispatcher with information on the accident and vehicle contents. The pilot test contractor would work with the participating carriers and receiving public safety dispatchers to document details of the chain of events of individual accidents within the test area. Documented information would include: (1) accuracy of information provided to the dispatcher by the carrier; (2) timeline of notification, information transfers, and response; (3) usefulness of information on vehicle location and contents to the first responders. Quantitative information from this test would be compared with quantitative information on responses to other commercial vehicle accidents as a comparison baseline. Participating first response agencies would be interviewed directly or would be asked to fill out questionnaires documenting this information.

Participants: HAZMAT carriers with AVL and communications capabilities and public safety dispatch agencies that receive notification of a commercial vehicle accident and use it in a response.

Data Collection/Measurements: The pilot test contractor will compile detailed event descriptions that include: (1) accident information provided to the public safety dispatcher by the carrier; (2) timing information; (3) a description of how this information was used by first responders. Participating carriers will provide AVL and communications costs (investment and operation) and identified business benefits (including safety).

Problems and Concerns: What is the degree to which the results of the pilot test can be expected to carry over into real life? Are carriers likely to install the equipment that is needed? If they know of an incident how likely are they to actually call?

Cost Effectiveness: Relevant costs to be estimated include AVL and vehicle-to-carrier communication equipment training costs of public safety dispatcher; benefits (effectiveness measure) include: information accuracy, response time (from notification to emergency response), and usefulness of information to first responders.

Output Products: Cost-benefit analysis of HAZMAT carriers proactively providing accident and vehicle content information directly to public safety agencies.

Table 5-4 Scenario B – Direct Computer Access by First Responders to Vehicle HAZMAT Contents Information and Material and Environmental Reference Information

Title: Scenario B – Direct Computer Access by First Responders to Vehicle HAZMAT Contents Information and Material and Environmental Reference Information.

First Responder Information Requirement: First responders now rely almost entirely on information from a placard, load manifest, or a vehicle driver to identify the contents of a highway vehicle involved in a HAZMAT incident. In some instances this information may be incomplete, ambiguous, or even in error. However, when a driver cannot provide any information, or an on-board manifest is unavailable, illegible or incomplete, or a placard is not in use or is obviously used incorrectly, there is still an urgent need to be able to determine the HAZMAT contents of the vehicle. In addition, when first responders know what hazardous material they are dealing with in an incident, they need immediate reference information essential to the treatment of injuries, protection of responders and the public, and near-term remediation.

Issue or Concern to be Tested: What is the impact on emergency first response of knowing what hazardous materials, if any, are involved? What other reference information is needed by HAZMAT response teams, and how should this information be made available to them?

Objective(s): Measure the usefulness to first responders of having direct, instantaneous, electronic access to commercial-carrier manifest information. Document instances when manifest information of participating carriers is used in a HAZMAT incident, and determine the usefulness of this information to public safety agencies. Measure the usefulness of other on-line reference information in HAZMAT response, for example, by documenting the usage of reference databases. Compare the usefulness of this information to the cost of operating the on-line service.

Description: This project test involves making both on-line reference environmental data and carrier manifest information available to first response teams and other users. Early planning for this type of test is currently under way in San Diego as part of the Connect EnviroNet project. It will integrate the existing facilities of a local university computing center and Internet site; Federal, state, and local government environmental reference databases (including maps, watershed data, regulatory data, waste site descriptions, etc.); public Internet databases of chemical (MSDSs), environmental, and regulatory information; privately maintained databases of MSDSs information available on a fee basis; and real-time shipping manifest data from participating carriers (including vehicle location and load status). Consortium members of the Connect EnviroNet project are preparing to develop the data and information infrastructure needed for the test. Information and mobile access terminals will be made available by the consortium to the San Diego Fire Department (including their HAZMAT response force). When all of the test components are integrated, users will be able to obtain real-time data in response to environmental accidents, including HAZMAT vehicle incidents. The pilot test suggested as part of this study will focus on data accuracy achieved in actual usage and the usefulness of this information to first responders of HAZMAT incidents.

Participants: An existing consortium of on-line network members composed of universities; federal, state, and local government agencies; computer manufacturers and wireless communications providers; the San Diego Fire Department and its HAZMAT response force.

Data Collection/Measurements: Statistical data on emergency response agencies' access to reference and carrier manifest information will be gathered. Documentation on specific incidents and the usefulness of reference and carrier manifest information will be sought by the pilot test contractor. Documentation of the costs associated with providing data services will be obtained by the test contractor.

Problems and Concerns: What is the degree to which the results of the pilot study can be expected to carry over into real life? Is the information likely to actually be made available to emergency responders? If only some companies provide information, how useful (and used) will on-line information be to emergency responders?

Cost Effectiveness: Relevant costs to be considered are: projected upkeep cost of National Incident Information Grid (Internet or others), reference database upkeep, interfaces with users; hardware and maintenance costs of Mobile Access Terminals for first responders. Benefits (effectiveness measures) include: quality of information received, responsiveness of the information grid to data requests, and response time (from notification to emergency response).

Output Products: An analysis report documenting the cost-benefit of providing material and environmental information and carrier manifest information to HAZMAT incident first responders will be prepared by the pilot test contractor.

Table 5-5 Scenario C – A HAZMAT Carrier Cross-Index Locator

Title: Scenario C – A HAZMAT Carrier Cross-Index Locator.

First Responder Information Requirement: First responders now rely almost entirely on information from a placard, load manifest, or a vehicle driver to identify the contents of a highway vehicle involved in a HAZMAT incident, which, in some instances may be incomplete, ambiguous, or even in error. However, when a driver cannot provide any information, or an on–board manifest is unavailable, illegible or incomplete, or a placard is not in use or is obviously used incorrectly, there is still an urgent need to determine the HAZMAT contents of the vehicle. Public safety dispatch officials must then be able to contact a carrier operations person who can provide essential HAZMAT manifest information from existing company records.

Issue or Concern to be Tested: In instances when public safety officials must resort to trying to contact a carrier directly to determine the load contents of a vehicle, considerable time can be wasted searching for the right contact person. Although every truck with HAZMAT is supposed to carry the name and telephone number of a contact who can answer the hard questions, typically they do not carry them or the papers are destroyed in the accident. Catalog, database, and other non-centralized records exist that could provide information to quickly locate a carrier's operations center for critical information. Would the availability of a single carrier cross-index locator help public safety dispatchers more quickly and accurately determine a vehicle's contents?

Objective(s): Measure the beneficial impact, if any, of a carrier cross-index locator against the cost of creating, distributing, and maintaining an up-to-date cross-index. Identify the most useful medium for distributing this information and the recipients who would benefit most from it.

Description: A master cross-indexed list of commercial highway carriers could be created from existing government computer databases and available industry association lists. It is likely that no new information would need to be gathered or created. A prototype cross-index of HAZMAT carriers created by the pilot test contractor would contain contact information about a carrier, with emphasis on phone numbers for operations locations that might have information on the contents of the carrier's vehicles. Contact phone numbers would be cross-indexed to various carrier identifiers such as company name(s), DOT permit number, ICC number, etc. The prototype cross-index would be distributed by the pilot test contractor to public safety dispatch and HAZMAT response organizations in one or more test areas. It could be made available to them in printed format as well as on computer-readable medium such as PC diskette or CD-ROM. Designated participants in the test public safety dispatch and first response organizations would be required to document their monthly usage of the cross-index product and provide this data to the pilot test contractor. Users would provide inputs on data accuracy, scope, and completeness. When the cross-indexed information was judged by the users to be instrumental in a HAZMAT response, users would be required to document the impact of its specific use in measurable terms.

Participants: Public safety dispatcher and first responder organizations; Federal government agencies with carrier information; commercial-carrier industry associations with HAZMAT carrier contacts.

Data Collection/Measurements: Example data needed to measure the usefulness of a carrier cross-index locator may include: (1) frequency of cross-index usage and numbers of errors encountered; (2) documented instances of how locator information impacted the resolution of specific HAZMAT incidents; (3) comments on the format and distribution medium of the cross-index. The pilot test contractor would document the cost of gathering, preparing, distributing, and maintaining the cross-index.

Problems and Concerns: How useful (and used) will the HAZMAT cross-index be if only some carriers are included: How useful (and used) will it be if named contacts cannot or will not provide needed information?

Cost Effectiveness: Relevant costs to consider are: master cross-index database development and maintenance, distribution costs (PC diskette or CD-ROM). Benefits (effectiveness measures) include: value of the information to first responders, responsiveness of contacts providing information to first responders, and response time (from notification to emergency response).

Output Product: The final test report prepared by the pilot test contractor will summarize and analyze the quantitative inputs from users of the cross-index products. Information usefulness will be described, evaluated, and compared against the cost of nationwide cross-index creation, distribution, and maintenance. Recommendations on implementation will be made in light of test experiences.

Table 5-6 Scenario D – On-line Computer Access to Material Safety Data Sheet (MSDSs) Information

Title: Scenario D – On-line Computer Access to Material Safety Data Sheet (MSDSs) Information.

First Responder Information Requirement: When first responders know what hazardous material they are dealing with in an incident, they also need immediate amplifying information on treatment of injuries, precautions required, and near–term remediation.

Issue or Concern to be Tested: Some basic information may be available from printed MSDSs literature in the HAZMAT vehicle as part of required shipping manifests, and some HAZMAT teams may carry MSDSs books with information on more commonly encountered materials. CHEMTREC also provides assistance to members via a toll–free telephone call. What is the usefulness of having MSDSs directly and immediately accessible to first responders via a computer network? How useful is direct access by first responders from the scene of a HAZMAT incident?

Objective(s): Measure the added usefulness of on–line MSDSs information in HAZMAT response by documenting the usage of two university-operated MSDSs databases. Compare the additional usefulness of this information to the cost of operating the on-line MSDSs service.

Description: Public domain MSDSs information is currently available on–line from Internet sites operated by the Chemistry Departments at two large U.S. universities. This test would sponsor the continued operation of two university MSDSs on–line databases and the connection of selected first response agencies to these MSDSs databases. Participating first response agencies' connections to the Internet could include public dispatch centers at fixed sites and mobile on–scene HAZMAT command vehicles. The pilot test contractor would arrange for the university sites to maintain operational databases during the test period. All designated users would be required to establish their own Internet computer accounts, and fixed–site (public safety dispatch) users would be responsible for their own computer terminal hardware and their initial connection to the network. The pilot test contractor would provide notebook computers and wireless communication devices to connect field HAZMAT responders to the Internet. The test contractor would arrange to have the volume and types of database usage by participating first response agencies documented. Using agencies would be interviewed by the test contractor to determine the viability of remote, on–scene wireless access, and the usefulness of this information in HAZMAT incidents. Users would be interviewed periodically to document the usefulness of on–line MSDSs information as compared to other sources of MSDSs information currently available.

Participants: Chemistry departments at two universities to operate and maintain public domain MSDSs databases; public safety dispatch agencies to provide information on their use of on–line MSDSs data; HAZMAT response teams to provide information on their use of on–line MSDSs data from incident scenes.

Data Collection/Measurements: Statistical information on MSDSs database usage by test participants to be gathered by the test contractor and universities operating the databases. Incident–specific information to document the usefulness of the on–line MSDSs information compared to traditional access methods to be gathered by the test contractor in conjunction with the users of the data. Cost information on the operation of MSDSs databases to be provided by two university sites.

Problems and Concerns: How realistic are the results of the pilot test? How much use will the on–line MSDSs information service get if it is known by emergency responders that many MSDSs are not included? How can chemical companies be encouraged to provide their MSDSs to the on–line service?

Cost Effectiveness: Relevant costs to consider are: development and operating costs of on–line MSDSs databases, upkeep of databases, commercial–off–the–shelf hardware and software costs, and training costs on MSDSs usage. Benefits (effectiveness measures) include: value (utility) of information to first responders at the site turnaround time of information retrieval, and response time (from notification to effective emergency response).

Output Products: An evaluation of the cost–benefit of making MSDSs data directly available on–line to public safety dispatchers and to first responders via on–scene wireless terminals.

Table 5-7 Scenario E – Access by First Responders to Vehicle Identification from Vehicle Transponder and HAZMAT Contents from Real-Time Information

Title: Scenario E - Access by First Responders to Vehicle Identification from Vehicle Transponder and HAZMAT Contents from Real–Time Information.

First Responder Information Requirement: First responders need to be able to determine the HAZMAT contents of a commercial vehicle even when such information is not available from the on–board manifest, driver, or placard or when an on–board manifest is unavailable, illegible, or incomplete. First responders now rely almost entirely on information from a placard, load manifest, or a vehicle driver to identify the contents of a highway vehicle involved in a HAZMAT incident. In some instances this information may be incomplete, ambiguous, or even in error. However, when a driver cannot provide any information, or an on–board manifest is unavailable, illegible, or incomplete, or a placard is not in use or is obviously used incorrectly, there is still an urgent need to be able to determine the HAZMAT contents of the vehicle.

Issue or Concern to be Tested: Vehicle location and contents may be tracked and interrogated in the event of a vehicle accident. What is the impact upon the emergency response to having immediate access to the contents of a vehicle?

Objective(s): Measure the usefulness of having direct, instantaneous, electronic access to commercial–carrier HAZMAT manifest information. Document instances when HAZMAT manifest information of a participating carrier is used, and determine the usefulness of this information to public safety agencies.

Description: Existing ITS projects (H.E.L.P. on the West Coast and Advantage I–75 in the Midwest) for automatic commercial vehicle identification (AVI), weigh–in–motion (WIM), and automatic vehicle classification (AVC) have infrastructures in place that document vehicles carrying cargo through major highway corridors. Vehicles equipped with special transponders (also known as smartcards) can travel along designated corridors at mainline speeds and do not need to stop for time–consuming weight and other revenue checks. Carriers document vehicle characteristics, cargo weight, and other permit and safety–related information in a central database that is checked each time the vehicle transponder is interrogated as it passes an automatic roadside reader. This pilot test would augment one or more of the existing ITS projects by having participating carriers input information on a vehicle's HAZMAT cargo. State and local HAZMAT agencies along a designated corridor would be further equipped with portable transponder "readers" to determine the identity of participating vehicles, which can then be used to query the main manifest database. This information would also be available, if transponder readers were not available or operable, by querying the central database with a vehicle number. When necessary, first responders could also query the central database for all HAZMAT shipments passing through the corridor. The pilot test would involve transponder interrogations, the viability of using and maintaining hand–held transponder readers, and the usefulness of this information in HAZMAT incidents. Major users would be interviewed by the pilot test contractor to document the usefulness of this method of access and the accuracy of manifest information.

Participants: Existing ITS motor carrier and government project participants; HAZMAT responders along designated test corridors.

Data Collection/Measurements: Statistical information on transponder interrogations and types of database access queries would be obtained from the sponsoring ITS project. Documentation on specific incidents and the usefulness of transponder and database information would be obtained from interviewing the first response users. Documentation of the costs associated with providing electronic HAZMAT manifest services would be obtained from the sponsoring ITS project.

Problems and Concerns: How realistic are the results of the pilot test? Will the information on the vehicle transponder be accurate? Will it be updated when changes to the HAZMAT cargo are made?

Cost Effectiveness: Relevant costs are hardware and software increments required to include HAZMAT information reporting on existing ITS project, portable transponder "readers," HAZMAT mobile data terminal, manifest database development and upkeep, interface cost with National Incident Information Grid, training costs to first responders. Benefits (effectiveness measures) are value (utility) of manifest information to First Responders at the site, turnaround time of information retrieval, and response time (from notification to effective emergency response).

Output Products: Analysis report documenting the cost–benefit of vehicle tracking information to HAZMAT incident first responders.

Table 5-8 Scenario F - On-line Access by First Responders to Vehicle HAZMAT Contents Information

Title: Scenario F – On-line Access by First Responders to Vehicle HAZMAT Contents Information.

First Responder Information Requirement: When an on–board manifest is unavailable, illegible, or incomplete, there is a need to be able to determine the HAZMAT contents of a commercial vehicle. First responders now rely almost entirely on information from a placard, load manifest, or a vehicle driver to identify the contents of a highway vehicle involved in a HAZMAT incident. In some instances this information may be incomplete, ambiguous, or even in error. However, when a driver cannot provide any information, or an on–board manifest is unavailable, illegible, or incomplete, or a placard is not in use or is obviously used incorrectly, there is still an urgent need to be able to determine the HAZMAT contents of the vehicle.

Issue or Concern to be Tested: What is the impact on emergency first response of knowing what hazardous materials, if any, are involved?

Objective(s): Measure the usefulness of direct, instantaneous, electronic access to commercial–carrier HAZMAT manifest information. Document instances when HAZMAT manifest information of a participating carrier is used, and determine the usefulness of this information to public safety agencies.

Description: An existing demonstration project (Operation Respond) within the Department of Transportation has developed a manifest database of railcar contents that can be accessed by public safety dispatchers at the maritime transshipment terminal in Houston, Texas. The current tracking system is used to identify the type and amount of bulk chemical contents of specific rail cars when first responders provide public safety dispatchers with descriptive car information. An optional pilot test for this program considers expanding the current database to include manifest information on all bulk motor carrier highway shipments originating from the transshipment terminal. This test project expansion would specifically provide public safety dispatchers in Houston and the principal interstate corridor out of the city toward Louisiana with direct access to the HAZMAT manifest database from project-provided computer terminals. The highway portion of this test would involve documentation by Operation Respond of the amount of central database usage by participating first response agencies and the usefulness of this information in truck–related HAZMAT incidents. First response users would be interviewed by the pilot test contractor to document the usefulness of this method of access and the accuracy of manifest information.

Participants: Existing Operation Respond transshipment terminal and public service dispatch project participants; motor carrier users of the transshipment terminal; additional public safety dispatchers.

Data Collection/Measurements: Statistical information on number of transponder interrogations and types of database access queries to be gathered by Operation Respond. Documentation of specific incidents and the usefulness of HAZMAT manifest database information would be gathered by the pilot test contractor. Documentation of the costs associated with providing data services would be compiled by Operation Respond.

Problems and Concerns: How realistic are the results of the pilot test? What will be the effect on emergency responders if many/some carriers/shippers do not choose to provide on–line access?

Cost Effectiveness: Relevant costs are: manifest database development and upkeep, computer terminals for local/regional emergency 911 dispatch, training costs. Benefits (effectiveness measures) are: value (utility) of information to first responders at the site, information access time, and response time (from notification to effective emergency response).

Output Products: Analysis report documenting the cost–benefit of providing the manifest database information to HAZMAT incident first responders would be prepared by the pilot test contractor.

6. ISSUES

Stakeholders (firefighters, motor carriers, chemical shippers, etc.) raised significant issues during this study that offer interesting perspectives on the first responders' information needs and use of information technology for HAZMAT transportation incident response. Two activities were conducted in order to solicit feedback from stakeholders:

- **A First Responders Workshop**, conducted by Ecology and Environment, Inc., was held in conjunction with the 1994 International Hazardous Materials Spills Conference in Buffalo, NY (29 October to 3 November 1994). Table 6-1 lists workshop participants. The **objective** of the workshop was to obtain direct feedback and comments from first responders on the six candidate pilot tests described in Chapter 5.
- **A Survey of Hazardous Material Carriers and Shippers** to obtain perspectives relative to the information requirements for first responders WBS conducted by ALK Associates, Inc. (January – February 1995). Likewise, the **objective** of the carrier/shipper survey was to obtain their feedback and comments relative to the six candidate pilot test scenarios and to the First Responders' comments. Table 6-2 lists the survey respondents.

By polling the various stakeholders, **a balanced perspective was obtained on information requirements and use of information technology by first responders**.

Table 6-1 First Response Workshop Attendees

NAME	TITLE/FUNCTIONAL POSITION
J. Jackson	Director EPA's Region 7 Technical Assistance Team (TAT) program (Midwest)
R. Bickum	Assistant to the Chief EMS, Montgomery (Maryland) County Department of Fire and Rescue
G. Carlson	Editor of Fire Protection Publications, Oklahoma State University and member of National Fire Protection Association Hazardous Materials Technical Committee
L. Blair	Past Chief of Townline Fire Department, NY and founder HAZWEST, West NY Regional Hazardous Materials Consortium
V. Hens	Director Western New York Regional EMS Agency and founder of International Emergency Nurses Association
M. Mazurowski	Department Chief, Doyle Fire Department, NY and policy maker for Western New York Region Emergency Medical Services
D. Barmore	Deputy Commissioner (EMS) of the Chautauqua County office of Emergency Services
W. Keffer	HAZMAT Emergency Response expert specializing On–Site First Responder Support Services and HAZMAT Training
J. Hess	Formerly Associate Director, National Response Center (USCG) and currently staff member at Office of Pipeline Safety
D. Zelazny	Member of U.S. EPA Technical Assistance Team, Region 5 through Region 10
J. Keane	Commissioner, Emergency Services, Erie County, NY
W. Rathke	Niagara County Fire Coordinator, NY
M. Sprague	Stenben County Emergency Manager, NY
P. Hanlon	Office of Fire Protection, NY State
G. Provatiere	Rochester, NY HAZMAT Team
M. Hartley	Assistant Chief, East Aurora (NY) Fire Department
G. Diskin	Kodak Park Fire Department, Rochester, NY
Sgt. P. Gang	New York State Police Regional Disaster Coordinator
Cdr. D. Beach	Past Director of USCG's National Response Center (recent assignment National Pollution Funds Center)
L. Adams	Director of Ecology & Environment's (E&E) Nationwide Corporate Chemical Emergency Response Team

Table 6-2 Carriers and Shippers Surveyed

CARRIERS
Mr. Tony Douglas, Director, Accident Prevention Chemical Leaman 102 Pickering Way, Exton, PA 19341 (610) 363-4437
Mr. John Yakovich, Safety Director Transportation Services Mr. Brian Logue, General Manager of Safety Mr. Jim Busko, Data Processing Manager DartAmerica, Inc. 61 Railroad Street, Canfield, OH 44406 (216) 533-9841
Mr. Brian Logue, General Manager of Safety Mr. Jim Busko, Data Processing Manager DartAmerica, Inc. 61 Railroad Street, Canfield, OH 44406 (216) 533-9841
Mr. Robert Maberry, Chemical Transportation Administrator Yellow Freight 10990 Roe Avenue, Overland Park, KS 66211 (913) 344-5890
SHIPPERS
Dr. Dennis Ashworth, Manager, Hazardous Materials Transportation and Emergency Response Chevron Chemical Company 1301 McKinney Road, Room 906, Houston, TX 77253 (713) 754-2561
Ms. Donna Carville, Emergency Response Coordinator The Dow Chemical Company P.O. Box 150, Plaquemine, LA 70765 (504) 685-8000
Mr. Raymond Beaudry, Sourcing Consultant (manages transportation emergency response for DuPont, also chair of the CMA's Emergency Planning, Response and Advocacy Task Group)
The DuPoint Company 1007 Market Street, Room D3070-1, Wilmington, DE 19898 (302) 774-3047
Ms. Dolly Lee, Risk Assessment Specialist Hoechst Celanese Corporation P.O. Box 1026, Charlotte, NC 28201 (704) 559-6796

6.1 SURVEY OBJECTIVES

A common set of objectives was set for both the First Responders Workshop and the Chemical Shipper Survey:

- What do you believe are the most important information needs of first responders when facing a highway transportation HAZMAT incident?
- For a new information element, procedure, or technology to be "more useful" to HAZMAT emergency first responders, it must deliver certain measurable benefits. What should be measured in a pilot test to justify the adoption of new information for first responders?
- Six candidate test scenarios involving different technologies are postulated to demonstrate the increased value of information, procedures, or systems either not now being used or receiving only limited use. What is your opinion relative to utility of information, feasibility of scenarios, problems and concerns and cost effectiveness?

The carrier/shipper survey included a second part that requested their opinions on first responders' perspectives toward the candidate pilot test scenarios.

A secondary objective of the first responder workshop and carrier/shipper survey was to enlist the future participation and cooperation by stakeholders as new information requirements are identified and as future pilot test(s) begin to take shape.

Six candidate pilot test scenarios were presented to first responders and carrier/shippers (Chapter 5). Three of the six scenarios (A, D, F) were presented to the stakeholders as primary; while the other three scenarios (B, C, and E) were presented as corollaries of Scenario F.

The three principal candidate test scenarios reviewed by the stakeholders were:

A. Public safety dispatchers notified directly of a HAZMAT incident by carrier.

D. On-line computer access to Material Safety Data Sheet (MSDS) information.

F. On-line access by first responders to vehicle HAZMAT contents information (Scenarios B, C and E are considered variants by the stakeholders).

These three scenarios as described to survey participants, are described in detail in Tables 5-3, 5-6, and 5-8.

6.2 SUMMARY OF FINDINGS

Tables 6-3, 6-4, and 6-5 paraphrase the first responders and carrier/shipper reactions to the three principal scenarios outlined above and detailed in Section 5.1. Of the three scenarios, **the on-line access to MSDS (Scenario D) appeared to have the highest degree of consensus among the first responders and motor carriers stakeholders**. However, the shippers view MSDS information as redundant with that contained in CHEMTREC and providing no additional benefits. (Some degree of bias may be built into this response, given the shippers' familiarity with and use of the CHEMTREC databases.)

Table 6-3 Scenario A – Public Safety Dispatchers are Notified Directly by the Carrier of a HAZMAT Incident

First Responder Summary
Participants concluded that the dispatchers with whom they worked, while qualified for their roles, were not qualified to process incident-specific information that would subsequently be used to make on site decisions. The level of HAZMAT-related training received by the "generic dispatcher" was not considered to be adequate. Further, there is a tendency for the dispatcher to truncate information through distillation, by not asking the appropriate follow-on questions, or by being distracted by other high priority tasks during the intense "first response" phase of a HAZMAT incident.
Carrier/Shipper Summary
This scenario received a mixture of responses. The three trucking companies responding were guardedly in favor of it, although one expressed concern over the possible "substantial financial investments." Shippers seemed to be more skeptical that this would actually work. Three of the shippers pointed out that they should also be immediately notified by the carrier in case of an incident.   Two respondents felt that direct notification would improve the timeliness and quality of the information and improve the ability to react to an incident. Another respondent felt that direct notification should only apply to selected hazardous shipments. A fourth respondent was in favor, but expressed concern that only a small number of carriers have Automatic Vehicle Location (AVL) capability and 24-hour/365-day dispatch/emergency staffing.   Two other respondents felt that this scenario was not needed since local response units are currently aware of most incidents in under fifteen minutes. The respondents also questioned whether carriers would actually contact public safety authorities and whether the dispatchers are properly trained to receive and use this information. The final respondent questioned whether the quality of this information would be any better than that of current information sources.

Table 6-4 Scenario D - On-Line Computer Access to Material Safety Data Sheet (MSDS) Information

First Responder Summary

This scenario was, it seemed, well received. However, the discussion was divided into two different perceptions of how it might work. First, the true on-line access was, in a rudimentary form, available through CMA's CHEMTREC. Although cumbersome at some times, many were happy with the outcome. However, distinction was drawn that this was not really on-line, but telephone/fax available. Expanding the role and capabilities of such a system were well received. An exception was taken by one chief officer who submitted his comments in writing. He had regular occasion to use CHEMTREC given his wide area of responsibility, and found the process lacking, particularly in response time and depth of information.

The second direction focused upon a slightly different interpretation. Instead of on-line, this direction is on-hand/on-line. This is a concept whereby a virtually complete file of MSDS type information is available on CD-ROM for local use in field portable computers. A form of such a program is currently in operation under the CAMEO program. In this program the chemical database, limited to some 3000 generic chemicals, has been derived using composite sources to enhance the usefulness and friendliness, and is regularly updated by the Federal government.

Carrier/Shipper Summary

The three trucking companies responding were strongly in favor of on-line access to MSDS information, while the four shippers felt that this was not necessary due to CHEMTREC. The trucking companies described MSDS with phrases like: "most valuable of all known information available to first responder" and "necessary to evaluate the potential danger associated with a chemical." Concerns of the trucking companies included training of emergency first responders in the use of the on-line system and establishing a simple, standard format for the MSDS information. One respondent stated that MSDS should include hazardous waste products and not just virgin chemicals.

The shippers unanimously stated that on-line MSDS information was unnecessary and would provide no additional benefits beyond CHEMTREC.

Table 6-5 Scenario F - On-Line Access by First Responders to Vehicle HAZMAT Contents Information

First Responder Summary

On–line computer access to any information database during the first response phase of an incident is difficult in the best of circumstances. Most first response personnel could not/would not use an on-line system unless such a system was hardwired in the dispatch center and could be immediately operated by a field-experienced person. This is not realistic or practical in the first response phase.

The participants questioned the basis for a HAZMAT Carrier Cross-Index Location system. The compliance of a few with the process would mean that valuable time might be expended trying to get information on a vehicle that is not part of a system. There was a sense of distrust in a computerized system linking the vehicles to carriers and to bills of lading. An expressed concern was that upkeep of the data in such a system would result in lack of information currency and poor compliance.

At first, most could not fully grasp the technology used for on-line access and, therefore, lumped it together with Scenarios B, C and E, which they also had some problem understanding. With explanation, the group seemed to be quite interested in seeing how such a system (tracking, monitoring, and smart card commodity tracking) could help them.

Carrier/Shipper Summary

Two trucking companies and one shipper felt that on–line access to vehicle contents was a good idea, but that it would be impractical and overly burdensome to small carriers. The third trucking company felt that this scenario was a bad idea due to the cost of entering every HAZMAT load into the system and the lack of computers at small and rural first response units. Two of the shippers felt that this system was not necessary since the shipping papers they currently fill out contain all relevant information.

6.3 CONCLUSIONS

Table 6-6 summarizes the key issues raised by the stakeholders from the first responders and carrier/shipper perspectives. Most importantly, **the table shows the consensus response obtained from all the stakeholders**. Some interesting conclusions were obtained from both surveys, which are worth noting:

First Responders Workshop Conclusions

- The workshop highlighted three areas where the participants felt improvements to first responder information flow are needed. They need to recognize the potential for a HAZMAT incident; find out what chemicals are on the vehicle, and determine and understand the synergistic properties of the involved chemicals with other shipments in the truck.
- First, as one participant put it, the first responder could have valuable information at the speed of light if the routine markings of HAZMAT could be improved. Clarifying and improving the existing placarding regulations and, possibly, adding some component of the NFPA's Standard for Chemical Marking, #704, would have the most positive impact on the first responders. Second, adoption of the new 16-point MSDS format together with global availability of the complete database for local use on field computers would be a positive tool.
- Finally, when the circumstance surrounding a possible HAZMAT incident precludes the visual identification of the specific vehicle or of its contents, evolving computer-based technology embracing vehicle tracking, monitoring, and contents identification might be a significant step forward. However, the First Responders found it hard to visualize the technical workings of such an information system and the potential benefits that could be derived from it.

A significant postscript to the First Responders workshop is that none of those attending had seen, read, or knew of the NAS report. A copy of the report summary has subsequently been forwarded to every workshop participant.

Table 6-6 Summary of Key Issues Raised by Stakeholders

SCENARIOS	FIRST RESPONDERS	CARRIER/SHIPPER	CONSENSUS RESPONSE
A Low-Level Technology	• Level of dispatcher qualifications to handle HAZMAT information • Add to dispatcher workload	• Concerned about level of investment required • Improved timeliness and quality of information	• Requires dispatcher training for effective response
D Medium-Level Technology	• Good utility from MSDS information, particularly on–line • Variants with potential (e.g., CD-ROM with portable computers)	• Trucking companies strongly in favor of on–line MSDS • Shippers saw redundancy with CHEMTREC • Standard format for MSDS	• Good response relative to utility • Potential duplication with CHEMTREC databases
F (B, C, E) High-Level Technology	• Hard to grasp technology and derived benefits • Questioned utility of Carrier Cross-Index Location • Distrust of computerized systems	• Excellent idea • Impractical and burdensome for small carriers • Costly for small/rural first responders	• Some sense of utility • Need to demonstrate technology to understand utility • Potentially high cost to implement

Carrier/Shipper Survey Recommendations

The survey revealed different viewpoints between shippers and carriers and from those of first responders. Below are the most significant:

- All **carriers** are in favor of an on-line computer access to MSDS information and all the **shippers** are opposed.
- All respondents (carriers and shippers) agreed with first responders that public safety dispatchers are not adequately trained to receive detailed information about a HAZMAT incident, nor should they be expected to make high-level decisions based on this information.
- All respondents reacted negatively to the On-Line Access by First Responders to Vehicle HAZMAT Contents Information (Scenario F and Scenarios B, C and E as variants). Three responses were received (two shippers and one trucking company); none was positive. Two responses pressed for improved adherence to current documentation and safety regulations, rather than new on-line information. The third response expressed concerns over security and an overabundance of information.
- On-line access to MSDS information received opposite reactions from shippers and carriers. The shippers felt that it would be better to upgrade CHEMTREC and that MSDS has not historically been a good source for first response information. The trucking companies felt that on-line access to

MSDS was an excellent idea, but that MSDS would need to include waste loads and not just virgin chemicals.

- Four responses (three shippers and one trucking company) were received regarding Direct Computer Access to Vehicle HAZMAT Contents Information and Material and Environmental Reference Information. All of the respondents basically agreed with the first responders that this is not a desirable scenario. There was a concern that too much effort would be wasted during a crisis trying to retrieve the information. One respondent took a longer-term view and expressed concern that reliance on a computerized system would detract from proper training of the first responders.

Over the short term, the on-line MSDS (Scenario D) offers the potentially lowest implementation cost with a high payoff. Issues of MSDS information duplication with CHEMTREC need to be addressed and potential synergies of both information sources explored. Over the long term, the On-Line Access by First Responders to Vehicle HAZMAT Contents Information (Scenario F) and its corollary scenarios (B, C and E) offer potentially a higher payoff (utility) at potentially high cost. However, the utility needs to be demonstrated to stakeholders by exploiting existing technology demonstrations programs, such as H.E.L.P./CRESCENT, Advantage I-75, Operation Respond and the Connect EnviroNet project (San Diego).

7. SUMMARY

Following is a summary of the report based on stakeholder (first responders, shippers, and carriers) inputs, related projects, and evolving technology applications:

1. **Over the short term, a pilot test project involving on-line MSDSs and CHEMTREC databases (Scenario D) provides potentially high benefits at moderately low costs.**

There was considerable interest in this scenario and overall consensus that CHEMTREC could make MSDSs information more readily available. A small demonstration project could be performed using either on-line MSDSs information from Internet sources described in Chapter 4 or CD-ROM resources. A pilot test would identify the utility of this information to first responders at the scene and would uncover the issues related to more wide-scale dissemination of the information.

2. **Ongoing demonstration programs in the U.S. such as H.E.L.P./CRESCENT, ADVANTAGE I-75, Connect EnviroNet and Operation Respond provide a cost-effective testbed on which to "piggyback" the more promising HAZMAT tracking technologies.**

Formal linkage already exists between DOT agencies with HAZMAT responsibility and Operation Respond. This type of interaction would prove beneficial with H.E.L.P./ CRESCENT, ADVANTAGE I-75, and Connect EnviroNet projects, as well. Each of these projects could be easily modified or modestly redirected at *minimal cost* to make HAZMAT information available to first responders. Each project already has, or is developing, an information network upon which HAZMAT information could "piggyback." These projects could be used as technology testbeds to track the performance of the relevant technologies as they apply to first responder applications.

3. First responders' lack of understanding of HAZMAT information technology presents barriers to technology implementation.

A significant issue uncovered in this study was the inability of first responders to understand or appreciate the value of information provided by computerized data and communications systems. As a result, they mistrust anything requiring "computers" and believe (based on anecdotal experiences) that the data will be unreliable and therefore unusable. Before first responders will embrace new technologies, they must (1) understand their basic functions, (2) use ("touch") them, (3) see them used by others, and (4) gain confidence over time in the validity of the information content. Education and demonstration activities (probably through professional and training associations) in order to develop a first responder population that is more receptive to new information technologies is a logical next step. (An encouraging note is the number, albeit a minority, of technically literate dispatchers, police, firefighters, and EMS personnel who expressed interest through the Internet in the HAZMAT information pilot project. As more of these individuals enter the profession we would expect to see a more receptive workforce.)

4. The fast pace of technology advancement offers DOT an incentive to actively track the progress of key enabling technologies.

Most, if not all, of the key enabling technologies discussed in Chapter 3 will continue to evolve rapidly without DOT investment. The commercial market for these enabling technologies is exploding and dramatic changes are taking place daily. DOT can play a significant role by maintaining a "technology watch" on the progress of key enabling technologies to identify those that will have fundamental impacts on HAZMAT information systems. A good example of this is the GPS survey being performed by the Volpe National Transportation Systems Center (Volpe Center). GPS was identified as an enabling technology that will have a dramatic impact on many types of transportation applications, and is thus worthy of ongoing examination for benefits to all of DOT.

5. Proactive notification technologies (as typified in Scenario A) promise potential benefits for First Emergency Response. DOT may find valuable application by actively tracking their progress in the U.S. and other countries.

While many respondents were not eagerly receptive to the idea of proactive notification of a HAZMAT accident, this is a concept that is being embraced for other types of accident notification. In the U.S. it is an important part of the accident response portion of the ITS concept of an Advanced Traffic Management System or Center where an intermediate focal point will be notified of an accident and will in turn either notify a dispatcher or notify emergency responders directly. Similarly, projects by the Ford Motor Company in the UK and BMW in Germany will be testing the relevant technologies that could be used directly for proactive HAZMAT incident notification in the U.S.

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