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INFORMATION TECHNOLOGY AND HAZ MAT EMERGENCY RESPONSE – CURRENT APPLICATIONS AND FUTURE POTENTIAL

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PREFACE AND ACKNOWLEDGEMENTS

This report examines the current applications of information technology to emergency response for hazardous materials incidents, with a focus on the needs and technology uses of HAZ MAT Emergency Responders within local and state Fire Department organizations. This report is a follow-up to 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."

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The authors wish to acknowledge and thank the HAZ MAT Response Officials of the Fire Departments that were visited and interviewed. In particular, we would like to recognize the contributions made by

Stephen Clendenin, Department of Massachusetts Fire Services Hazardous Materials Response, Stow, Mass.

James Controvich, Springfield LEPC Coordinator, Springfield, Mass.

Captain Lawrence P. Ferazani, Cambridge Fire LEPC Coordinator, Cambridge Mass.

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themselves represented a useful mix of community size, with attendant implications for different levels of safety technology funding and use. Schedule availability of officials and travel resource considerations were also taken into account in targeting these particular communities and their response officials. The communities and agencies that these officials represent are displayed in the exhibit below. Additional information is provided in Appendix A.

Exhibit 1-1: HAZ MAT Emergency Response Agencies Visited

LOCATION	EXPERTS INTERVIEWED	PURPOSE
Department of Fire Services, HAZ MAT Materials Emergency Response, Stow, MA	Mr. David M. Ladd, Director Mr. Stephen Clendenin, Director of Operations Paul Otenti, Data Systems Ms. Casey Jensen, Administrative Assistant	Discuss the Massachusetts District Team Program, technology devices, operating guidelines, information technology applications, tour of TOMs vehicle. Obtain statistics of TOMs vehicle utilization since inception of Program. Obtain feedback on report.
Cambridge Fire Department, HAZ MAT Response	Capt. Lawrence Ferazani, LEPC Coordinator	Discuss Local Emergency HAZ MAT issues of City Department.
Chelmsford FD, HAZ MAT District Team 6	Chief John E. Parow	Discuss Mass. District Team operations and IT application issues. Obtain feedback on report.
Mass. Emergency Management Agency	Mr. John P. Tommaney, Deputy Chief, Operations	Discuss State HAZ MAT response activities and coordination with City and District Teams.
Boston FD, HAZ MAT Unit, Emergency Management Division,	Lt. Richard Parker, HAZ MAT Officer and LEPC Coordinator	Discuss IT applications and issues relative to HAZ MAT response in City of Boston. Tour of Mobile Command and Control Unit
Marlborough FD, HAZ MAT District Team 3	Deputy Chief Robert Rennie Capt. Paul Otenti	Discuss Mass. HAZ MAT District 3 operations and IT applications Attend monthly drill of HAZ MAT District 3 Obtain feedback on report
Newton FD, HAZ MAT District Team 2	Lt. Mike Castro, Team Leader	Discuss HAZ MAT District Team operations and IT applications Obtain feedback on report
Springfield FD, HAZ MAT Response	Mr. Jim Controvich, Director of Emergency Preparedness/ LEPC Coordinator	Discuss HAZ MAT IT application in City of Springfield Obtain feedback on report
South East New Hampshire HAZ MAT Mutual Aid	Chief Alan Sypek	Discuss New Hampshire's HAZ MAT response and IT applications Obtain feedback on report
New Hampshire Office of Emergency Management	Mr. Lee Kimball, Program Management and SERC Coordinator	Discuss New Hampshire's HAZ MAT Regional Response organization Obtain feedback on report
New Hampshire Capital Area Response Team	Lt. Andy Paskalis, HAZ MAT Team Leader	Discuss New Hampshire's Central Region (Capital Area) HAZ MAT response organization
Brattleboro, Vermont, Fire Department	Chief David J. Emery Mr. James Matteau, Associate Director, Windham Regional Commission	Discuss HAZ MAT emergency response in the Brattleboro area, cross-border cooperation, and the impact of a near-by nuclear reactor

1.4 REMAINDER OF REPORT

The remainder of this report is organized as follows. Chapter 2 defines the stages of HAZ MAT emergency response, the personnel involved in each stage, and the IT/communications functions associated with each stage. Chapter 3 discusses current technology applications that are being used to meet needs in each of the response stages. Finally, Chapter 4 discusses emerging technologies that are expected to be applicable to emergency response management in the near term.

At the end of this report are four appendices. These contain (1) brief overviews of the responses of the HAZ MAT emergency organizations contacted; (2) a detailed description of the command vehicles currently deployed by the six HAZ MAT emergency response districts in Massachusetts; (3) a description of the functions of HAZ MAT response team members in the six Massachusetts HAZ MAT districts, and (4) information on products and services of selected satellite-based communications companies.

2. RESPONSE STAGES, PERSONNEL, AND INFORMATION AND COMMUNICATIONS FLOWS

2.1 INTRODUCTION

To better understand the role of information technology (IT) and communications in managing HAZ MAT incidents, it is helpful to understand the response stages, personnel, response levels, and information and communications flows that comprise a typical HAZ MAT transportation incident. Accordingly, this chapter first provides an overview of the basic stages of an incident, the safety personnel involved, and the general levels of response that occur. Then the chapter discusses the information and communications flows that usually occur within each incident stage, identifying the technology and equipment that facilitate those flows.

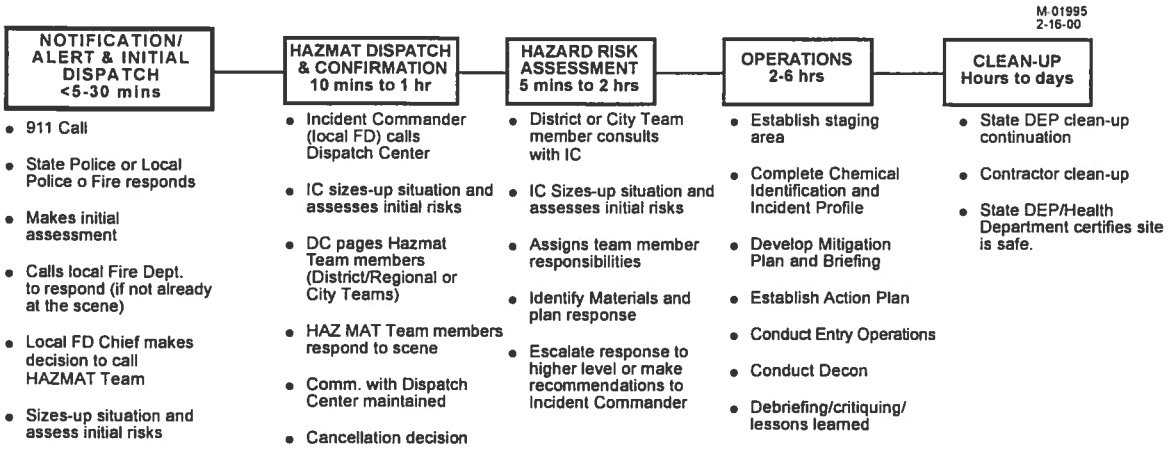
2.2 STAGES OF HAZ MAT RESPONSE

The U.S. Department of Transportation considers a HAZ MAT incident to be any unintended release of hazardous materials from the packaging (box, canister, tank truck, rail car, etc.) in which the material is contained. For the mishap to be a transportation incident, it must occur during loading, transport, or unloading of the material. There need not be a truck, rail car, aircraft, or water vessel accident associated with the HAZ MAT release, although there often is. If the release or potential for release is serious enough to warrant help from public safety personnel, an emergency response is triggered.[1]

Starting with a HAZ MAT release or a similarly threatening event, a HAZ MAT emergency response may be characterized by five basic stages: (1) notification/alert dispatch, (2) HAZ MAT dispatch and confirmation, (3) hazard risk assessment, (4) operations, and (5) clean-up. These stages are delineated in Exhibit 2-1, along with key activities and approximate duration associated with each stage.

[1]While the emphasis in this report is on transportation HAZ MAT incidents, the discussion generally applies to either transport or fixed-facility incidents. Where a distinction is warranted, the point is clarified. Fixed facility HAZ MAT incidents may involve chemical plants, research laboratories, clinics, public utility plants, or the many other fixed locations where hazardous materials are stored or used. It might be noted that fire departments and other safety agencies that track the number of emergency responses that they conduct typically report that transport HAZ MAT emergencies are often less than half their annual total.

Exhibit 2-1: Five Stages of HAZ MAT Emergency Response*



Notes: FD = Fire Department
Comm. = Communications
Decon = Decontamination
DEP = Department of Environmental Protection and similar state organizations
Source: Discussions with HAZ MAT and other Emergency Responders
*Response times are nominal values; municipal or rural response times may be higher

2.3 PUBLIC SAFETY PERSONNEL

RESPONSE UNITS AND TEAMS. In communities throughout the United States, the job of responding to a HAZ MAT incident – an often difficult, dangerous, and highly technical task – is typically the responsibility of the local Fire Department. Fire Departments have frequently addressed this difficult responsibility by creating special HAZ MAT Emergency Response units. Members of these units receive specialized training in handling HAZ MAT emergencies. As defined by NFPA 472[2], an important source of guidance for HAZ MAT emergency responders, there are four levels of this training: Awareness, Operational, Technician, and Command. Awareness is the lowest level of training. Most HAZ MAT response units consist of individuals trained to the Technician level (i.e., trained to use specialized protective clothing and control equipment in containing and mitigating releases at HAZ MAT incidents), supported by individuals trained to the Operational level (i.e., trained in the containment and mitigation of releases at HAZ MAT incidents from a safe distance). Response units are often further specialized, with position distinctions such as safety officer, science/information specialist, logistics officer, and so forth. Most HAZ MAT technicians (if not all) work as parts of teams; there are no "free agents" in the HAZ MAT response arena.

In a number of states, HAZ MAT response units have been organized on a team basis, using that structure at the local, regional, or statewide levels. Those HAZ MAT teams are generally organized as follows:

[2] "NFPA 472: Professional Competence of Responders to Hazardous Materials Incidents," National Fire Protection Association.

Local Teams: organized by the Fire Department of a locality and under the supervision of that locality's Fire Chief. In Massachusetts, there are local teams in Boston, Cambridge, and Springfield. In New Hampshire, the state's largest city, Manchester, has a local team.

Regional Teams: organized by a coalition of Fire Departments of several communities within a region of a state and under the overall guidance and supervision of an agency of the state. In Massachusetts, six regional HAZ MAT teams provide coverage for the entire state. In New Hampshire, seven regional HAZ MAT teams provide coverage for the central and southern parts of the state. No regional teams exist in the northern part of that state.

Statewide Team: a strategically located team, sometimes contractors, managed by the State Department of Environmental Protection (DEP) or similar organization and providing statewide HAZ MAT emergency response coverage. Vermont has this type of team.

In areas where regional or statewide teams are available, the type of team that responds to a given incident depends on the seriousness of that incident. That assessment -- how serious an incident is or is likely to be -- is a judgement call usually undertaken in concert by a local fire department and the regional or statewide team. Depending on which type of team is called to respond, the duration of the five HAZ MAT stages may be affected (Exhibit 2-2). This is particularly true in the Dispatch & Confirmation stage, where multiple communication layers may be required to reach appropriate members of regional or state teams, and team members may need to travel considerable distances to reach an incident site.

Exhibit 2-2: Representative Response Times at Each HAZ MAT Emergency Response Stage

HAZ MAT STAGES	CITY TEAM	REGIONAL OR DISTRICT TEAM	STATE-WIDE TEAM
ALERT/NOTIFICATION/ INITIAL DISPATCH	< 5 Mins	< 15 Mins	< 30 Mins
HAZ MAT DISPATCH & CONFIRMATION	< 10 Mins	< 45 Mins	< 2 Hr
HAZARD RISK ASSESSMENT	5 Mins – 2 Hrs	45 Mins – 2 Hrs	45 Mins – 2 Hrs
OPERATIONS	2 or 6 Hrs	2 or 6 Hrs	2 or 6 Hrs
CLEAN-UP	Hours or Days	Hours or Days	Hours or Days

Source: Discussions with HAZ MAT Emergency Responders

OTHER SAFETY PERSONNEL

COMMUNICATIONS SUPPORT. The judgement and skills of specially trained emergency response personnel and the coordinated deployment by local, regional, and statewide units may be the most crucial ingredients in successful HAZ MAT incident management. The mere existence of multiple stages of a HAZ MAT incident, however, attest to the fact that incident response requires important contributions by other safety personnel early on and throughout the course of an incident. One such group of safety personnel are the communications experts involved in handling emergency calls, dispatching information to response team members, and maintaining the expeditious flow of information throughout the course of an incident. These personnel typically operate from local 911 or emergency communications centers (ECC), or they may staff a specialized dispatch center devoted just to coordinating communications for a fire department. They too must be considered a fundamental part of the overall HAZ MAT incident management equation.

As technology grows more sophisticated and call volumes in most communities increase, emergency communications responsibilities have grown more complex and, in some cases, more specialized. For example, computer-aided dispatch and geographic information systems (GIS) potentially offer great speed and accuracy to the overall dispatch process, but they require considerable computer skills. In some communities, ECCs have adapted by operating with dedicated "call-takers" who survey the incoming callers and quickly compile incident profile information such as general location, time of incident, vehicle status, cargo type if known, etc. In turn, these call-takers relay the caller survey information to specialized dispatchers who map the location, automatically notify strategically located response personnel, and arrange for arrival of needed equipment. (Because transportation and fixed facility HAZ MAT incidents are processed through the same ECCs, major synergies are achieved through task specialization and automation.)

FIRST RESPONDERS. First responders are usually the first safety officials to arrive on-scene at the site of a HAZ MAT incident. Generally they are not members of the more specialized HAZ MAT response units, instead they are likely to be police (City, State), EMS or non-HAZ MAT trained firefighters. After an alert has been initiated, these safety officials arrive at the scene to provide a general assessment of the incident situation -- noting vehicle or fixed facility circumstances, potential evacuation and traffic rerouting requirements, and other early incident conditions. These first responders normally carry with them the NAERG book and are able to perform an initial risk assessment at the scene. However they are not trained to assess the specific incident risks and mitigate any material release. In this case, the first responder calls upon HAZ MAT emergency response personnel who are qualified to make in-depth assessment of the risks of the specific hazardous material cargoes involved.

2.4 LEVELS OF HAZ MAT EMERGENCY RESPONSE

The seriousness of an incident, as judged by first responders and on-scene fire department personnel, will normally dictate the level of response: that is, the size and make-up of the HAZ MAT team notified to respond and the various equipment requested to help manage the incident. In states like Massachusetts, response levels are formally tiered to reflect increased risks.

Activities associated with the various levels of response in Massachusetts are listed in Exhibit 2-3, along with operations-related tasks accomplished by larger teams in higher risk (tier) situations. While the exhibit illustrates the tier and response activity associated with regional response in Massachusetts, the relationship of teams and activities is characteristic of response practices generally.

Exhibit 2-3: Response Levels Protocol by Massachusetts Department of Fire Services Hazardous Materials District Response Teams

TIER	DEFINED AS	RESOURCES	DURATION*	ACTIVITIES
One	Hazard Risk Assessment	5 Technicians 1 TOM	1 to 3 hours	• Assign Functions (Team Leader, Science, Safety and Communications) • Assess risk • Research materials • Explore options • Make recommendation to IC
Two	Short Term Operations	2 Groups of Technicians & 2 Groups of Support Personnel (about 20 team members in all) 1 TOM 1 ORU	4 to 8 hours	• Determine need for more resources/equipment • Perform Medical, Entry, Logistics and Decon functions • Conduct limited mitigation • IC may request response of Statewide Incident Command Communications Unit (if required)
Three	Long Term Operations	Full Response Team (all technicians and support personnel—about 40 team members in all) 1 TOM 1 ORU 1 OSU	8 to 24 hours	• Conduct multiple entries • Use specialized mitigation equipment • Specialized Mitigation and Decon • Statewide ICCU dispatched to incident • Director's office will respond • Lengthy operations
Four	Multiple Team Operations	Full Response Team (plus additional response groups and equipment)	Days	• Very large incident • Requires multiple Team Response

* Time estimates based on discussions with HAZ MAT responders interviewed.

Notes: TOM = Technical Operations Module (i.e., mobile command vehicle)
ORU = Operational Response Unit (i.e., equipment, and decontamination vehicle)
OSU = Operational Supply Unit (i.e., supply vehicle)
Decon = Decontamination
ICCU = Incident Command Communications Unit
IC = Incident Commander

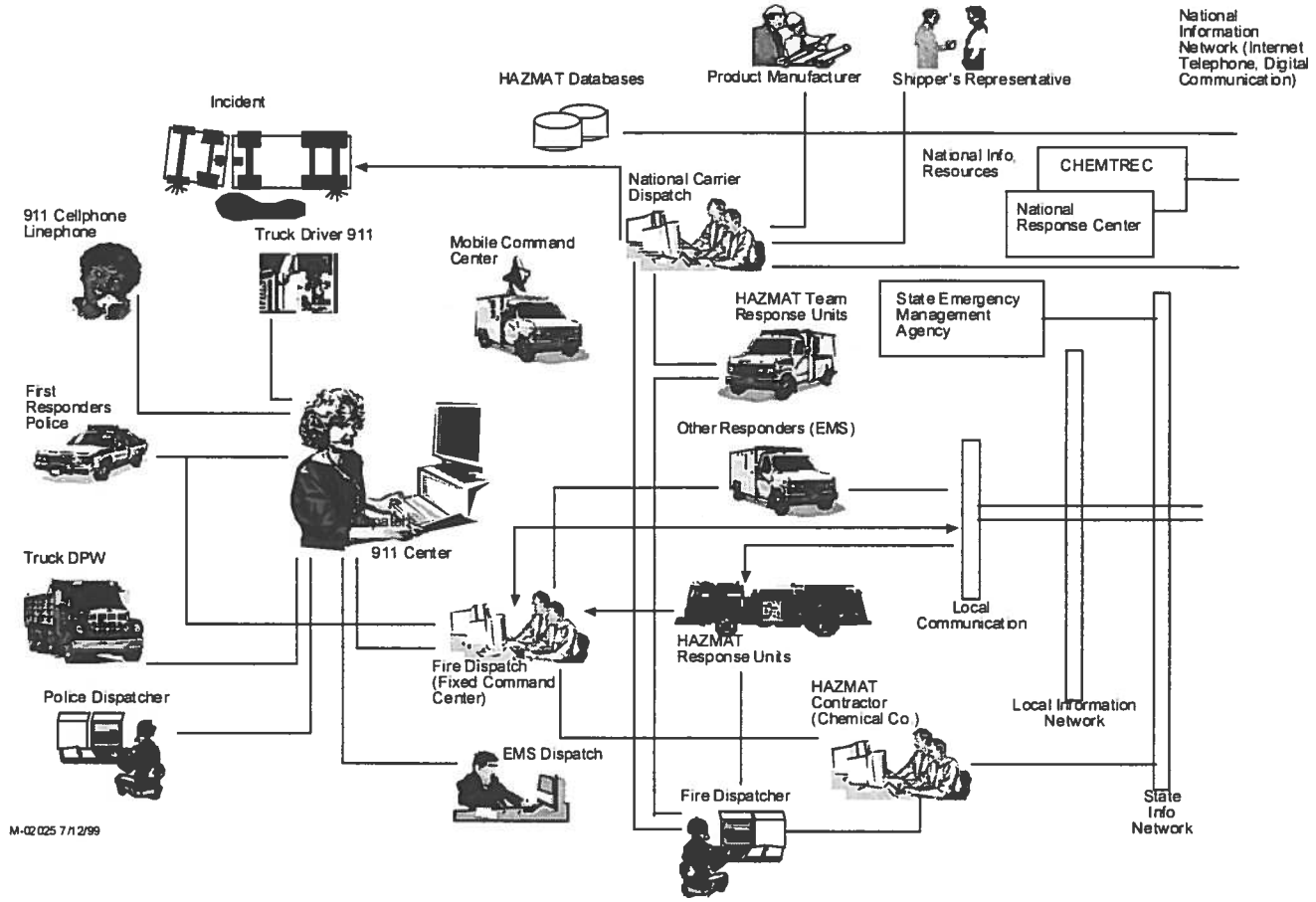
Source: Massachusetts Hazardous Materials Response, "Standard Operating Guideline," May 1, 1998 (Ref. 3).

2.5 INFORMATION TECHNOLOGY AND COMMUNICATIONS USES DURING HAZ MAT INCIDENT STAGES

No stage of a HAZ MAT incident can be easily scripted. While the identifiable stages of HAZ MAT incidents follow a general pattern, each HAZ MAT incident is still very much a dynamic and unpredictable event. This is certainly true of containment and mitigation efforts by responders on the scene, with an incident's location, cargo type, vehicle and shipment damage,

weather conditions, and other factors all influencing the operations and outcome of an incident. But, even the Alert & Initial Dispatch and the HAZ MAT Dispatch & Confirmation stages can be hectic, uncertain events. The interplay of people, communications equipment, and unfolding circumstances affect whether and how key individuals receive the information they need, when they need it. The complexity of this interplay is conveyed by the following exhibit (Exhibit 2-4).

Exhibit 2-4: Illustrative HAZ MAT Emergency Information and Communications Network



In discussing technology applications for the various HAZ MAT emergency response stages, it should be pointed out that there may be considerable overlap between the stages, either in terms of time or function. For example, if the first responder on the scene of a gasoline truck incident happens to be a police officer with some training in HAZ MAT emergencies, the Risk & Hazard Analysis stage will begin immediately. Most likely he/she will carry a copy of the NAERG book in the police cruiser. Not only might that police officer initiate an alert call to 911, fire dispatch, or police headquarters, but the same official, familiar with the characteristics of a loaded 8,000 gallon gasoline tank truck and mitigation of spills from same, might also serve as a risk analyst, giving early assistance to the HAZ MAT response unit responding afterwards at the scene. *Most First Responders (police officers, etc.) are taught at the awareness and operations level of HAZ MAT response. This training includes the use of the NAERG handbook which includes hazards assessment. Procedures for the First Responders are included in the Notification Procedures and*

Local Response Plan.

Similarly, the Alert & Initial Dispatch and the HAZ MAT Dispatch & Confirmation stages may easily overlap. For example, an initial radio communication alert that simultaneously reaches a 911 call center and the headquarters of a HAZ MAT response unit would serve to combine alert and HAZ MAT dispatch functions. Thus, the discussion and exhibits that follow are not meant as inflexible delineations of response stages or functions, but rather general schematics of how incidents unfold and IT/communication technologies facilitate incident management.

NOTIFICATION/ALERT/INITIAL DISPATCH

The Notification/Alert & Initial Dispatch stage involves detection of a HAZ MAT incident and notification of First Responder and the initial dispatch of Responders (Fire, Police, EMS) to the incident scene. There are many ways that an incident is first detected and the alert processed triggered. These include:

- 911 call from a passing motorist, taxicab driver, other truck driver, etc.
- Detection by police or other public safety official
- Driver of incident vehicle (truck or train) calls shipper, carrier, or 911
- Company official calls 911 or the fire department serving the affected locality

Arrangements for handling public safety emergency communications vary widely throughout the US. The fact that only 75 percent of the communities in the US actually have 911 emergency call centers is indicative of the potential variation. A community's emergency call volume, the experience of its call-takers and dispatchers, local communications equipment funding levels, and many other factors dictate a locality's communications configuration and how calls for HAZ MAT emergency response are initiated and subsequently managed. While precise configurations vary enormously, nevertheless, there are also major similarities in how calls are handled and assistance is dispatched.

One schematic followed in cities, where high call volumes often dictate specialization, is to have trained 911 *call-takers* get incident location and related information from the person initiating the 911 call. When the call-taker has obtained basic details of the incident -- generally within 30-90 seconds of receiving a call -- the information provided by the caller is passed electronically to the responding agency's dispatch (e.g., fire department, police, or emergency medical services) which direct the response units to the incident scene. In many, if not most, instances, the dispatch communication from a 911 call center is only an initial dispatch – the Fire Chief or contacted local fire station official, once at the scene, then assumes the responsibility of dispatching HAZ MAT team members to the incident scene.

To help identify communications that may occur during the Notification/Alert & Initial Dispatch stage, a communications matrix (partial) of voice and data flows, along with the technologies or devices used, is presented in Exhibit 2-5. Each communication cell in the exhibit represents a one-way flow of voice or data information. This level of detail is provided in part to address the precision that is often required in discussing emergency response technology applications. For example, a Fire Chief in charge of notifying a HAZ MAT team fully appreciates the difference

Exhibit 2-5: Voice and Data Communications Matrix for Alert & Initial Dispatch Stage (Technology or Devices Used)

From/To	IVD	PM	LSP	CCH	DC	FR	FD
Incident Vehicle's Driver (IVD)				payphone, CB radio, truck or cell phone	payphone, truck, CB radio, or cell phone		
Passing Motorist (PM)					highway call box, pay, car, cell phone, or CB radio		highway call box
Local, State Police Patrol (LSP)					radio, cell phone, data terminal	radio, cell phone	radio, cell phone, cable alarm (pull box)
Carrier Corp. Hdqtrs. (CCH)	wire phone, cell phone, radio or CB radio				radio, cell phone, fax	radio, cell phone	radio, cell phone, fax
911, Dispatch Center (DC)			radio, cell phone, data terminal			radio, wire phone	radio, wire phone, fax
First Responder (FR)					radio, cell phone, data terminal		radio, cell phone, data terminal, cable alarm (pull box)
Fire Dispatch Center (FD)			radio, cell phone, data terminal		radio, cell phone, fax	radio, cell phone	

between one-way and two-way paging. The Chief might have the necessary network coverage, pagers in each team member's possession, and the budget to afford essentially unlimited pager messages to each member of the HAZ MAT response team. If the pagers are all one-way pagers, however, the chief or fire dispatch center remains uninformed about which team members are actually responding to an alert until those (page) message recipients call or radio back their acknowledgments.

Regional or District Team notification entails the need to notify individual team members rather than manned response units typical of a City Fire Dispatch. Message receipt and individual availability must generally be collected by the Dispatcher from telephone or pager information.

Equipment and personnel then must assemble at a pre-defined staging area prior to heading to the incident scene. This process adds to the response time for Regional or District Teams.

Similarly, today's communications literature often speaks of wireless access to the Internet with the result that many readers may infer access to an array of service levels that resemble those available on desktop computers. The casual observer, for example, may easily misconstrue "wireless Internet" as access to World Wide Web sites, when the only Internet service being offered is text retrieval or electronic mail. Those are technically wireless Internet services, but they do not equate to the ability to download vehicle drawings, facility blueprints, or other graphics-rich material with the potential to help response personnel attempting to analyze the risks associated with a given rail car or vehicle design. In recognition of these important kinds of distinctions, the following matrix and companion matrices associated with later incident stages have been compiled.

Note: Marked cells indicate initiated communication. Empty cells indicate little or no communication initiated between the two parties. Thus, the driver of a vehicle involved in an incident may contact a local 911 or dispatch center (DC), but the reverse is not likely. This note also applies to Exhibits 2-6, 2-7, and 2-9.

HAZ MAT DISPATCH & CONFIRMATION.

As indicated earlier, there may be considerable overlap between the Alert & Initial Dispatch stage and the HAZ MAT Dispatch & Confirmation stage. Thus, communication among the dispatch center, first responder, and fire dispatch center is indicated in both the Alert and HAZ MAT Dispatch matrices (Exhibits 2-5 and 2-6). To the extent a local community relies on help from a regional or district HAZ MAT team, as is often the case in Massachusetts, for example, additional dispatch communication would occur between local dispatch or local fire dispatch and the regional HAZ MAT units. (This communication between local and regional organizations is not specified in Exhibit 2-6.)

Exhibit 2-6: Voice and Data Communications Matrix for HAZ MAT Dispatch & Confirmation Stage (Technology or Devices Used):

From/To	DC	FD	FR	HT	IC	FICC
Dispatch Center (DC)		wire phone, radio	radio, cell phone	pager, wire phone, radio		
Fire Dispatch Center (FD)			radio, cell phone	pager, wire phone, radio	radio, cell phone	
First Responder (FR)	radio, cell phone	radio, cell phone			radio	cable alarm systems
HAZ MAT Team (HT)		wire phone, radio, cell phone				
Incident Commander (IC)	radio	radio		radio		radio, cell phone, cable alarm systems
Fixed Command Center (FICC)	wire phone, radio	wire phone, radio			wire phone, radio, pager	

Dispatching to individuals in response units, whether conducted by central dispatch, fire department dispatch, or regional (fire/HAZ MAT) dispatch, is usually handled with pagers, but may also entail radios or land-line (wire) phones. Successfully contacted team members are typically required to confirm their availability, and this response may be accomplished by radio, wire phone, cell phone, or two-way pager.

City team communication procedures are more direct since they are manned HAZ MAT teams already assembled at Fire Stations. In this case, the Dispatch call goes directly to the HAZ MAT Engine and/or Ladder companies assigned responsibility for a certain neighborhood of the City. Depending on the Level of Response (0, 1, 2, or 3) resources are dispatched according to protocol. Different cities vary as to protocol depending on the resources available, geographic size, HAZ MAT incident risk, and other factors. Procedures and protocols for the cities of Boston, Cambridge, and Springfield are detailed in Appendix A.

Given pressures to keep down the costs associated with response activities, the identification and cancellation of unnecessary calls to HAZ MAT response units is becoming more common with Regional or District Teams. (Unnecessary calls include those made "just to be on the safe side" and those that should have been directed to an organization such as the State DEP rather than to HAZ MAT emergency responders.) In Massachusetts, for example, procedures for identifying and canceling unnecessary calls were recently instituted by one of the state's regional HAZ MAT response teams and are now being extended to all of the regional teams. When a cancellation occurs, a cancellation call to response personnel will be issued. This again would be transmitted by pager, radio, or wire phones.

HAZARD RISK ASSESSMENT

Analyzing the risks of an unfolding HAZ MAT incident shall occur as soon as public safety officials are alerted to the situation – even before arrival of safety officials on the scene. Formal risk and hazard analysis, however, generally begins with arrival of ranking Fire Department official or Incident Commander at the incident site. Depending on the incident location, alert and dispatch task performance, availability of responders, traffic conditions, and other factors, this stage of incident response is likely to begin about 15 to 60 minutes after the initial event (e.g., the vehicle accident, product spill, etc.).

In-depth hazard risk assessment is usually undertaken by experienced technicians with a knowledge of chemistry and data information sources. *Hazard risk assessment should start as early as possible with the arrival of the First Responders (Fire, Police, EMS) at the scene*. They are typically equipped with NAERG handbooks, information from shipper/carrier and CHEMTREC, and they are able to make an initial assessment. The Incident Commander at the scene do not have the luxury of time to wait for trained HAZ MAT Technicians to arrive prior to start of the risk assessment. The Hazard Risk Assessment stage can be the most information and communications intensive stage of an entire incident, especially if the involved chemicals are unknown and key information sources are difficult to access. Manual access to hard-copy documents like the NAERG handbook, phone calls to carriers, shippers, and third party experts (e.g., CHEMTREC); and computerized access to various data bases (including CD-ROM, locally

installed, and intranet- or Internet-based) are just a part of the information/communication flow that may occur during the risk assessment stage. Ongoing contact with dispatch personnel, the on-scene HAZ MAT response team, and safety officials from neighboring jurisdictions are also elements of this response stage.

Again, a matrix is presented to help identify the kinds of voice and data flows that may occur during the Hazard Risk Assessment stage (Exhibit 2-7).

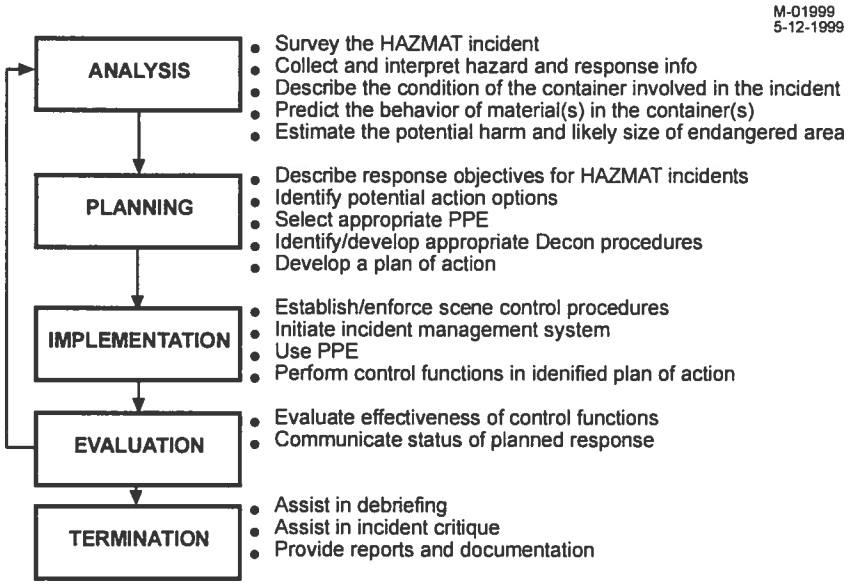
Exhibit 2-7: Voice and Data Communications Matrix for the Hazard Risk Assessment Stage (Technology or Devices Used)

From/To	HTIS	ERG	Electronic Data Base	IC	FD	Carrier	Shipper	CHEMTREC, etc.	LCCA
HAZ MAT Team Information Specialists (HTIS)	voice, radio	hardcopy, laptop (CD)	laptop, vehicle-based computer	radio, voice	radio, cell phone	radio, cell phone	radio, cell phone	radio, cell phone	cell phone, radio
Incident Commander (IC)	voice, radio	hardcopy			radio, cell phone			cell phone	cell phone
Fire Dispatch (FD)	radio, cell phone	hardcopy, desktop computer	desktop computer	radio, wire phone		wire phone	wire phone	wire phone	cell phone; radio
Carrier		hardcopy	desktop computer	wire phone	wire phone		wire phone	wire phone	wire phone
Shipper		hardcopy, desktop computer	desktop computer	fax, wire phone	fax, wire phone	fax, wire phone		fax, wire phone	
Third Party Experts (CHEMTREC, etc)	radio, cell phone, fax	hardcopy, desktop computer	desktop computer	fax, wire phone	fax, wire phone	fax, wire phone	fax, wire phone		
Local Chemical Company Advisors (LCCA)	radio, cell phone, fax	hardcopy, desktop computer	desktop computer	fax, wire phone	fax, wire phone				

OPERATIONS

Information and communications technology continues to play an important role throughout the Operations stage of a HAZ MAT incident. High quality radio communication (continuous and uninterrupted) between the Entry/Decon teams and the Incident Commander and HAZ MAT team is highly critical in this stage. This criticality is due in large part to the dynamic nature of mitigation procedures. In other words, what the hazard risk analysts recommend and the operations personnel initially implement will be constantly re-evaluated until the incident is brought fully under control. (This, of course, means that the Hazard Risk Assessment stage will generally continue concurrently with the Operations stage.) How the chemical reacts to mitigative measures, changing weather, further material release, and so forth may very likely require the response team to re-evaluate risks, consider additional measures, and possibly implement alternative procedures. The iterative nature of this process is illustrated in Exhibit 2-8.

Exhibit 2-8: Major Functions During the Operations Stage of Response



Note: PPE = Personal protective equipment

Much of the information exchange during the Operations stage may entail eye-to-eye contact and unaided voice communications, that is, talking to (or shouting at) fellow team members. Still, there are many crucial voice and data flows that require or would be enhanced by improved IT/communications equipment (Exhibit 2-9).

Exhibit 2-9: Voice and Data Communications Matrix for the Operations Stage (Technology or Devices Used)

From/To	HT	IC	MCC	FICC	DC
HAZ MAT Team (HT)	talk, radio	talk, radio	talk, radio		
Incident Commander (IC)	talk, radio		radio	radio, cell phone	radio, cell phone
Mobile Command Center (MCC)	talk, radio	talk, radio		radio, cell phone, wire phone,	radio, cell phone
Fixed Command Center, Off-Site (FICC)		radio, wire phone	radio, wire phone		wire phone, radio
Dispatch Center (DC)		radio, wire phone	radio, wire phone	radio, wire phone	

CLEAN-UP

After the Operations stage, incident site clean-up efforts are undertaken. They may be performed by local, regional, or state government agencies, but they are normally conducted by a private contractor. After clean-up, usually a state agency such as the health or environmental protection department is charged with certifying that a facility or site is safe for renewed use.

During the Clean-Up stage, voice and data flows generally continue between the site Incident Commander and various other parties, including police and traffic management officials. GIS and traffic monitoring devices may be deployed during this stage, along with routine wireless voice communications. If health and traffic officials have kept a transport facility closed during an incident, voice and data flows during this phase may very well be time sensitive. They are unlikely, however, to be critical to preserving life.

As the economic cost of traffic delays becomes more critical to local, regional, and even national economies, restoring normal traffic flow will become an increasingly important function of HAZ MAT incident management. Naturally, *expediency* needs to be balanced with the *safety* of the public, responders, and contractors at the scene. This delicate balance between speed of traffic restoration and safety can be aided with advanced technology. Whether traffic flow restoration is emphasized as part of Operations or Clean-up or whether it attains its own separate response stage remains to be seen. Nonetheless, Intelligent Transportation Systems (ITS), wireless Internet applications, GIS, possibly satellite communications, and potentially many other devices should play a major role in this activity.

3. CURRENT INFORMATION TECHNOLOGY AND COMMUNICATIONS EQUIPMENT AND APPLICATIONS

3.1 INTRODUCTION

This chapter presents an overview of information technology (IT) and communications equipment and applications currently available to HAZ MAT emergency responders. The focus is on advanced and state-of-the-art equipment and applications. Because of budgetary and other considerations faced by local communities, the equipment and applications discussed in the chapter will not necessarily be used by all emergency response organizations. They are used by many such organizations, however, and they should be familiar to most in the emergency response community.

This chapter begins with a characterization of the IT and communications equipment and applications used in HAZ MAT emergency response. That characterization is followed by an overview of command centers, which are frequently operational focal points for IT and communications equipment and applications. The chapter ends with a discussion of lessons learned based on the experience of HAZ MAT emergency responders currently using advanced IT and communications equipment and applications.

3.2 HAZ MAT RESPONSE TECHNOLOGY CHARACTERIZATION

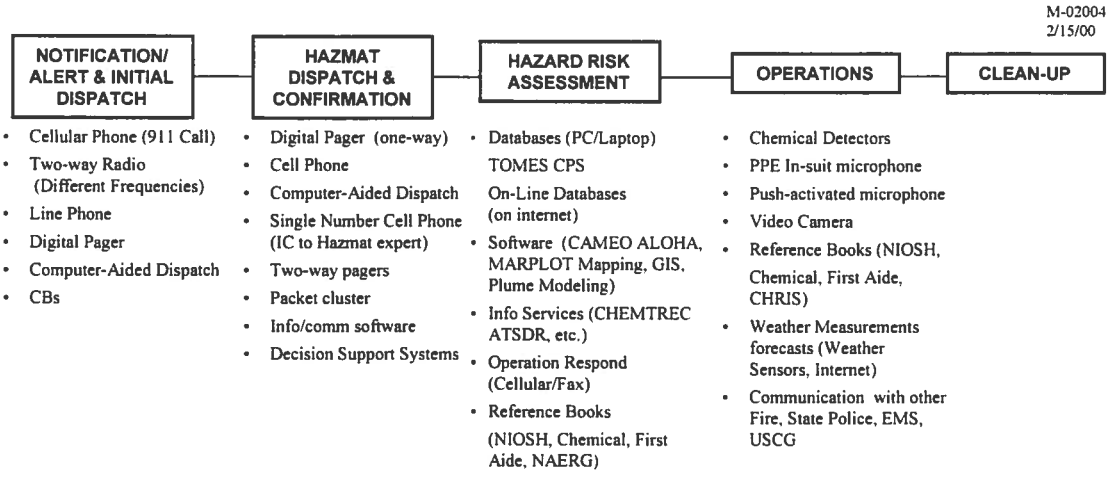
A number of current information technology and communications equipment and applications are being used in HAZ MAT emergency response. In general, these are used during an incident to (1) inform others of unfolding developments and (2) retrieve or develop technical information. Exhibit 3-1 shows a mapping of some relevant IT and communications equipment and applications to the HAZ MAT emergency response stages defined in Chapter 2.

The equipment and applications shown in Exhibit 3-1 can be grouped into the following five categories:

- Communications devices
- Information transfer and communication software aides
- HAZ MAT detection and identification devices
- HAZ MAT information sources
- HAZ MAT modeling and assessment software

In the remainder of this section, these general categories are discussed in greater detail.

Exhibit 3-1: Information and Communications Technology Mapped to HAZ MAT Emergency Response Stages



Notes: PPE = Personal Protection Equipment
IC = Incident Commander
USCG = United States Coast Guard
ATSDR = Agency for Toxic Release and Disease Registry
NAERG = North American Emergency Response Guidebook
Info/Comm = Information/Communication
NIOSH =
EMS = Emergency Medical Service

3.2.1 Communication Devices

During the response to a HAZ MAT incident, communications devices are primarily used as a means of informing others of developments and as a conduit for obtaining information. The communications devices typically used during a HAZ MAT emergency response include line/wire telephones, cellular phones, pagers, computer modems, fax machines, and radios. As can be seen in Exhibit 3-1, many of these communications devices have multiple applications during an incident.

Cell phones and radios are the primary means of communications employed during a HAZ MAT emergency response. If a response is complicated or is expected to take a relatively long time, the emergency responders may have the local telephone company drop a wire from the nearest telephone line, thereby establishing temporary wired phone service at the incident site.

A well-known problem with cell phones, and one noted by emergency responders, is that local cells on the systems can quickly become overloaded, particularly in localities experiencing a major traffic disruption. When that happens, cell phone communications may be rendered useless for emergency purposes.

Pagers are used primarily in the initial and HAZ MAT dispatch stages of an incident to notify HAZ MAT emergency responders that they are needed. The pagers used are usually one-way (i.e., they can receive messages, but cannot send them), and they may be either analog or digital, depending on the local paging network. Some of these pagers can receive alphanumeric messages, but many can only receive numbers. When a response to a page is required, a telephone or radio must generally be employed.

receive alphanumeric messages, but many can only receive numbers. When a response to a page is required, a telephone or radio must generally be employed.

At present, very little two-way paging is done. (In two-way paging, messages can be received and sent.) This is primarily a result of its newness and its cost. As two-way paging becomes more firmly established, the networks supporting it expand their coverage, and its costs come down, more two-way paging may be used for public safety situations, including HAZ MAT emergency response.

Some digital cell phone networks have begun to offer two-way paging and, in some cases, direct unit-to-unit communications, as well. As with two-way pagers, these services are relatively new and expensive. While the inclusion of messaging into one integrated communications device eliminates the need to use multiple devices and provides the utility of messaging when voice communications is not advantageous, it is unlikely that these devices will be widely adopted by HAZ MAT emergency response organizations until their costs come down substantially.

3.2.2 Information Transfer and Communication Software Aides

Effectively organizing information during a HAZ MAT incident is essential for saving lives, time, and money. A number of information transfer and communication software aides have been developed for emergency management officials to enable them to access records and other mission critical databases. These software tools utilize local databases stored on personal computers, as well as wireless communications to search remote databases.

Undoubtedly the most important of these software aides are computer-aided dispatch systems. These systems are designed to enhance the ability of public safety agencies to respond to emergencies. The systems can be integrated with real-time communications and mapping programs. They also can include features allowing them to easily communicate and share information with mobile data terminals in police cars, fire trucks, and HAZ MAT emergency response vehicles. A system used by Atlanta, Georgia, handles approximately one million calls annually. Phoenix, Arizona, uses the same system to integrate approximately 700 mobile laptops with its computer-aided dispatch system.

3.2.3 HAZ MAT Detection and Identification Devices

Fast and accurate identification of the hazardous material involved in an incident enables emergency responders to start mitigation early, take action to guarantee public safety, and save property and money. Usually the hazardous material involved in an incident can be readily determined by looking at the placard on the vehicle or rail car, examining shipping papers or manifests, talking to the truck driver or train conductor, or contacting the shipper or carrier. Sometimes, however, these standard sources cannot provide the necessary information.

One of the most challenging aspects of HAZ MAT emergency response is the identification of the hazardous materials present at an incident when no information is available from standard sources. Incidents that involve multiple chemicals or where

Exhibit 3-2: Frequently Asked Questions About CHEMTREC

FAQ	ANSWER
Who can use CHEMTREC?	• HAZ MAT Response officials, authorized government municipal personnel, and chemical companies subscribing to service
Cost of service?	• No cost to responders or authorized government personnel
Are there various levels of CHEMTREC service?	• Yes, ranging from simple advice to chemical experts' advice
Who initiates contact with CHEMTREC at the time of an incident?	• Incident Commander or HAZ MAT Team personnel at the scene (CHEMTREC prefers to talk directly to responders at the scene)
What information is offered?	• Details on chemical characteristics and how to best mitigate • Assistance in chemical identification • Limited assistance on mix of chemicals and reactivity
How does CHEMTREC get the information back to the incident site?	• Telephone (voice), fax
What is the communications protocol with CHEMTREC? -Take a telephone number and call back? -Caller holds on line until information is provided?	• Responders talk directly to CHEMTREC advisors. If specialized expertise is needed, then CHEMTREC contacts experts who contact responders at the scene.

ATSDR

ATSDR (Agency for Toxic Substances and Disease Registry), part of the Centers for Disease Control, maintains the HazDat Database, a searchable online database supplying information on the release of hazardous substances from Superfund sites and emergency incidents, and on the effects of selected hazardous substances on humans. It is especially valuable for incidents involving a mixture of chemicals and potential reactivity. ATSDR offers an emergency call-in service that provides critical information to emergency responders during a HAZ MAT incident and is available via the INTERNET (www.atsdr.cdc.gov/hazdat.html). ATSDR call-takers can provide callers with details about substance identification and procedures for handling and containment. ATSDR is a valuable information resource to HAZ MAT responders at the incident scene, especially for medical treatment and toxicology information.

NAERG

The NAERG (North American Emergency Response Guidebook) is a pocket-sized reference book developed jointly by the U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico. The NAERG, which offers a quick guide on what to do, is used primarily by first responders (Police, EMS, Fire) at the scene of HAZ MAT incidents. It is designed to help first responders identify the hazardous materials present at an incident site and an appropriate course of action to ensure their own safety and that of the general public. It is generally useful for the first 30 minutes of the response. It is a "first aid" tool and normally supplemented by more detailed sources (NIOSH, CAMEO, CHEMTREC, etc.) Various

computerized implementations of the NAERG are now available from commercial vendors. These implementations include features such as a searchable chemical database, a report creator, and a map importing capability. An Internet version of the NAERG is available on the Web site of the Office of Hazardous Materials, U.S. DOT. Its WEB address is HAZ MAT.dot.gov/gydebook.htm.

Commercial Purveyors of MSDSs and Related Services

A number of companies offer MSDSs (Material Safety Data Sheets) and related services to subscribers. Generally, the subscribers are shippers of hazardous materials. One of the companies offering MSDSs is Chem-Tel, which reportedly has one of the largest MSDS and HAZ MAT databases in North America. One service of Chem-Tel, MSDS Upon Demand, allows a client to call in and have MSDS information transmitted to any party via fax, Internet, Intranet, LAN, WAN, CD-ROM, or other delivery system. This information can be sent directly to emergency responders and other emergency management agencies. Chem-Tel also builds and hosts Internet websites for any organization wishing to provide ready access to their own MSDS information.

Other Important Information Sources

A number of other sources of information are routinely consulted by emergency responders. These sources provide general guidance, MSDS and similar information, software for use during HAZ MAT incidents, and a variety of other services. Exhibit 3-3 identifies some of the sources with a presence on the Internet.

Exhibit 3-3: Some Additional Internet Sites Used by HAZ MAT Responders

RESOURCE	INTERNET ADDRESS
EPA's Chemical Emergency Preparedness and Prevention Office (for information on the CAMEO, ALOHA, and MARPLOT computer programs)	www.epa.gov/ceppo/cameo/index.htm
National Emergency Management Association (NEMA)	www.nemaweb.org/index.cfm
International Association of Emergency Managers—IAEM (formerly National Coordinating Council on Emergency Management—NCCEM)	www.uetc.org/IAEM.htm www.iaem.com
National Institute for Urban Search and Rescue	niusr.org/welcome.html
Federal Emergency Management Agency (FEMA)	www.fema.gov/
National Fire Protection Association	www.nfpa.org/
Chemical Manufacturers Association, home of CHEMTREC	www.cmahq.com/
OSHWEB	oshweb.me.tut.fi/cgi-bin/oshweb.pl/
Center for MSDS Partnership	www.fpn.navy.mil/
Emergency Information Infrastructure Partnership	www.emforum.org/
National Weather Service (NWS), Internet Weather Source	weather.noaa.gov/weather/curcond.html
National Hurricane Center, Tropical Prediction Center	www.nhc.noaa.gov/index.html

The Chemical Emergency Preparedness and Prevention Office, U.S. Environmental Protection Agency (EPA), is the current supplier of the CAMEO computer program, along with its ALOHA, MARPLOT, and other modules (more will be said about the CAMEO computer program later in this chapter). The Web site given in Exhibit 3-3 provides information on ordering CAMEO, as well as serving as the new online technical support system for CAMEO software.

A number of databases are available on the Internet that can be used by emergency responders seeking information on specific chemicals. These databases generally provide details on the chemicals' properties. The databases include the Hazardous Chemical Database, developed by the University of Akron Chemistry Department (Web address: ull.chemistry.uakron.edu/erd/); and ChemFinder.Com (Web address: www.chemfinder.com) a Web-based search engine that checks a large number of indexed Internet sites for requested chemical information, and which is available free of charge to the scientific community and is subscription-based for access from corporations, academic institutions, and government organizations.

3.2.5 HAZ MAT Modeling and Assessment Software

Chemical Databases

A number of chemical databases are available to HAZ MAT emergency responders. These databases are generally accessed via computer either at the scene of an incident or at a fixed command center (frequently located at the local fire or police dispatch center). The databases provide critical information for the Hazard and Risk Assessment undertaken during an incident response.

Of the chemical databases, CAMEO (Computer-Aided Management of Emergency Operations) is probably the most widely used. CAMEO software, which runs on personal computers, is available in both Windows and Macintosh versions. CAMEO consists of several modules:

- Chemical Database – contains over 6,000 chemicals (and 50,000 chemical synonyms) with information on each chemical about characteristics, fire hazards, fire fighting procedures, appropriate protective clothing, non-fire response, health hazards, etc. Exhibit 3-4 depicts a sample output for chlorine.
- ALOHA (Areal Locations of Hazardous Atmospheres) – plume modeling module that projects the plume trajectory from a chemical spill. Inputs are type and quantity of chemical, weather conditions, tank description, release rate, etc.
- Facilities Database – locally generated database with characteristics of chemical facilities located in a city or region, including schematics (when available).
- MARPLOT Module – used in conjunction with ALOHA for plotting the plume dispersion trajectory.
- Incidents Database – record keeping on past incidents in a city or region.
- Contact Database – directory of local and national contacts for HAZ MAT emergency response.
- Census Database – population of a city or region from U.S. Bureau of the Census databases.

Exhibit 3-4: Sample CAMEO Output for Chlorine

Chemical Database – Response Information Data Sheet		
Preferred Name: Chlorine		
Chemical Source: NOEPA	**NOAA #:** 2862	
NFPA Codes	**F:**	0 – Will not burn
	H:	3 -Extremely hazardous
	R:	0 – Normally stable
	S:	Oxidizer
General Description Chlorine is a greenish yellow gas with a pungent suffocating odor. It is used to purify water, bleach woodpulp, and to make other chemicals. It is toxic by inhalation. It is slightly soluble in water. It reacts explosively or forms explosive compounds, with many common chemicals. It is normally shipped as a liquid in cylinders or tank cars. Contact with liquid should be avoided as it can cause frostbite. The liquid readily vaporizes to a gas. Chlorine does not burn but will support combustion (lets other articles burn). Long term exposure to low concentrations or short-term exposure to high concentrations may result in adverse health effects from inhalation. The vapors are much heavier than air and tend to settle in low areas.		
Fire Hazard – May ignite other combustible materials (wood, paper, oil, etc.). Mixture with fuels may cause explosion. Container may explode in heat of fire. Vapor explosion and poison hazard indoors, outdoors or in sewers. Hydrogen and chlorine mixtures (5-95%) are exploded by almost any form of energy (heat, sunlight, sparks, etc.). May combine with water or steam to produce toxic and corrosive fumes of hydrochloric acid. Emits highly toxic fumes when heated. Avoid plastics and rubber. Avoid heat and contact with hydrogen gas or powered metals.		
Fire Fighting – Evacuate area endangered by gas. Stay upwind; keep out of low areas. Wear positive pressure breathing apparatus and full protective clothing. Move containers that are exposed to flames until well after fire is out. If it is necessary to stop the flow of gas, use water spray to direct escaping gas away from those effecting shut-off.		

The CAMEO databases requiring local input need constant updating and maintenance. SARA Title III Reports, which must be prepared and submitted by all local chemical facilities, can be a reliable source of information for the maintenance of CAMEO.

The time and effort needed to set up CAMEO's local databases are not insignificant. For example, the City of Springfield, Massachusetts, took three to four years to initialize its CAMEO chemical and facility inventory databases. Centralized efforts to establish and maintain state-wide CAMEO databases, such as the one undertaken by the Massachusetts Emergency Management Agency (MEMA), can be cost-effective, particularly given the fact that localities often lack the resources to do an effective job.

Exhibit 3-5 summarizes key information on CAMEO.

Exhibit 3-5: Frequently Asked Questions About CAMEO

FAQ	RESPONSE
How is CAMEO used at an incident?	1. Installed on laptop or desktop computer (Mobile Command Center), provides ready reference to the chemical type, data on response, health effects and first aid.
Is there a charge (cost) to run CAMEO?	2. There is no charge for the software, which may be ordered on the Internet using the form that can be found at the following Web address: www.epa.gov/swercepp/cameo/reqform.htm
Who uses it?	3. HAZ MAT emergency responders, Fire Chief or Deputy, First Responders
Where is the user located (e.g., at the scene, at fixed Command Center, etc.)?	4. CAMEO used at scene (laptop) or Command Center (desktop PC), Command vehicle desktop
Is there a link between CHEMTREC and CAMEO?	5. These are Independent sources of information and are not currently linked.
What are its functional strengths?	6. To be effective, databases need to be maintained with current information (e.g. facilities, storage locations, incidents, contact data, etc.), which requires a labor-intensive effort.

Other chemical databases are also available to responders, including OMH/TADS (Oil and /Hazardous Materials Technical Assistance Database), RTECS (Registry of Toxic Effects of Chemical Substances), and CHRIS (Chemical Hazard Response Information System). Each database presents information a little differently and concentrates on different areas. HAZ MAT emergency responders need to understand their differences and to use those that are most appropriate for handling a specific incident or situation.

Atmospheric Plume Modeling

Beginning during the Hazard Risk Assessment stage of HAZ MAT incident response, and continuing through the Operations stage, the ability to model the atmospheric dispersion of noxious gases or toxic fumes can be a critical element in the decision making of emergency responders. Understanding how potentially harmful gases or fumes may move in the atmosphere and affect the population and environment enables on-scene responders to determine whether a situation necessitates evacuation or other precautionary containment measures.

To determine the behavior and trajectory of gaseous plumes, emergency responders generally turn to atmospheric plume models. These models use interconnected systems of mathematical equations to predict the direction and potential extent of a plume. Atmospheric plume models use as inputs the quantity and nature of the hazardous material involved in the incident, and local weather conditions, along with other parameters, to develop a best estimate of the extent of potential exposure in the vicinity of an incident. Model output generally includes a map indicating the areas that are expected to be threatened by the plume. Exhibit 3-5 shows a sample output of an atmospheric plume model.

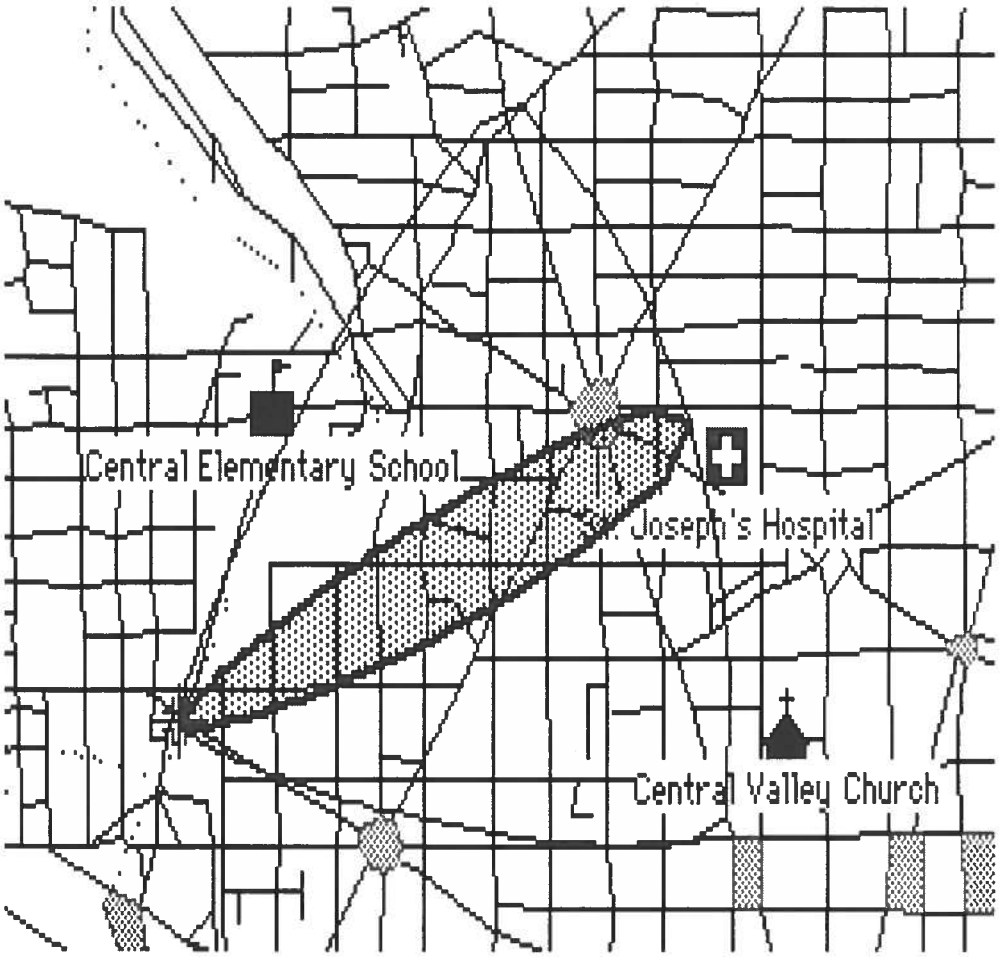


Exhibit 3-6: Sample Output from an Atmospheric Plume Model

Currently, there are two atmospheric plume models that are widely used by emergency responders due to their low cost. ALOHA (Areal Locations of Hazardous Atmospheres) and ARCHIE (Automated Resource for Chemical Hazard Incident Evaluation). Of these, ALOHA is probably the most frequently used during emergencies. Although ARCHIE is becoming obsolete because of lack of model support, it is widely distributed among HAZ MAT Responders. Both models can be run on personal computers.

ALOHA, as mentioned earlier, is one of the modules that make up CAMEO. ALOHA was specifically designed for evaluating gas transport and dispersion in the atmosphere in emergency situations. It takes into account the toxicological and physical properties of the pollutant, as well as the characteristics of the incident site, such as the atmospheric and release conditions. ALOHA includes a database with the important properties of about 700 substances, and can graphically display the results of simulations. It assumes a flat terrain, no chemical reaction, no fire, stationary emission conditions (a time varying source is modeled as a sequence of constant releases). It has the ability to predict the behavior of a chemical release from a variety of sources including broken gas pipes, leaking pipes and tanks, and puddles of toxic substances.

One weakness of ALOHA is that it assumes a flat terrain. When incidents occur in hilly or mountainous regions, or in urban settings, the actual trajectory of a gas plume may differ significantly from that predicted by ALOHA. Atmospheric plume modeling tools that can take complex terrain into account have recently become commercially available. One such tool, by SAFER (Systematic Approach for Emergency Response) Systems, L.L.C., is currently being used by all of Massachusetts' regional HAZ MAT emergency response teams.

ARCHIE models not only toxic gas dispersion, but also fire and explosion hazards, as well. ARCHIE utilizes wind and temperature to determine the effects of local weather on toxic clouds. Unlike ALOHA, ARCHIE does not have a chemical library, so the user must provide all necessary chemical data. Also unlike ALOHA, it is location independent. The model is in the public domain and is distributed for free by Federal agencies. It runs on the MS-DOS operating system on IBM-compatible microcomputers.

In addition to ALOHA, ARCHIE, and the SAFER models, there are many other atmospheric plume models available to HAZ MAT emergency responders, including ADAM (Air Force Dispersion Assessment Model), AFTOX (Air Force Toxic Chemical Dispersion Model), DEGADIS (Dense Gas Dispersion Model), SLAB, and TSCREEN (Toxic Screening Model).

Other Computer Programs

A variety of specialty computer programs are available to emergency responders. One such program with considerable potential utility is the Chemical Reactivity Worksheet. This computer program can be used to determine the reactivity of hazardous chemicals or mixtures. The database that comes with the program contains reactivity information on more than 4,000 chemicals. The Worksheet allows users to determine the potentially harmful reactions that may occur when two or more chemicals are mixed. Emergency responders can determine how two or more substances may react at the site of a HAZ MAT incident, provided that they know the chemicals that are involved. The Worksheet, a joint product of the CAMEO Team set up by NOAA and the EPA, can be downloaded for free from the following Web page: www.epa.gov/swercepp/cameo/react.htm. The Worksheet is now part of CAMEO.

3.3 HAZ MAT COMMAND CENTERS

During HAZ MAT emergency response, incident command posts are generally established. Those command posts, frequently referred to as Command Centers, are where most of the IT and communications activities and functions performed by and for emergency responders are concentrated during an incident.

Typically, a HAZ MAT Command Center will be the focal point for all communications relating to an incident, including communications with emergency responders, police and other public agencies, shippers and carriers, and CHEMTREC or similar organizations. It will also be the site at which computer programs, such as CAMEO or atmospheric plume models are run. Internet access, if necessary, can be performed from the Command Center.

Given the dynamics at a HAZ MAT incident site, the decreasing costs of computer and software products, and the fact that Incident Commanders are to be found at incident, sites, more and more communities, cities state agencies are evolving towards the use of mobile Command Centers. The regional HAZ MAT teams in both Massachusetts and New Hampshire, use HAZ MAT response vehicles as mobile Command Centers. The cities of Boston, Springfield and Cambridge also deploy mobile command posts at large incidents. These vehicles vary somewhat in configuration and level of sophistication. In all cases, however, they serve as the information/telecommunications center for the HAZ MAT personnel at an incident scene. In some cases, the vehicles also double as the equipment vehicle that carries protective clothing, chemical detection devices, and mitigation equipment to the site of an incident.

The Massachusetts District HAZ MAT Teams vehicles, referred to as TOMs (Technical Operations Modules), are the most sophisticated of those in Massachusetts and New Hampshire. The TOMs units (see Exhibit 3-8) serve as a mobile Command Center and are equipped with a fully computerized tactical response operations unit and a pervasive telecommunications suite. These vehicles are used by the HAZ MAT Team leadership to plan and coordinate activities at the scene. The Incident Commander, generally, uses another vehicle or facility, or may use the TOMs vehicle as the Incident Command Post. An example of the type of IT and communications equipment found inside Mobile Command Centers such as the TOMs can be found in Appendix B. These units were custom made according to specifications prepared by Massachusetts HAZ MAT personnel. They are equipped with the latest technology of the time (mid-1990's), which can be readily upgraded with newer technology as it becomes available.

Exhibit 3-8: One of the Technical Operations Modules (TOMs) Used by Massachusetts HAZ MAT District Teams

3.4 HAZ MAT EMERGENCY RESPONDERS' EXPERIENCE AND LESSONS LEARNED

This section captures some of the experience and lessons learned by HAZ MAT emergency responders from their use of IT and communications equipment and applications. The material is organized by the HAZ MAT emergency response stages defined in Chapter 2. While it is based on information obtained from HAZ MAT response officials in Massachusetts, New Hampshire, and Vermont, it has general applicability to all HAZ MAT emergency responders.

Exhibit 3-9 summarizes the most critical information needs of the HAZ MAT Team and the Incident Commander (IC). Some of these needs are expanded in the following sections.

3.4.1 Alert & Initial Dispatch Stage

***Issue 1: Cost Considerations* — There is often a tradeoff between the cost of HAZ MAT response and consequences of an incident**

When a HAZ MAT incident occurs, the local fire department, which typically assumes responsibility, must make a decision of whether to summon a HAZ MAT emergency response unit. That decision often contains an economic component. Mobilizing the local HAZ MAT emergency response unit can result in additional costs. When outside help must be summoned--for instance, a regional HAZ MAT emergency response team--those costs can go up dramatically. Those additional costs are borne by the local community, which may attempt to invoice the responsible party or parties for the incident costs. Cost recovery from the responsible party ought to be a priority of the local community in order to ameliorate the overall costs to the HAZ MAT Response unit.

Because of cost considerations, a local fire chief will often need to justify any decision to mobilize a HAZ MAT emergency response unit to the local town or city government. This can affect the decision-making process. If the unit is mobilized and it later proves that that mobilization was an overreaction to the situation, then the fire chief is faced with the job of explaining that, along with the costs of that mobilization, to his or her superiors in the local government. On the other hand, if the fire chief does not mobilize the HAZ MAT emergency response unit and it later turns out that mobilization was needed, that decision too will bring criticism.

In addition to the decision of whether to mobilize the HAZ MAT emergency response unit, a fire chief must also decide whether that unit is the appropriate organization for the task. In some cases where HAZ MAT is involved, other organizations might be more appropriate than the emergency response unit. In most situations the HAZ MAT response unit should take initial mitigation action followed by notification of proper agency. For instance, in the case of a bulldozer leaking fuel into a pond in southern New Hampshire, the local Fire Department will first respond to the scene and would boom and pad or dike or plug leak in the bulldozer first and then summon the State Department of Environmental Protection (DEP) for the cleanup operation. If HAZ MAT emergency responders are incorrectly mobilized in such a situation, again the fire chief is faced with the task of explaining the costs of the unnecessary mobilization to his or her superiors in the local government.

Exhibit 3-9 Information Needs In HAZ MAT Emergency Response

STAGE	COGNIZANT TEAM	CRITICAL INFORMATION REQUIRED
Notification, Alert & Initial Dispatch	HAZ MAT Team	• Location of incident • Description of situation
Hazard Risk Assessment	Incident Commander, HAZ MAT Team	• Chemicals - substances involved Contained/not contained Quantities involved Hazards associated with them or mixtures of chemicals PPE requirements Population protection models
Operations	HAZ MAT Team	• Container characteristics Tanker/trailer specifications (size, valve cutoffs, drains, etc.) Container weaknesses/strengths
Operations	HAZ MAT Team, Incident Commander	• Site location information Structural floor plans Utility cutoffs Knowledgeable persons • Environmental considerations (Population, wildlife, water bodies)

In Massachusetts, efforts have been undertaken by the regional HAZ MAT response districts to help the local fire chiefs in deciding whether to mobilize emergency responders. The HAZ MAT team leader in one Massachusetts HAZ MAT response district initiated a policy of contacting the local fire chief for discussions whenever the HAZ MAT emergency response team for that district was summoned. While these discussions were underway, it should be noted, the emergency response team was being dispatched to the incident scene in the event that the team was actually needed. If the District Team Leader and the local fire chief agreed that a HAZ MAT team response was called for, or if the fire chief insisted on a HAZ MAT team response, then the response was completed. On the other hand, if the team leader and the fire chief agreed that the response was really unneeded, then the response was cancelled. No costs were incurred by the local fire department if the request was cancelled within 30 minute of being made. This policy, called pre-screening, has been so successful that it now being instituted in all six of the HAZ MAT emergency response districts in Massachusetts.

Technology Implications: Fire chiefs frequently need advice from a HAZ MAT expert on whether to call out a full HAZ MAT response or not. As the experience of Massachusetts amply demonstrates, such expert advice can be made available via telephone.

Benefits: Pre-screening of incidents by HAZ MAT officers via telephone would reduce cost of unnecessary response, increase the utilization of HAZ MAT units in situations where such use is appropriate, and improve overall safety at the sites of HAZ MAT incidents.

3.4.2 HAZ MAT Dispatch & Confirmation Stage

Issue 2: <u>En-Route Communications</u> **– Once an incident occurs, fast and efficient communications become of paramount importance. The receipt of incident information by HAZ MAT emergency responders by the Shipper or Carrier, by CHEMTREC, DEP and others can be of great value for mobilization of required resources.**

Constant communication between dispatch and HAZ MAT responders responding to the scene of an incident is of utmost importance.

In a District Team response, the members of a particular team will be arriving piecemeal at the incident site. Communications with team member allow the team leader to know who is underway (by name) and what their expected time of arrival (ETA) at the site is. A HAZ MAT response team is often assembled at a staging area, and assignments can be pre-arranged while traveling to the scene. (Some responders perform better in specific roles such as Science/Information Officer, etc. than others). With information on who is responding and their ETA, the team leader can more readily assign the best available person to the job.

In a City Team response, the HAZ MAT Team (Company or Ladder) responds as a unit thus the communications protocol is less involved than the District Team. In this case, the City Team members know their roles and assignments prior to responding to the scene.

Information transmitted by dispatch to emergency responders *should* include the following as a (minimum)*

- Directions to and address of the incident, along with traffic jams caused by the incident (or other situations) and alternative routes to the staging area staging area..
- Information incident conditions (i.e., over turned truck, fire, etc.), including updates on changing incident conditions. This information can help experienced responders to be better prepared when they arrive at the incident site.
- Equipment and other resources at or on their way to the site
- That a call has been canceled (if such occurs).

Technology Implications: The one-way pagers often used for dispatch are somewhat limited. Pager screens are small and can be difficult to read. Alphanumeric messages sent to responders, as a consequence, are often hard to read, particularly while driving to the scene of an incident. Furthermore, they do not provide a convenient way for emergency responders to feed information, such as the fact that they are responding to the call or their ETA, back to dispatch. Two-way pagers would be of value to emergency response teams, because it would be useful for team leaders to know who has received messages and who is responding to an incident.

The reliability and coverage of pager systems can also be an issue. The need for emergency response organizations to acquire reliable pager service throughout the areas that they serve is a priority.

*HAZ MAT responders interviewed in this study mentioned that this information is ideal, however, they stated that generally less data are transmitted to them.

Benefits: Constant communication with dispatch and continuous information flow to HAZ MAT responders, shippers/carriers and others involved in an incident is of critical importance. Two-way pagers, integrated cellular/paging, and cell phones with conference call capabilities would reduce on-scene preparation and planning time and improve overall response time. Reliable pagers connected to systems with wide-area coverage can also improve overall response time in situations where such are not currently used.

3.4.3 Hazard Risk Assessment Stage

Issue 3: Hazard Risk Assessment--The toughest and most time-consuming task of HAZ MAT emergency response is the hazard and risk assessment, particularly when an unknown substance, or mix of substances, is involved.

Typically, hazard and risk assessment begins when First responders (Police, Fire, EMS) arrive at the scene of an incident and continues throughout the life of the incident. This assessment may begin with the responders consulting reference books, such as the NAERG, first aide books, chemical reference books, or a NIOSH guide. If necessary, the assessment may move on to use other resources.

The assessment process can be the most time-consuming step of the entire response because of the uncertainty and risk involved in making a wrong decision. Response to a HAZ MAT incident can range from a higher level of response than is needed to underestimating the mitigation required. Responders have noted that the vast majority of the chemicals at an accident are known, but the few unknowns create the most work and pose the greatest danger. The greatest challenge for HAZ MAT Responders often lies in reactivity programs. The difficulty in reactivity programs is that the responders do not know which chemicals or more importantly the quantity of chemicals that are being mixed in the incident.

In Massachusetts Standard Operating Guidelines (SOG) for emergency responders require that they use three independent sources of information to determine the appropriate response, suit protection level, etc., at a HAZ MAT incident. A number of different sources were found to be used by Massachusetts emergency responders. Some examples are CHEMTREC, CAMEO, MSDSs, CHRIS Manual, and the Association of American Railroads.

On-line and call-in services such as CHEMTREC and ATSDR are widely used by the HAZ MAT responders that were interviewed. ATSDR (Agency for Toxic Release and Disease Registry), part of the Centers for Disease Control in Atlanta, is considered to be an excellent source of chemical information. Furthermore, it can be a valuable source for HAZ MAT responders faced with unknown chemicals. One responder claimed that a call to ATSDR with merely a description of a chemical's odor and color often resulted within minutes in a faxed response identifying the chemical or at least its class. ATSDR provides information on corrosion, human impacts, and material handling.

CAMEO is widely used by HAZ MAT responders. Nevertheless, one responder indicated that CAMEO could be improved by having more information on protective clothing.

CHEMTREC is a reliable source of information. However, it is only useful when the type of chemical they are dealing with is known with certainty. CHEMTREC can provide a

down-link fax service right to the site of an incident. In Massachusetts, a direct link from the TOMs units to CHEMTREC is generally established.

Technology Implications: Suggestions by HAZ MAT responders included the development of decision logic software to be used as a front-end search engine for chemical data sources. This PC-based software would aid the HAZ MAT responder by "walking through" the identification process and selecting the best sources of information for a particular chemical or mixture. It could be very valuable for helping to identify unknown chemicals, as well as for providing advice for mitigating effects of known substances.

Benefits: The primary benefits are time reduction during the substance identification process, and improved accuracy of identification. Operations are essentially halted until the chemical is properly identified, the hazards and risks are assessed, and appropriate mitigation actions are planned.

Issue 4: Reactivity of Chemical Mixtures--Predicting the reaction of mixed chemicals is an extremely important but difficult task.

The potential reactions of mixed chemicals in an accident scenario, can be important for HAZ MAT responders to obtain. This can be particularly true in locales with medical, research, or university laboratories. In Boston and Cambridge, for instance, with their high concentrations of medical and university laboratories, chemical mix explosives and potential reactions present a very real challenge to HAZ MAT emergency responders.

No good single source of information on reactions of mixtures currently exists. Responders depend on obtaining expert opinion on potential chemical reactions, which could be very time consuming. There are several sources that give some useful hints, such as the CHEMICAL REACTIVITY WORKSHEET and ATSDR. By and large, however, in an uncertain situation HAZ MAT emergency responders will depend on consultation with an expert.

Technology Implications: There is no one resource that HAZ MAT responders can readily access for advice when responding to incidents involving unknown chemicals or potential reactions of chemical mixtures. CHEMTREC, which is the most frequently accessed chemical information resource, does not offer reaction predictions.

Some responders indicated that an information clearinghouse that could provide a quick access to a chemical reaction expert for consultation might prove highly beneficial. They suggested CHEMTREC as the natural location for such a service. An expert system designed for use on computers and built upon the knowledge of a number of chemical reaction experts could also prove useful. Such a program might take up where the CHEMICAL REACTIVITY WORKSHEET leaves off.

Benefits: The primary benefits are significant time reduction in exploring potential chemical reactions and, most importantly, enhanced safety to responders and others in mitigating incidents involving chemical mixtures.

Issue 5: Identifying Shipment Contents--Identifying the materials they are dealing with remains a critical issue for HAZ MAT responders.

Identifying the products involved in a hazardous materials incident is a crucial, time-critical aspect of incident management. Emergency responders are usually familiar with the HAZ MAT handled by local chemical plants and other nearby fixed facilities (e.g., testing laboratories, research facilities, etc.). Thus, when a fixed facility incident occurs, responders generally know the products they are forced to deal with.

This may not be the case with transport incidents, however, since many involve shipments that neither originate nor terminate locally. Furthermore, when placards are missing, destroyed, or other wise illegible; when shipping papers are missing, inaccessible, or inaccurate; and when the driver is injured, uninformed, or otherwise unable to advise responders, the identification task is even more difficult. Mixed loads can complicate the identification task further: sometimes their presence is not immediately known, and interactions of the chemicals may be both difficult to predict and extremely hazardous when they occur.

When attempting to identify the material involved in a rail transport incident, HAZ MAT emergency responders usually rely on shipping documents, rail car placards, and even the shape or features of the rail car and tanker trailer itself. Shipping documents, which should be in the possession of the rail crew, are supposed to identify the cargoes and provide preliminary guidance on mitigation. Even when a derailment occurs, locomotives and crew areas are often less vulnerable to impact damage than the rail cars and so documents may still be available to provide responders with correct shipment information.

Placards, if properly displayed, visible, and accurately reflective of what is in an affected rail car, provide a product's UN number and therefore enough information for responders to consult the North American Emergency Response Guide (NAERG). In turn, the NAERG provides important mitigation guidance consistent with products corresponding to that UN number. Product guidance may not correspond precisely to the chemical formulation(s) contained in a particular shipment. Similarly, dealing with the amount of product involved may require advice beyond the basic information provided in the NAERG. For both reasons, additional contact with the shipper or carrier is likely to be pursued. Nevertheless, placards often provide the necessary initial product identification.

The shape of rail tank cars and truck trailers may also provide clues to shipment contents and therefore to appropriate mitigation actions. Reference books, for example, sometimes identify the products carried by specific types of tank cars. The books may also provide clues about whether a tank or tank car has likely been breached, thereby better informing responders of imminent risks. (In many cases, the breach of the outer hull will not reach the product because of insulation, packaging strength, and so forth. Some containers, for example, have almost as much hull as they have product-carrying core. Such information about packaging integrity may guide HAZ MAT team incident management strategies.)

Identifying truck incident HAZ MAT is similar but not identical to dealing with rail incidents, and while often accomplished quickly, it may prove very time-consuming. A

typical sequence of efforts entails a check of placards and shipping papers and then consultation with the driver and finally with the shipper or carrier.

Emergency responders report that they have had mixed experience with placards: they can be very useful when available, but they may not be available or may be incorrect when they are available. Shipping papers are usually more reliable and provide greater product detail than placards. Problems with shipping papers generally arise when they are missing, inaccurate, or are destroyed in an incident or vehicle accident. Similarly, while drivers may be very helpful in identifying contents, they are sometimes not knowledgeable about the onboard shipment, or they may be unavailable because of injury/death or by being away from the vehicle.

Contacting carriers may require use of vehicle registration or identification numbers to consult databases that list appropriate carrier telephone numbers. With that information, dispatch officials or responders may locate carrier personnel who have direct knowledge about the cargo contents or provide shipper contacts who have that knowledge. (The shipper contacts themselves may be private organizations hired by the shipper to provide product assistance.) CHEMTREC, which specializes in providing mitigation information once a product has been identified, may actually help identify the shipment contents just by having the name of the carrier, descriptions of the product or vehicle, etc.

In recent years, considerable attention has been given to improving ways of identifying HAZ MAT shipment contents when an incident occurs and when neither placards, shipping papers, nor the driver provide enough information. Two broadly distinct approaches have been explored:

- Providing direct responder access to information about shipment contents;
- Providing better responder access to knowledgeable carrier or shipper contacts, especially through centralized carrier directories.

Direct responder access could be achieved in one of several ways. One is establishment and use of a comprehensive, nation-wide, shipment database that had real-time access to every HAZ MAT shipment moving in the US. If cross-correlated with a vehicle registration number or some other identification means, the contents of any shipment theoretically could be identified. *Sometimes referred to as the Applegate approach (named for a Congressman proposing such a system in the late 1980's), that approach has been studied and judged highly cost-ineffective (see TRB Special Report 239).*

A second approach would entail responder access to individual carrier databases, facilitated by carriers making arrangements with individual communities and their emergency response officials. Operation Respond, Inc., has pursued this approach, striking agreements with several hundred communities to have access to individual railroad shipment databases. Because there are so few major US railroads and most communities are served by only one or two railroads, this approach has shown some potential in helping responders identify rail car shipment contents more quickly. Several HAZ MAT emergency responders interviewed for this study spoke favorably of Operation Respond and suggested that it was a good model to follow.

A shortcoming of this approach, however, is that carrier databases need to be constantly updated to ensure accuracy. And, perhaps more significantly, only a few trucking companies have agreed to participate and provide emergency response access to their corporate databases. With more than 450,000 registered trucking operators in the US, responder access to only a handful provides little prospect of routinely identifying truck shipment contents through this approach. Responders also noted what they viewed as the high cost of subscribing to the service. Serveral drawbacks are evident: (1) the electronic tag would malfunction if caught in a fire, (2) distance to the responder may impair usability depending on the radio frequency involved/

A third approach to providing direct responder access to shipment specific contents would involve the use of re-writeable electronic tags mounted on every vehicle and updated with each shipment's specific contents. Responders would be equipped with devices to read tags from a safe distance when an incident occurred. Several drawbacks are evident: (1) the electronic tag would malfunction if caught in a fire, (2) distance to the responder may impair usability depending on the radio frequency involved. In addition costs of the tags and reading equipment, are far too expensive currently to mandate requirement of such a system. Moreover, unless all trucking companies deployed such technology, routine use would be unreliable.

Providing better responder access to carrier and shipper contacts (i.e., the carrier directory approach identified above) may warrant further consideration and development. Use of the Internet to host centralized databases allows widespread PC access to potentially informed carrier and shipper contacts. The Federal Highway Administration's SAFER System (Safety and Fitness Electronic Records System) is one such example. At the same time, improved wireless access to the Internet and better mobile phone coverage might allow responders to research and locate carrier/shipper contacts much more swiftly from the incident scene.

Technology Implications: Some emergency responders suggested that making video images of the specifications of rail containers, tankers, truck trailers, etc., available on computer media, such as CDs, would be valuable in giving early indications of what products might be contained in a specific vehicle or shipment. The technology could be used for quick reference at an incident site.

Improving responder access to centralized carrier directories may also prove beneficial, especially with rapidly unfolding wireless Internet developments and expanded mobile phone network coverage. Making contact with an informed carrier or shipper information source may always entail several phone calls and some inevitable delays, but streamlining and improving the "contact trail" may be a very cost-effective way of helping responders ascertain shipment contents when an incident occurs. At the same time, it could speed the contact between response teams and the product experts who provide guidance on mitigating incident hazards.

Benefits: The benefits of quickly being able to identify hazardous materials potentially or actually involved in a transportation incident would be quicker and safer mitigation and clean-up.

Issue 6: Plume Model Limitations[**]**--Projections from plume models can lack accuracy and fidelity, hampering the incident mitigation and evacuation-planning process for large incidents.**

The plume model most commonly used by HAZ MAT responders is ALOHA, supplemented with maps from MARPLOT. ALOHA does provide a reasonable first-order approximation of plume trajectory. ALOHA's fidelity, however, is hampered by the lack of topographic information, which can distort the projected trajectory of a plume, particularly in hilly terrain and urban areas, with possible adverse impacts on evacuation decisions.

Currently there are high fidelity plume models with topographic maps available that do provide more accurate plume projections. One such model is SAFER Risk Management, which is a high-resolution plume model that contains a topographic map, which, when combined with atmospheric conditions, gives plume direction and health effects (dependent on the chemical). The Department of Defense has high-resolution models used in chemical-biological warfare that could potentially be applied to HAZ MAT emergency response. These models would be very useful at the local (city) level. Exhibit 3-10 depicts how high-resolution models might work within the HAZ MAT response environment . These high resolution models, however, require a more powerful computer platform on which to run than the ALOHA model.

Exhibit 3-10: High-Resolution Plume Modeling Operation

ACTIONS	LOCAL ACTIVITIES
High Resolution Model initialized	1) Fire Dispatch Center or Mobile Command Center sends incident data via the Internet • location of incident (latitude and longitude) • type of chemical, amount, container, etc. • weather conditions
HAZ MAT Team at incident site updates and augments initial information and sends it via the Internet	1) Local weather data from on-board instruments (deployed around the site) 2) Type of chemical (if not previously provided) 3) GPS location (exact latitude and longitude) 4) Calibration data of actual plume or release characteristics taken from deployed weather sensors around site
Outputs received via the Internet from High Resolution Models	1) Plume trajectory map and health impact data from plume dispersion model 2) Chemical intensity (in parts per million) (at various ranges from incident) 3) Effects on humans (at various ranges from incident) 4) Impacts on the environment
Mitigation Actions	1) Incident Commander gets model results and decides very quickly on appropriate actions with respect to endangered population • Evacuate • Shelter in-place • Other research • Take other remedy

[**]Plume modeling begins during the Hazard Risk Assessment stage and may continue throughout the Operations stage.

Technology Implications: High-resolution plume models could provide more accurate projections than low-resolution models frequently used at present by HAZ MAT responders. Advances in PC computing capacity and the Internet will provide easy access to these models in the future.

Benefits: Decision-making concerning endangered populations would be improved, lowering risks to those populations. Additionally, fewer unnecessary evacuations would be taken, lowering the costs of incidents.

Issue 7: Current Weather Information* **– Weather information and forecasts can be extremely important, especially for incidents involving hazardous materials that are toxic by inhalation. Periodic updates of wind, precipitation, and temperature conditions at the incident site are of vital importance.**

Weather conditions can impact an incident, particularly one involving a hazardous material that is toxic by inhalation.

To monitor weather conditions, portable weather stations are sometimes deployed by HAZ MAT responders at incident sites. In Massachusetts, the Technical Operations Modules (TOMs) used by the HAZ MAT Response Districts have built-in weather stations with deployable remote sensors to monitor weather conditions at the site of an incident. Exhibit 3-11 shows a photo of the weather station installed on one of the TOMs.

Information from on-site weather stations can be supplemented and complemented by weather forecasts obtained by HAZ MAT responders from a variety of sources, including the National Weather Service, by fax or from the Internet. These forecasts provide useful information for the area or region containing the incident site. With information on latitude and longitude, gridded forecasts from the National Weather Service can be obtained. These forecasts are currently available for 10-kilometer squares. Efforts are underway to provide forecasts for even smaller areas; however, the impression is that these forecasts are not yet ready for ready for general use.

* The gathering of weather information in support of plume modeling begins during the Hazard Risk Assessment stage and may continue during the Operations stage.

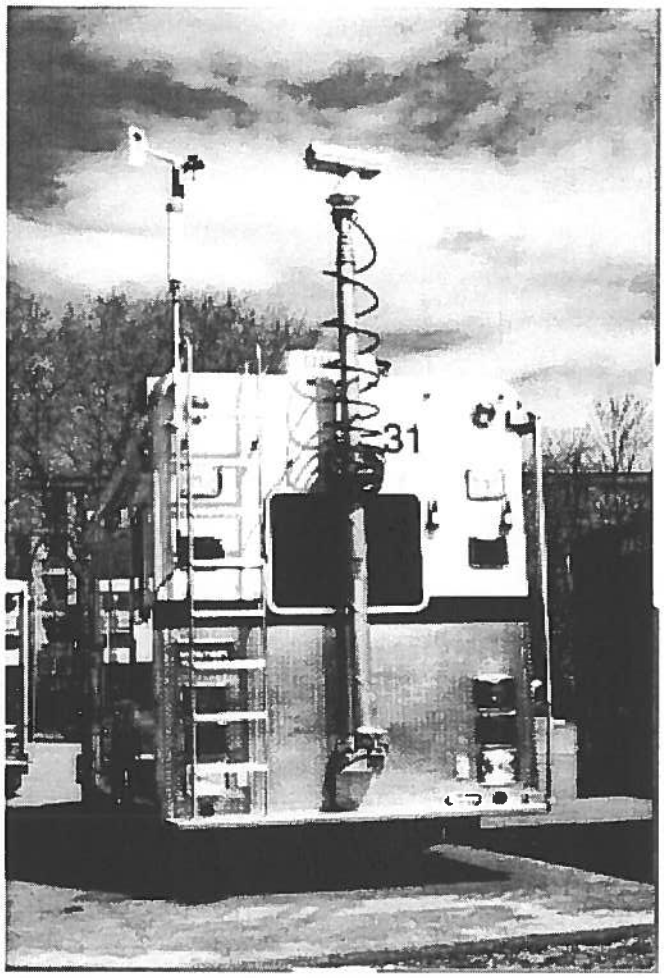


Exhibit 3-11: A Massachusetts Technical Operations Module with Weather Sensors and Video Camera Deployed

Technology Implications: Portable weather stations can be of considerable value at incident sites. Internet-based weather forecasting services provide easy access to weather forecasts, which when combined with local weather monitoring by the on-scene HAZ MAT responders, provides needed weather information on a near real-time basis. Weather sensors locally deployed at the site provide accurate data for plume model initialization.

GPS location technology would provide exact latitude and longitude of an incident site for obtaining accurate National Weather Service weather forecasts for the location of that site.

Benefits: Portable weather stations and local forecasts obtained by fax or the Internet can provide accurate weather information that can reduce the risks to the general public from HAZ MAT incidents, especially those involving materials that are toxic by inhalation.

Issue 8: *Chemical Identification Devices (CIDs)* – CIDs are useful for identifying unknown chemicals at a site; however, the plethora of devices on the market today need to be integrated for most effective use by HAZ MAT Responders.

Chemical reactions, vapors emitted, air monitoring, identification of chemicals and possible reactions are all examples of the need for effective CIDs at HAZ MAT incidents. HAZ MAT emergency responders currently use a series of chemical detectors that allow identification of unknown chemicals and mixes. Some of the most common devices are shown in Exhibit 3-12.

Exhibit 3-12: Detection Devices Commonly Used by HAZ MAT Emergency Responders at an Incident Site (Ref. 4)

DETECTION DEVICE	DESCRIPTION
Carbon Monoxide Meter	The carbon monoxide meter is limited in that it will measure only carbon monoxide. It may not indicate whether an area is oxygen-deficient, and it will not indicate the percent of the lower explosive limit.
Calorimetric Tubes	Calorimetric tubes are designed to read a specific material, so responders need to know the material they are sampling. The tubes have a limited shelf life and are affected by both temperature and humidity, so tube supplies must be monitored to ensure that they are still usable. Calorimetric tubes may not be very accurate, giving responders only a general idea of the presence of a material.
Combustible Gas Indicator (CGI)	The combustible bas indicator (CGI) measures only whether the atmosphere contains a flammable material that is within a percentage of the lower explosive limit (LEL). This information can warn responders that they have entered a dangerous atmosphere.
Photoionization Detectors	Passive dosimeters, or passive samplers, are limited in several ways. The responder must know what material is going to be sampled, as well as any other chemicals present that may interfere with the reading.
PH indicators and/or PH meters	Both PH paper and strips may be difficult to read if the material sampled has been contaminated with oil, mud, or some other material.

Emergency responders could more effectively identify unknown chemicals and mixes if they could get access to a set of portable tools that combine the functions currently performed by these and other CIDs. Furthermore, the integration of the information from CIDs with electronic chemical databases to quickly determine the chemical type and potential reactions would be useful according to HAZ MAT responders interviewed.

Technology Implications: The critical issues here are portability and usability of the chemical identification devices (CIDs) by integrating the devices into a manageable set. Also, ruggedization of the devices for use in winter weather (below 32° F) is critical.

New technology uses "chips" that can take numerous readings, rather than using individual stain tubes.

Benefits: The primary benefit of an integrated set of tools would be a reduction in the risks faced by HAZ MAT and other emergency responders, as well as the general public, when HAZ MAT incidents occur.

3.4.4 Operations Stage

Issue 9: *Managing Voice Communications* – The communications requirements of HAZ MAT emergency responders make communications at the site of an incident a complex issue to manage.

Generally speaking, two groups of Responders need communications capabilities at the scene: HAZ MAT Team Operations and IC Operations. The communications requirements vary according to the magnitude of the incident. The more prevalent incidents are usually of smaller magnitude.

The emergency response unit at the site of a HAZ MAT incident needs multiple radio frequencies. These include

- One frequency for the HAZ MAT Team commander
- A second frequency for entry personnel in suits
- A third frequency for everyone else at the site
- At least one additional frequency for contacting off-site organizations, such as the State Police, local Police, DPW, Fire, EMS.

In Massachusetts, the HAZ MAT Response Districts have solved the problem by establishing a Communications Center inside their Technical Operations Modules (TOMs). The radio console in back of each of the TOMs has five different bandwidths, which enable radio communications with entry personnel, local fire departments, police, and medical facilities, as well as State, Federal, and other organizations. Neither voice access nor voice congestion is a noted problem. It is an effective and pervasive communication suite. In addition to its radio communications capabilities, each of the TOMs has seven cellular phone lines, as well as the capability to page HAZ MAT team members directly from the vehicle. Each HAZ MAT team member carries an alphanumeric pager and can receive written instructions while en-route to an incident site. The radio frequencies that can be accessed from the TOMs are summarized in Exhibit 3-13, while a picture of the communications console in the TOMs can be seen in Exhibit 3-14.

Exhibit 3-13: Radio Frequencies on Massachusetts' Technical Operations Modules (TOMs)

UHF 453-488 MHz range--handles 80 different frequencies Medical (CMED 10 frequencies) Smart Routes (traffic) Various Fire Departments
800 MHz--trunked and conventional for in-suit communication, 8 channels Marlboro Fire Department, Police, other TOMs units and in-suit communications
Low Band--30-36 MHz--handles 32 frequencies
Low Band -42-50 MHz--handles 32 frequencies Mass. State Police, Mass. Hwy., Red Cross, various Fire Departments
VHF 146-174 MHz--handles 104 frequencies Massachusetts Emergency Management Agency, National Fire, US Coast Guard, Army National Guard, various Fire Departments

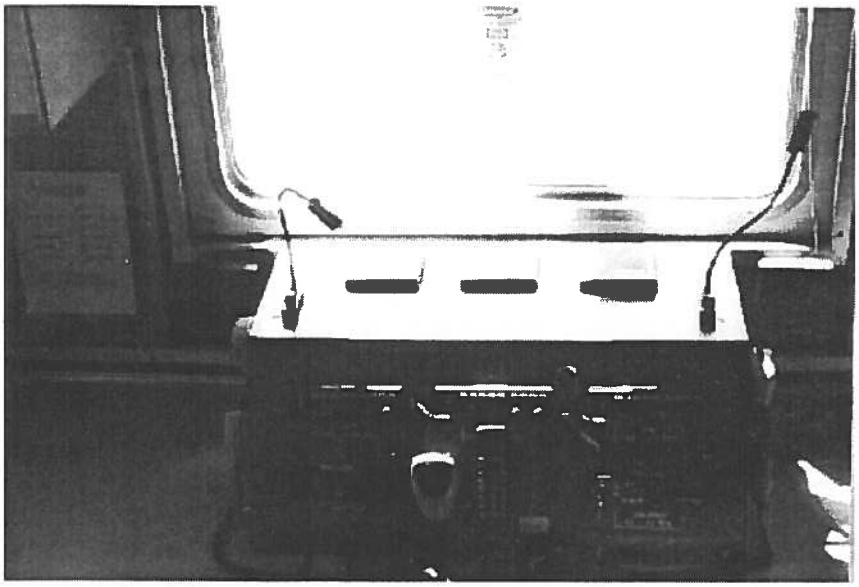


Exhibit 3-14: Communication Center in one of the Massachusetts Technical Operations Modules (TOMs)

HAZ MAT responders are very interested in improved voice communications, although cost factors limit the practicality of their interest. Among the improvements that they indicated that they would like to see were (1) digital systems with direct person-to-person communication at prices that their organizations could afford, (2) cellular-to-cellular calls without air time, and (3) special cellular phones with communications priority. The last item on this list reflects a concern over the potential for congestion on cellular phone systems due to system overload during emergencies.

Technology Implications: A communications suite, such as the one deployed by the Massachusetts HAZ MAT Districts in their Technical Operations Modules, offers a pervasive communications capability that can reach all relevant stakeholders during emergency response to a HAZ MAT incident.

Consideration ought to be given to a dedicated communications frequency for HAZ MAT emergencies. This would significantly reduce the congestion and complexity of the communications problems at the site of an incident.

Recent technology advances in integrated receiver telephone, paging and radio offer potential benefits to emergency responders in having a single device for the bulk of their communications needs. Costs currently prevent the widespread use of these; however, the costs are likely to decline in the near future.

Benefit: The benefit of improved communications is quicker mitigation and more effective response to HAZ MAT incidents.

***Issue 10: Incident Commander (IC) Communications* – Continuous communications between the IC at the scene of a HAZ MAT incident and the on-site HAZ MAT emergency response unit is a crucial activity that requires innovative solutions.**

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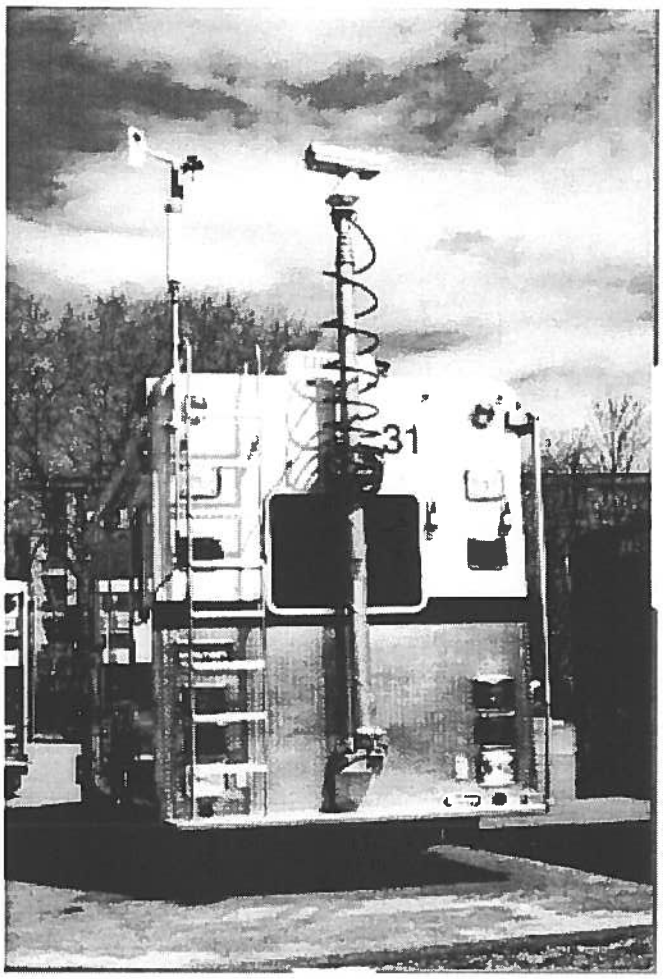

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Benefits: The primary benefit of an integrated set of tools would be a reduction in the risks faced by HAZ MAT and other emergency responders, as well as the general public, when HAZ MAT incidents occur.

3.4.4 Operations Stage

Issue 9: *Managing Voice Communications* – The communications requirements of HAZ MAT emergency responders make communications at the site of an incident a complex issue to manage.

Generally speaking, two groups of Responders need communications capabilities at the scene: HAZ MAT Team Operations and IC Operations. The communications requirements vary according to the magnitude of the incident. The more prevalent incidents are usually of smaller magnitude.

The emergency response unit at the site of a HAZ MAT incident needs multiple radio frequencies. These include

- One frequency for the HAZ MAT Team commander
- A second frequency for entry personnel in suits
- A third frequency for everyone else at the site
- At least one additional frequency for contacting off-site organizations, such as the State Police, local Police, DPW, Fire, EMS.

In Massachusetts, the HAZ MAT Response Districts have solved the problem by establishing a Communications Center inside their Technical Operations Modules (TOMs). The radio console in back of each of the TOMs has five different bandwidths, which enable radio communications with entry personnel, local fire departments, police, and medical facilities, as well as State, Federal, and other organizations. Neither voice access nor voice congestion is a noted problem. It is an effective and pervasive communication suite. In addition to its radio communications capabilities, each of the TOMs has seven cellular phone lines, as well as the capability to page HAZ MAT team members directly from the vehicle. Each HAZ MAT team member carries an alphanumeric pager and can receive written instructions while en-route to an incident site. The radio frequencies that can be accessed from the TOMs are summarized in Exhibit 3-13, while a picture of the communications console in the TOMs can be seen in Exhibit 3-14.

Exhibit 3-13: Radio Frequencies on Massachusetts' Technical Operations Modules (TOMs)

UHF 453-488 MHz range--handles 80 different frequencies Medical (CMED 10 frequencies) Smart Routes (traffic) Various Fire Departments
800 MHz--trunked and conventional for in-suit communication, 8 channels Marlboro Fire Department, Police, other TOMs units and in-suit communications
Low Band--30-36 MHz--handles 32 frequencies
Low Band -42-50 MHz--handles 32 frequencies Mass. State Police, Mass. Hwy., Red Cross, various Fire Departments
VHF 146-174 MHz--handles 104 frequencies Massachusetts Emergency Management Agency, National Fire, US Coast Guard, Army National Guard, various Fire Departments

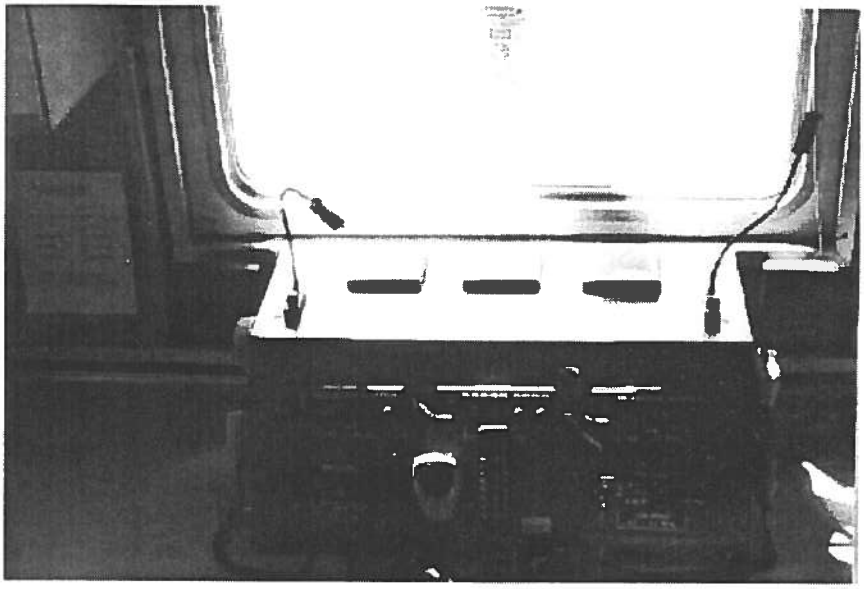

Exhibit 3-14: Communication Center in one of the Massachusetts Technical Operations Modules (TOMs)

HAZ MAT responders are very interested in improved voice communications, although cost factors limit the practicality of their interest. Among the improvements that they indicated that they would like to see were (1) digital systems with direct person-to-person communication at prices that their organizations could afford, (2) cellular-to-cellular calls without air time, and (3) special cellular phones with communications priority. The last item on this list reflects a concern over the potential for congestion on cellular phone systems due to system overload during emergencies.

Technology Implications: A communications suite, such as the one deployed by the Massachusetts HAZ MAT Districts in their Technical Operations Modules, offers a pervasive communications capability that can reach all relevant stakeholders during emergency response to a HAZ MAT incident.

Consideration ought to be given to a dedicated communications frequency for HAZ MAT emergencies. This would significantly reduce the congestion and complexity of the communications problems at the site of an incident.

Recent technology advances in integrated receiver telephone, paging and radio offer potential benefits to emergency responders in having a single device for the bulk of their communications needs. Costs currently prevent the widespread use of these; however, the costs are likely to decline in the near future.

Benefit: The benefit of improved communications is quicker mitigation and more effective response to HAZ MAT incidents.

***Issue 10: Incident Commander (IC) Communications* – Continuous communications between the IC at the scene of a HAZ MAT incident and the on-site HAZ MAT emergency response unit is a crucial activity that requires innovative solutions.**

The first and perhaps best-known of the LEO satellite systems is Iridium, a 66 satellite system backed by Motorola, SATcom, and others. With satellites launched in 1997-98 and service initiated in 1998, it declared bankruptcy in 1999. Its phones sold for about $2,500 - $3,000 each with usage fees running about $1-$3 per minute. The future of the system is uncertain, but it is likely to continue operating even at reduced service levels.

While the operational and financial difficulties of Iridium have cast some uncertainty on the other proposed systems, the 48 satellite Globalstar network was still scheduled to begin service in late 1999. Backed primarily by Loral Space & Communications, Ltd., and Qualcomm, Inc., if successful, it too would add to the voice communications options available to the public safety community.

For communities facing budget constraints that limit safety equipment outlays of as little as $1,000 or less for pagers, fax machines, or the like, the cost of satellite phones and usage fees would undoubtedly be prohibitive. Nonetheless, there may be situations, particularly if equipment is shared among police, fire, EMS, and other safety officials, where satellite phones fill a service gap not met by other technologies. Furthermore, just as private trucking operations are the largest users of satellite data transmission services, they may also opt to supply their drivers with satellite phone service to preclude communications "holes." In such instances, satellite phones have the potential to improve driver-to-headquarters and driver-to-emergency call center communications, thereby shortening the Alert and Dispatch stages of an incident – even if the equipment is not purchased for public safety official use.

While the focus of satellite phone systems is generally on voice communications, wireless access to the Internet will also be achievable with these new systems (if not directly, then with 2-piece and 3-piece modem and cable configurations). To the extent that mobile wireless access to the Internet becomes more useful in the Hazard Risk Assessment stage of incident management, expanding the geographic coverage of that capability via satellite networks could grow in importance as well.

4.2 MOBILE WIRELESS INTERNET (MWI)

Mobile Wireless Internet has important potential for data flow and emergency response management. In this HAZ MAT safety context, the term assumes not only the ability to send and receive e-mail via the Internet but also to access to the World Wide Web (WWW). [3]

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[3]The term Wireless Mobile Internet (MWI) may be distinguished from the terms *mobile computing* and *wireless Internet.*

Mobile Computing. This term sometimes refers to situations where people use a laptop computer, portable modem, and a wired connection to a telephone wall jack to access office files, the Internet, or some other remote data source. Because access is achieved without a desktop computer and can be done from a hotel room or from home, rather than an office, it is said to demonstrate *mobile computing.* As the telephone wall jack used in these situations would attest, however, "mobile computing" is not necessarily *wireless* mobile computing.

Wireless Internet. Many fixed point wireless services transmit voice, data, or both. Networks consist of one or more fixed broadcasting facilities and often fixed receiving points, such as small satellite dishes installed

Mobile wireless access to the Internet has been available in various forms since at least the mid-1990s. The wireless devices, their capabilities and service coverage, however, have been limited. The current profusion of investment in wireless Internet capability, both in terms of network construction and design of more powerful, convenient devices, portends enormous changes over the next 1-3 years. The devices may soon prove more useful in HAZ MAT incident management, particularly in the post-dispatches stages of an incident.

Until recently, most wireless devices with Internet access have been clumsy and inconvenient, with very few 1-piece handsets available and limited features and coverage for those that were. Instead, 4-piece and 2-piece devices have dominated the mobile wireless Internet market. A typical 4-piece device/configuration consists of a laptop, modem, connecting cable and cell phone, while a 2-piece usually includes a PDA with a cigarette-pack sized radio transceiver inserted into the PDA's card slot.[4] Four-piece configurations are still widely used by office workers and other non-safety personnel. While technically *mobile* and *wireless*, 4-piece devices have limited portability and ease of use in emergency safety situations, however. Two-piece devices, do offer greater portability, but limited network coverage and device capability have restricted widespread use of these devices in either safety or non-safety applications.

Even 1-piece devices, stand-alone handheld units capable of sending and receiving at least short messages via the Internet, have suffered shortcomings. Small screens, slow data transfer speeds, small or peculiar keypads, unfamiliar operating systems, and other limitations have curbed use of the devices. Limited service areas or "footprints" -- primarily because of incomplete carrier tower networks or lack of supporting hardware/software to handle data transmission -- have further prevented acceptance and spread of the technology.

As of mid-1999, this picture was dramatically changing. Investment in mobile wireless services was skyrocketing, including purchase of major wireless network carriers by some of the largest telecom companies in the world. Convenience and features of wireless handsets were also improving, with at least nine different 1-piece Internet capable handsets either on the market or targeted for near-term release. Marketing alliances among software providers, handset makers, Internet service providers, and

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on roof tops or other strategic locations. Because voice and data can be transmitted at high speeds and can bypass the local networks (and rental fees) of telephone carriers and cable companies, fixed point wireless has become a potentially attractive technology in the mid and late 1990's. And, because Internet services are expected to be transmitted over these networks, the technology is sometimes referred to as *Wireless Internet*. Such *fixed-point* wireless Internet service, however, is not the same as *mobile* wireless Internet.

[4]During the 1997-98 time frame, portable radio transceivers were typically priced at about $300-$400, in comparison to portable modems whose prices had dropped to the $150 range.

In order to actually access the Internet, 4-piece and 2-piece users also need communications application and Internet browser software separately installed in the laptop or PDA; a wireless carrier subscription, and, in some instances, a separate Internet service account. The 1-piece handsets being touted in mid and late 1999 come with communications software and "micro" browsers built into the handsets, but they still need wireless carrier subscriptions and separate Internet service accounts.

of GPS receiver technology inside the handset and use of the cell phone's radio capability to re-transmit the latitude-longitude information as part of the 911 call.[5] The FCC's original mandate, the revised schedule, and revised precision requirements are shown in Exhibits 4-2, 4-3, and 4-4.

Exhibit 4-2: 1996 Wireless E911 Mandate

	Location Precision	Effective Date
Phase I	Nearest Cell Tower *	April 1998
Phase II	125 meters *	October 2001 **

* Phone number included.
** September 15, 1999 decision to allow handset solutions, and includes earlier deadlines and stricter accuracy.

Exhibit 4-3: Revised Deadlines for Phase II E911 Requirements

Date	Action
October 2000	Carrier Chooses Either Network or Handset Approach
March 2001	If Handset, Must Begin Selling ALI-capable Handsets
October 2001	50% of New Handsets Activated Must Be ALI-capable
October 2002	95% of New Handsets Activated Must Be ALI-capable

ALI = Automatic Location Identification

Exhibit 4-4: Revised Accuracy Requirements

Approach	Accuracy Requirement
Network	100m for 67% of calls; 300m for 95% calls
Handset	50m for 67% of calls, 150m for 95% of calls

Source: FCC, September 15, 1999 (FCC 99-245)

Both network and handset approaches will provide 911 Dispatch Centers with better information about the source of emergency calls. When a call comes from a HAZ MAT vehicle driver or from a passerby reporting a HAZ MAT incident, safety personnel can be

[5]So-called hybrid solutions would use GPS receiving technology in the handset, but then re-transmit the signals before making the actual lat-long calculation. Upon receiving the re-transmission, a communications center would complete the lat-long calculation -- and thus determine the location of the call. Because a mobile phone caller might be moving as the call is made (or move after the call is made), the E911 requirement applies to caller location when the 911 call was initiated.

dispatched with greater efficiency to the proper site. Fire dispatch centers monitoring the status of HAZ MAT team members or units and safety equipment approaching an incident site would be more informed. Plume models (Hazard Risk Assessment stage) could eventually be more accurate with precise location information, as well as with weather data that reflects precise latitude and longitude. Finally, the Clean-up/traffic renewal stage could benefit from lat-long data feeds that meshed with Geographic Information Systems (GIS) providing traffic updates.

Emergency communications centers (ECC) will have to be equipped to handle the GPS information transmitted to it. That is, GIS software will have to be installed to convert the latitude and longitude data into recognizable geographic places (street addresses, activity centers, etc.). Furthermore, there will undoubtedly be places throughout the country where a wireless 911 call is sent using GPS technology and the receiving call center is only equipped with network-level resolution; this could mean precision of only 100 meters v. 1 meter. Still, whether networks or handsets are used to comply with the FCC's E911 mandate, ECCs are slated to have considerably more powerful call location tools.

As a final observation, it may be noted that GEO and Little-LEO (low-earth orbit, data-only) satellite systems already play a role in re-transmitting GPS information. Future LEO systems may also be involved in retransmission. Furthermore, as the price of GPS receiver chip sets in phones, PDAs, and other wireless devices declines, the combination of more prevalent GPS receivers and more ubiquitous retransmission capability should redound to the benefit of safer HAZ MAT incident management.

GIS mapping with overlays is another technology that is becoming prevalent and will be of value to HAZ MAT response. GIS technology is being used in many communities in mapping fixed facilities for planning purposes. Use of GIS databases allows fixed facilities to be mapped with details of the infrastructure (pipes, valves, drums, etc.) and with a high degree of fidelity. This information is available and totally adaptable to HAZ MAT response at minimal cost.

4.4 WIRELESS VIDEO AND THERMAL IMAGING

HAZ MAT emergency responders may encounter numerous adverse conditions upon arriving and operating at a HAZ MAT incident site. Obstacles they encounter include fire, smoke, darkness, and unfamiliar structures. These obstacles usually occur with fixed-facility incidents, but they can occur with HAZ MAT transport incidents as well. Whichever the obstacle, wireless video and thermal imaging devices can aid the emergency responder under such unfavorable conditions.

In this discussion of wireless video, it is understood that the technology exists and is presently deployed on a limited basis; however, current costs are prohibitive for widespread application. As video streaming technology for Internet/PC applications improves, and as wireless data transmission speeds increase, sending video from an incident scene and monitoring activities via PC or cable TV hookup will become more affordable and practical. When that stage of development and deployment is reached, initially during the next two to four years, broader public safety applications are quite likely. Furthermore, in terms specifically of HAZ MAT incident management, there will

be potential uses during every stage of response: Alert-Dispatch, Hazard Risk Assessment, Operations, and Clean-up.

Thermal imaging technology has recently become a tool of firefighters for situations where smoke and fire obscure vision and create dangers that are not readily apparent. Firefighters can apply thermal imaging technology to locate hot spots in walls and floors, and to rescue people trapped or injured in burning buildings. This technology could also be used by responders to assist in detecting and identifying hazardous materials, and in determining if there were fire or hot spots that could trigger combustion of hazardous materials. The technology is applicable primarily in buildings, but could apply to mixed load HAZ MAT shipments, as well.

Some thermal imaging devices currently on the market are designed specifically for firefighters and public safety officials. These include models that are handheld and feature temperature measurement displays, video superimposing, wireless transmission, and image color enhancement. One design uses microbolometer technology, which generates an image by focusing heat onto a set of microscopic picture elements and then converting the measured change of heat into an electrical signal. Other models can be mounted on vehicles, offer remote control viewing, and are compatible with standard video.

APPENDIX A
SUMMARY OF HAZ MAT RESPONSE ORGANIZATION INTERVIEWS

This appendix contains summaries of the interviews with the HAZ MAT emergency response organizations that were visited during the study. These HAZ MAT response organizations have different protocols and response procedures in responding to a HAZ MAT incident. These protocols have been established according to the HAZ MAT response requirements (time and efficacy), town geographic extension, and Fire Department organization, and are defined by the city and/or town officials and the Fire Chief. For instance, the HAZ MAT Response Unit of the Massachusetts Department of Fire Services has response levels one through four; Boston and Cambridge also utilize four levels of response (Levels 0 to 3) and New Hampshire has two levels (A and B). These levels are characterized by the resources (staff and equipment) that respond to an incident.

A.1 MASSACHUSETTS REGIONAL HAZARDOUS MATERIALS RESPONSE SYSTEM

Like many other states, the initial hazardous materials response from the public sector in Massachusetts is handled by local fire departments. Low incident numbers coupled with the high costs of equipment and training, and the difficulty in recovering those costs from those responsible for HAZ MAT releases and large scale HAZ MAT incidents, convinced Massachusetts fire fighters to consider a regional team approach for HAZ MAT emergency response. They started planning and implementation in the early 1990's and now regional HAZ MAT response teams are fully deployed across the state.

The Commonwealth of Massachusetts, Department of Fire Services, Regional Hazardous Materials Response System was established to provide specialized services to the 351 communities in the Commonwealth, to enable them to protect the public, the environment, and property during incidents involving a release or potential release of hazardous materials. Regional Hazardous Material Response Teams are strategically located to support local fire departments with technical information and specialized equipment to handle hazardous materials incidents.

The regional teams in Massachusetts are organized in six HAZ MAT districts. Exhibit A-1 shows a map of the districts. Team sizes and skill mixes vary according to district. Overall, Massachusetts has a total of 350 HAZ MAT technicians and support personnel in the six districts.

In each response district, there are between 30 and 70 personnel able to respond, and they are mobilized in tiers as need is determined. In addition, each district has two types of specialized hazardous materials response vehicles. Technical Operations Modules (TOMs) contain Information Technology and communications equipment (see Exhibit A-2). Operational Response Units (ORUs) contain all of the appropriate protective clothing that might be required, in addition to other equipment and materials that might be needed at HAZ MAT incidents (see Exhibit A-3). Exhibits A-4 and A-5 show the video and the computer installations in the interior of one of the TOMs.

Exhibit A-1: Massachusetts HAZ MAT Districts

Exhibit A-2: One of Massachusetts' Technical Operations Modules (TOMs)

Exhibit A-3: One of Massachusetts' Operational Response Units (ORUs)

Exhibit A-4: TOMs Video Installation

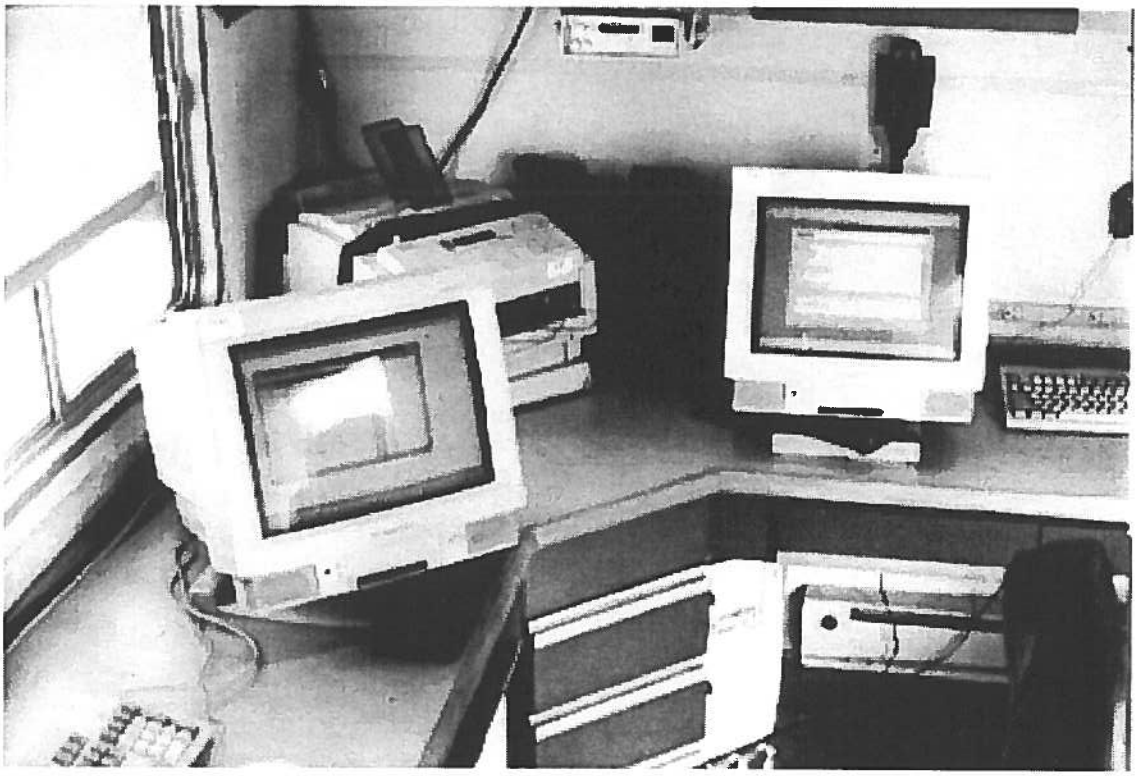


Exhibit A-5: TOMs Computer Installation

Exhibit A-6 shows the annual breakdown of HAZ MAT incidents handled by Massachusetts regional teams by facility type (fixed facility, railroad, highway transport, and other) and level of response (i.e., Tier Level). Several observations can be made:

- The number of incident responses has increased dramatically since the program's inception. This increasing trend is due to the heightened awareness and increased use by local fire departments of Hazardous Materials Response District resources.
- A shift from Tier Level 3 to Tier Levels 1 and 2 (i.e., from higher to lower levels of response) has taken place, resulting in lower response cost. Early on, entire district teams were mobilized for small incidents. Now, teams mostly respond under Tier 1 (the lowest level of response), and they generally escalate to a higher level only if the situation appears to warrant it.
- In 1998, the District Teams instituted a cancellation policy for calls, thereby avoiding unnecessary responses and their attendant costs. In 1998, a total of 13 calls were cancelled after a screening call between the local fire chief and the Hazardous Materials District Team was placed.
- Most incidents occur at fixed facilities, although transportation incidents have been increasing.

Exhibit A-6: Incidents Handled by Massachusetts HAZ MAT District Teams

	# OF RUNS (INCLUDING CANCELLED)	FIXED FAC	RAILROAD	HIGHWAY TRANSPORT	OTHER	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	TOMS	ORU	INJURIES	CANCELLED
1998	74	42	3	13	3	55	16	0	0	51	14	0	13
1997	43	27	1	11	4	32	3	8	0	26	13	2	
1996	48	36	2	8	2	27	8	13	0	14	30	11	
1995	41	31	0	10	0	21	4	16	0	7	28	0	
1994	43	32	1	10	0	24	5	15	0	5	33	1	
1993	23	16	0	7	0	12	0	12	0	3	21	0	
1992	21	18	1	2	0	0	0	21	0	7	21	0	
1991	14	12	0	2	0	0	0	14	0	3	14	0	
1990	5	4	1	0	0	0	0	5	0	0	5	0	
Total	312	218	9	63	9	171	36	104	0	116	179	14	13

	LOCAL LEVEL RESPONSES						
	DISTRICT 1	DISTRICT 2	DISTRICT 3	DISTRICT 4	DISTRICT 5	DISTRICT 6	TOTAL
1998	2	1	1	0	2	0	6

Source: Massachusetts Department of Fire Services

A.2 CITY OF BOSTON HAZ MAT RESPONSE TEAM

OVERVIEW

In part because it is a major healthcare and medical research center, the City of Boston has thousands of laboratories and facilities using and producing hazardous materials. It also has all modes of transportation by which hazardous materials are transported, including an active seaport, a major airport, interstate highways, major rail facilities, and thousands of miles of roadways within the city. Based on these factors and population density, the City of Boston in a study by US EPA Region 1 was identified as #1 in the Commonwealth of Massachusetts for the amount of hazardous materials in the community.

The Boston Fire Department, having the primary responsibility for response to hazardous material incidents in the City of Boston, established a Hazardous Materials Response Team in 1986. The Hazardous Materials Response Team program is coordinated by the Hazardous Materials Office of the Emergency Management Division of the Boston Fire Department.

RESOURCES

Exhibit A-7 lists the HAZ MAT resources that the City of Boston has for Emergency Response.

Exhibit A-7: City of Boston HAZ MAT Resources

Personnel	Over 80 technician-level trained personnel Over 160 decontamination (decon) trained personnel 1500 first responder operation-level trained personnel
HAZ MAT Team	Ladder Companies 15 & 16 Engine Companies 33 & 53 80+ members
Special Units	H-2 Special Unit, responds to level 1 & 2 HAZ MAT incidents (Stationed at Engine 3). H-3 Hazardous Materials Unit, responds on level 2 & 3 incidents (Stationed at Ladder 16, Engine 53). Unit employs compartmented beverage-type delivery truck. That vehicle contains onboard computer with TOMES database, CAMEO (including Title III facilities, chemical inventories, etc.), reference library, communications equipment, and chemical monitoring equipment.
Decon Companies	Eight specially trained companies, Engine Companies 10, 20, 33, 42, 49, 51, 53, 56 (160+ members) Each engine carries decon equipment on board to begin decon operations The Fire Department is in the planning stages of acquiring a decontamination trailer There are plans to increase the number of decon companies.
Expert Resources	G-12 Hazardous Materials/Title III Inspector, who responds to level 1 incidents. G-4 Hazardous Materials/Title III Officer and Local Emergency Planning Committee (LEPC) Coordinator, who responds to level 3 incidents. C-26 Boston Fire Department Chemist, who can be called to any incident by Incident Commander (IC).

RESPONSE LEVELS

HAZ MAT response in Boston consists of a four-tiered system. Exhibit A-8 summarizes the criteria and resources deployed for each tier.

Exhibit A-8: City of Boston Levels of Response

TIER	CRITERIA	RESOURCES DEPLOYED
Level 0	Spill of less than 10 gallons of gasoline, diesel, etc.	1 Engine Company 1 Ladder Company IC (Incident Commander) may order upgrade to appropriate level
Level 1	10-50 gallon spills of petroleum products Spills from transformers or capacitors on a utility pole	1 Engine Company 1 Ladder Company H-2 (Special Unit) District Fire Chief G-12, Technician IC can order a Rescue Co. and H-3 (HAZ MAT Unit) if needed IC can upgrade to Level 2 if quantities and/or hazard greater
Level 2	Spills in excess of 50 gallons of petroleum products such as gasoline, diesel oil, fuel oil, etc. Unconfirmed reports of chemical spills, leaking containers, process malfunctions, accidents or fires producing irritating, corrosive, or flammable vapors including ammonia and chlorine leaks.	1 Engine Company 1 Ladder Company 1 HAZ MAT Engine Company (No. 33 or No. 53) 1 HAZ MAT Ladder Company (No. 15 or No. 16) 2 Decontamination (decon) Companies H-2 (Special Unit) H-3 (HAZ MAT Unit) District Fire Chief H-1 (Safety Chief) Mobile Command Post (MCP) G-4 (HAZ MAT Officer) G-12 (HAZ MAT Inspector) G-25 (Technician) If HAZ MAT Engine and Ladder are not available, IC can call Rescue One or two decon companies at the incident. Notify Division Deputy, Department Chemist, G-2 Chief, Police 1, Boston Police Dept., Emergency Medical Services
Level 3	Report by the Incident Commander (IC) of materials or conditions requiring the use of the special chemical protective suits clothing Evacuation of areas and buildings adjacent to the HAZ MAT incident Other extreme conditions necessitating additional equipment and specially trained personnel.	Response to the Level 2 units Additionally call: Division Deputy, G-4 (HAZ MAT Officer), K-6 (HAZ MAT Technician), K-7 (HAZ MAT Technician Team Leader) Increase/Decrease/Change the deployed resources of Level 2 and EPA, DEP, USCG

Exhibit A-9 summarizes the comments received from the City of Boston HAZ MAT personnel interviewed. The comments are organized by incident response stages.

Exhibit A-9: Summary of Comments Received from the City of Boston HAZ MAT Responders

ALERT & INITIAL DISPATCH	• Use Enhanced 911 • Calls come in at Boston Fire Dispatch, use protocol for HAZ MAT responses • Dispatcher has substantial authority for HAZ MAT team dispatch
HAZ MAT DISPATCH & CONFIRMATION	• Fire Dispatch uses protocol to determine level of response and resources dispatched to scene. Questions in protocol request information about such things as UN numbers, placard ID and number, incident condition, amount spill, etc. Automatically activate a Level 2 response when material is unknown. • Fire Central Dispatch (Boston Fire Dept. Fire Alarm Operations) is used for communications with shippers/carriers, supervisory personnel at fixed sites, etc.
HAZARD RISK ASSESSMENT	• CAMEO database is the "workhorse data base" for Boston FD Dispatch. The responder calls Dispatch to obtain information on all major chemicals and mitigation methods. All supervisory personnel have CAMEO on their laptops, which are carried to the scene as a information resource • CAMEO needs to be updated periodically • Rely heavily on the TOMES database with information to several sources (e.g., MEDTEX, MIOSH, etc.). Subscription is expensive: $2,000 per year. • ALOHA software has few uses. It is used only for major dispersions and continuous release situations that last hours.
OPERATIONS	• In-suit Communication with the Command Center is extremely important. • Voice-activated microphones not very clear, breathing of the entry technician can interfere with communications. • "Push-to-talk" microphones (technician presses on suit chest area to activate) with clips on mask provide clearer communications. • FM low frequency portable radios (AIRMARK) are effective for inside building communication • Video camera for entry personnel could be effective way to capture images of container, piping, etc., inside fixed facility and/or tanker/trailer in order to troubleshoot incident and arrive at mitigating action. Helmet mounted camera would be ideal. Hand-held unit would also be effective, but perhaps cumbersome, depending on size. Video camera would be hard to decontaminate. • Thermal imager for entry personnel would be effective in detecting hot areas, "hidden" spills, and possible victims. Helmet-mounted would be ideal, but hand- held unit is second choice. • Data transmission of measurements from inside facility, tanker/trailer, etc., to Command Post would be useful for science analysis to be conducted quickly in identification of chemical and selection of the proper mitigation action. • Geo-location of technicians inside facility or large train derailment would be effective for accountability of personnel and for mitigation actions. • Equipment needed includes: simplified gas chromatographs, MSGS, mass spectrometers, photo ionization devices, and chemistry kits used for sampling. • Use communication equipment to identify the material in a truck or trailer. Responders call the shipper, trucking company, Mass. Registry of Motor Vehicles, and outside agencies for material identification and hazard analysis. Central Dispatch or Boston FD Mobile Command Vehicle is used in most HAZ MAT transportation accidents. • It takes over an hour or longer to identify the materials in the truck or trailer, without a bill of lading, placards or proper markings in the containers.

A.3 CAMBRIDGE FIRE DEPARTMENT

In part because of its large number of university and other research laboratories, the City of Cambridge, Massachusetts has one of the heaviest concentrations of chemical and biological materials in the country. It is ranked third on the U.S. EPA Region 1 list of priority planning areas with a comparative likelihood of chemical accidents.

The ranking is based on the following EPA criteria:

- Population density
- Density of highway and railway transportation routes
- Number of industries in the area
- Number of hazardous material spills in the area over a specified range of time

Because of this high risk, Cambridge has implemented an innovative approach to HAZ MAT Emergency Response that involves various community resources. The city of Cambridge recognized the need to maintain a continuous state of preparedness. Industry, public safety agencies, healthcare organizations, and interested citizens began planning for chemical accidents in order to reduce the risk to the public from toxic chemicals released into the environment.

As a first step, in the mid 1980's the Cambridge Fire Department developed and staffed its own hazardous materials response team (this team has since been incorporated into the state-run regional response system as part of District 3). The team members are highly trained experts equipped with the latest technology to respond to any hazardous materials release in the community.

Captain Lawrence Ferazani of the Cambridge Fire Department was appointed to chair the Local Emergency Planning Committee (LEPC). He organized the community's response to hazardous materials incidents by creating subcommittees made up of representatives from the city departments, such as the fire department, the public works department, the water department, and law enforcement, as well as representatives from local industry and healthcare organizations. The subcommittees included Assessment, Medical and Health, Law Enforcement, Public Information, Resource Management, Low Level Radiation, Warning Evacuation and Communication, American Red Cross, and University Planning (Harvard and MIT).

Each subcommittee chairperson participated in a training program sponsored by the EPA that qualified them as hazardous materials technicians. Fire fighters and police were already offered first responder training through their training academies. A regional training program was designed for personnel throughout Middlesex County. The program satisfies the state and federal mandates for EMS personnel and contains pertinent information specifically for these personnel.

A local hospital was brought into the HAZ MAT Response System. The Mount Auburn Hospital Protection Services Department plays a vital role in the plan due to its extensive involvement with the hospital's Safety Program and the availability of officers 24 hours a day. Officers are trained to do the following:

- Assist and back up Emergency Department staff in the decontamination room
- Obtain appropriate chemical information by in-house material safety data sheets or by the CAMEO database
- Secure the area from vehicle and pedestrian traffic

- Inform press representatives of appropriate staff contacts
- Assist with the implementation of the hospital's Internal Disaster Plan, if needed
- Notify the infectious waste hauler for HAZ MAT decontamination disposal

According to the plan, after each incident, a critique will take place that includes all participating parties. All incidents are then reviewed by the Mount Auburn Hospital Safety Committee to evaluate the overall coordination effort.

The Fire Department of the City of Cambridge has its own fully trained and equipped HAZ MAT response unit that can handle most local HAZ MAT incidents. The City of Cambridge experiences 300 to 400 HAZ MAT incidents a year, many of which requiring a HAZ MAT investigation (the lowest level of response by the HAZ MAT unit).

HAZ MAT response in Cambridge consists of

- HAZ MAT Task Force consisting of Ladder Company, Engine Company, Foam Unit and Command Vehicle
- Special Operations Units – with suits and communication systems, HAZ MAT library, computers (MSDS, CAMEO, etc.)
- Professional Ambulance and Hospital
- Decontamination Task Force
- Mobile Command and Control Unit
- Five levels of response (Shown in Exhibit A-10)

Exhibit A-11 depicts the resources (equipment and human resources) deployed for each level of response. Note that Cambridge uses an intermediate Level 1(called working) where a specialized call to HAZ MAT units, rescue, and other resources is placed in special situations. Level 1 response is handled by First Responders.

A.4 SPRINGFIELD HAZ MAT RESPONSE

Like Boston and Cambridge, the City of Springfield, located in western Massachusetts, has its own fully trained and equipped HAZ MAT Response Team, and only relies on the Massachusetts regional response teams in back up situations. The Springfield team, first organized in 1985, responds to about 100 incidents a year. Following are the key characteristics of that team.

Exhibit A-10 City of Cambridge Hazardous Materials Incident Response levels

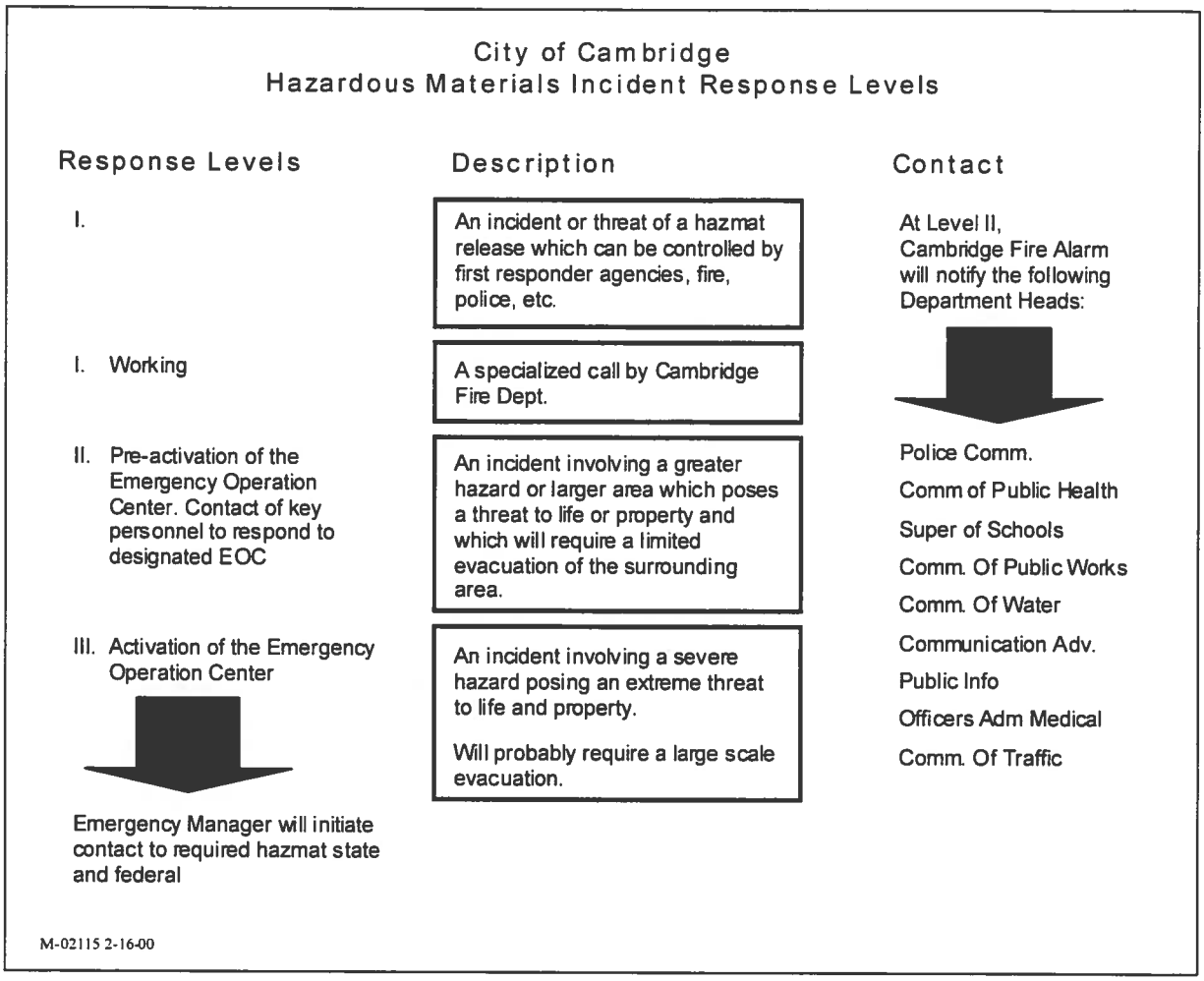


Exhibit A-11 HAZ MAT Response Resources (HAZ MAT Materials Spill, Leak or Danger as Designated by SOP #6)

RESPONSE LEVELS	TOTAL RESPONDING UNITS ON SCENE	NOTIFICATION
Level 0	Total Responding Units: 1 Engine, 1 Truck, 1 Division Chief	Cambridge Fire Chief of Department Fire Alarm Radio Room
Level 1	1 Engine, 1 Truck 1 Rescue 1 Division Chief 1 HAZ MAT	All Agencies in Level 0
Level 1 Working	1 Engine, 1 Truck 2 Rescue 1 ALS 1 HAZ MAT 1 HAZ MAT Task force (Ladder 1, Engine 1, Engine 3) 1 Air Supply Unit 3 HAZ MAT Officers 1 Communication Unit 2 Training Division 1 Fire Photo Unit 1 Sara Officer	All Agencies in Level 0
Level 2	1 Engine, 1 Truck 2 Rescue, and 1 ALS 1 HAZ MAT Task Force (L-1, E-1, E-3) 1 Air Supply 2 Division Chief 3 HAZ MAT Officers 1 Communications Unit 2 Training Division Fire Photo Unit REPORT TO EOC Chief of Department SARA Officer Emergency Management Police Department Fire Alarm	Notification All Agencies in Level 1 plus all Agencies in Level 0 Public Works Department Health Department Red Cross State Police Public Utilities Comm of Traffic Public Health Police Chief Com. Of Water Officers Adm Medical Public Info. Super Intendent of Schools
Level 3 – Emergency Operational Center Activated (EOC)	1 Engine, 1 Truck 2 Rescue, and 1 ALS 1 HAZ MAT Task Force (L-1, E-1, E-3) 1 HAZ MAT and AIR Supply Unit 2 Division Chiefs 3 HAZ MAT Officers 1 Communications Unit 2 Training Officers Fire Photo Unit REPORT TO EOC Chief of Department 1 SARA Officer Emergency Management Police Department Fire Alarm Special Call Units as Required by OIC	All Level 1 and 2 Agencies plus the following as needed: Mutual Aid Fire Police EMS

RESOURCES

- The HAZ MAT Team is composed of 12 to 16 full time firefighters trained to technician level
- Resources include:
  - HAZ MAT command vehicle and Equipment truck
  - CAMEO database, variety of HAZ MAT reference volumes
  - ALOHA, MARPLOT, CAMEO software (PC-based)

The HAZ MAT Team for the City of Springfield consists of four Fire Companies in addition to EMS Police, DPW and OEP. Command Vehicle serves as an Incident Command Post for everyone at an incident: State Police, DPW, State DEP. The command vehicle is deployed only on Level 2 or 3 incidents.

RESPONSE PROTOCOL

Springfield uses the following response protocol:

- Dispatch Center has protocol for identifying HAZ MAT incidents and obtaining needed information
- In the case of a HAZ MAT incident, 1 to 2 fire companies respond
- Additionally, HAZ MAT teams called either by City protocol or Fire Department units who have arrived already at the scene.
- LEPC coordinator may respond to an incident, depending on its level of severity
- Two parts of the response:

  Logistical – has all the investigation equipment, suits, hardware, etc.

  Chemical – data intensive, investigation, CAMEO, chemical information systems, expertise in identification.

Exhibit A-12 summarizes the comments received from the City of Springfield HAZ MAT personnel. The comments are arranged by response stage.

LEVELS OF RESPONSE

The City of Springfield utilizes four levels of response in addressing HAZ MAT incidents. The four levels are summarized below:

LEVEL 1: An incident that Police, Fire DPW, and Emergency Medical personnel can easily handle with the initial emergency response crews. Evacuation is not necessary. Examples of a Level 1 incident include: a small gasoline spill which is contained, reports of natural gas in residential areas, releases that pose no or little threat to residents or the environment, etc.

LEVEL 1 INVESTIGATION: A investigative response in a resident or non-industrial areas to an unknown odors/smells; unidentified drums or containers; or, situation where the person indicates the presence of hazardous materials is vague to what the situation is. Industrial facilities are **not** covered by this level.

LEVEL 2: An incident that is more complex than level 1. At this level additional resources will be needed to contain and mitigate the incident. Haz-mat Companies and a Command Post response shall be a requirement to this level. Examples of a Level 2 incident include: A situation where the material has not yet been identified in non-residential areas; etc. incidents involving rail car or trucks leaking hazardous materials, etc. hazardous material incidents with victims; incident at SARA facilities with extremely hazardous materials. Leaks involving toxics, poisons, or extremely hazardous materials; fire involving pesticide storage.

LEVEL 3: An incident beyond the capability of the City and local resources or an incident that is anticipated to last longer than 24 hours, State and Federal Resources will be needed. A Disaster Declaration will have to be considered.

Exhibit A-12: Summary of Comments Received from City of Springfield HAZ MAT Personnel

Alert & Initial Dispatch:	First responders to incident by city protocol are Local Fire, Police, EMS, and DPW, and Office of Emergency Preparedness and State Police when Interstate Highways are involved.
City HAZ MAT Team:	City HAZ MAT team is called as a team Command Post vehicle (temporarily out of service and being replaced by new vehicle) called to major incidents. LEPC coordinator notified of all spills HAZ MAT team using CAMEO-ALOHA, also available in Fire Dispatch. Plans are being made to put CAMEO in Police, EMS Dispatch Centers too. Also carried in laptops.
Hazards risk assessments:	CAMEO used frequently. Much effort is expended in keeping facility databases, and other information sources up to date. ATSDR has been found to be very effective and excellent source of toxicology and chemical information. ARCHIE is used for explosion modeling. Reactivity worksheets are also used. CABIN for WMD was used but since it has not been supported it has been dropped from the resource list MSDS Sheets have generally been found **not to be useful** for emergency response operations. Fire Dept and LEPC have created product ID sheets following National Fire Academy guidelines for EHS and high risk chemicals found in Springfield industries
Operations	Done pre-science on 20 chemicals found in Springfield. Product Data Sheets carried to site as reference material Unknown chemicals present a tough problem; time consuming to investigate-area where Information Technology can help through Decision Tree or Expert System ALOHA and ARCHIE are widely used because of low cost; evaluation threshold is loosely defined; limitations as to demarcation of evacuation zones, low model resolution CAMEO GIS displays too many data layers, difficult to read, higher mapping resolution needed MSDS not a useful reference source for mitigation Video cameras useful to survey interior of facilities, lighting presents problems In-suit communication not effective inside metal structures Geo-location of HAZ MAT technicians inside a facility would be useful
Clean-up	City protocols generally have private clean up contractors at the expense of the responsible party to conduct the clean up at the site. State DEP oversees contractor performance.

A.5 NEW HAMPSHIRE HAZ MAT MUTUAL AID DISTRICT TEAMS

The New Hampshire Hazardous Materials Mutual Aid Districts are organized as a regional solution to the hazardous materials problem. The purpose of the districts is to prepare the communities, regionally, for responses to hazardous materials incidents, both with training and equipment.

Currently, New Hampshire has seven Districts:

- South Eastern New Hampshire Hazardous Materials Mutual Aid District (SENHHMMAD)
- Souhegan Mutual Aid Response Team (SMART)
- Seacoast Technical Assistance Response Team (START)
- Manchester Fire/HAZ MAT Team
- Keene Fire Hazardous Material's Response Team
- Crown Vantage/City of Berlin Hazardous Materials Team
- Central New Hampshire.

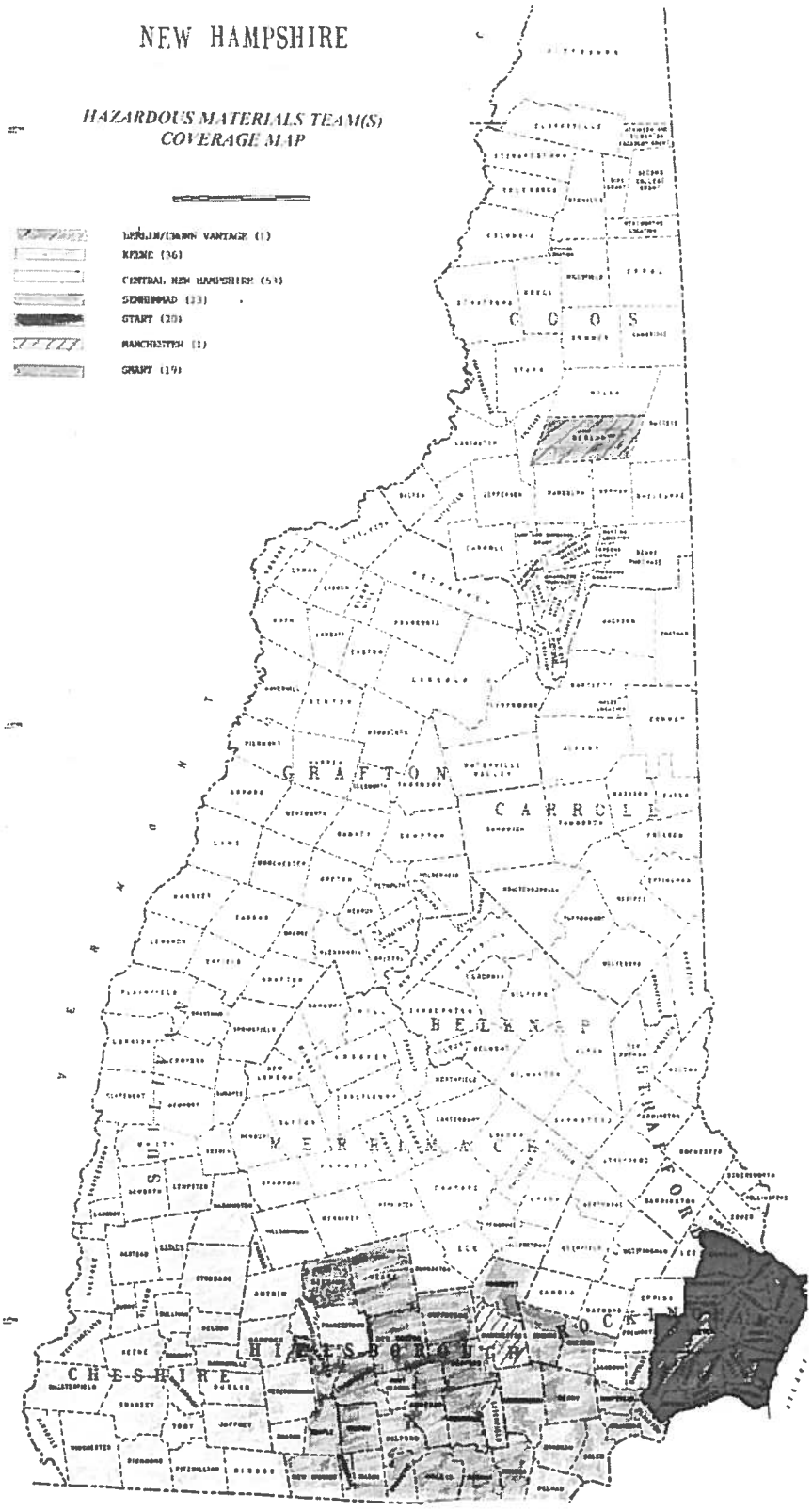
Exhibit A-13 presents the composition and resources of the New Hampshire teams.

Exhibit A-14 presents a map showing the coverage of the HAZ MAT Districts. Generally, the districts cover the regions of the state with the highest population. The teams are capable of providing levels A or B response. NFPA (Ref. 4) defines various levels of HAZ MAT response capabilities: A: for Light Hazards, B: Medium Hazards, C: Extreme Hazards, D: Water Reactive Hazards, E: Etiological Hazards, R: Radioactive Hazards. New Hampshire districts are equipped for A and B level response. They possess fully encapsulated suits, a variety of monitoring equipment, a resource library, self-contained breathing apparatus, plugging and diving equipment, absorbents, tools and equipment to support operations, decontamination equipment, and communications and information. The teams are comprised of volunteer firefighters, on-call firefighters, and toxicologists or chemical experts from private sector.

Exhibit A-13 Composition of New Hampshire District HAZ MAT Teams

DISTRICT HAZ MAT TEAMS	CENTRAL NH HAZ MAT TEAM	SENH HAZ MAT TEAM	SMART	KEENE	SEACOAST	BERLIN	MANCHESTER
# of Communities Covered	53	14	17	70	22	1	1
# of Personnel	16 (+)	36	40	28	28	25	90
# of Vehicles	3	1 (2tr)	3	1 (1tr)	2	2	1
Level of HAZ MAT Capability	A	B	A	A	A	A	A

Exhibit A-14 New Hampshire Hazardous Materials Team(s) Coverage Map



Each HAZ MAT district in New Hampshire is organized somewhat differently. The Southeastern NH HAZ MAT Mutual Aid District is managed by an Operations Committee, consisting of a Chief Officer from each member community, which carries out the day-to-day business of the organization; and a Board of Directors, consisting of an elected or appointed member of the municipal government in each community, which provides oversight and fiscal management.

A total of 15 communities are covered by the Southeastern New Hampshire HAZ MAT District. District resources include two response trailers, equipped with generators, oil spill and decontamination equipment, and chemical reference materials. The District also owns a response truck, equipped in the same manner as the trailers. Equipment upgrades to the Derry Fire Department Special Services Vehicle, and the Pelham Fire Department Rescue Truck, enable these vehicles to function as mobile command posts, complete with computerized reference software, as well as radio, fax, and cellular communications. The trailers and truck are strategically located to respond to any community within the district that requests them.

Exhibit A-15 summarizes the comments received from New Hampshire HAZ MAT emergency responder. It includes comments received from SENHHMMAD, the Central New Hampshire District, and the State Emergency Management Agency.

	connect to Command Center. Pockets of the state do not receive cell phone signals (especially in the mountainous area in the north of the state). • Central New Hampshire District has three vehicles: a van and two trucks. The van is equipped with the following: (1) a personal computer with various databases (TOMES, CAMEO, and MSDSs) and mobile radios, (2) various reference materials, (3) equipment used for training, (4) 6 Level A and B suits for the entry and a backup team (voice-activated microphones are hooked up to masks on these suits), and (5) grounding equipment needed for tankers and trailers accidents set up in the perimeter of the truck or tanker. • For chemical identification, districts rely on Dragger "Chips" technology. Can make numerous readings with a clip, usability is very good, used for readings around perimeter for high/low concentrations of chemicals, effective in identifying chemical family. Dragger is delivering new chemical and biological detectors to the State (funding is coming from the Federal Government) • Use Polaroid cameras to take photos inside facility or truck for planning mitigation actions. Video cameras would be more effective, but there is a problem with decontamination. • Geographic Information System (GIS) can be a very valuable tool for mapping drainage networks, terrain, road network. State received a grant of $60,000 to establish a statewide GIS system. Teams do lots of diking work to prevent spills from getting into the drainage network and waste water treatment plants. Maps of the drainage networks are essential. • Technology that would be very useful : (1) GIS with vehicle location equipment, (2) weather stations and related hardware and software, (3) better in-suit radio communications, (4) two-way pagers for notification, (5) additional (or better) mobile radio equipment, (6) additional (or more reliable) portable telephones, (7) infrared images (some fire departments already have these), and (8) portable chemical detection devices, such as gas spectrographs and mass spectrometers, for identification of chemicals inside a facility or truck.
CLEAN-UP	• HAZ MAT teams do not perform clean-up activities. • For clean-up, a private contractor or Department of Public Works contacts are used.

APPENDIX B
MASSACHUSETTS' TECHNICAL OPERATIONS MODULES (TOMS)

This Appendix presents the unit features and vehicle specifications for Massachusetts' TOMs, hazardous materials emergency response vehicles deployed by the six Massachusetts Hazardous Materials Response Districts. The main IT and communications features of the TOMs are presented below:

INFORMATION SYSTEM/DATABASES AND SOFTWARE

- ALOHA 5.2 used for plume modeling for vessels, tankers, and piping
- CAMEO
- MARPLOT MAPPING used for incident plotting
- TOMES CPS, published by Micromedex Inc.--Contains MSDS sheets, Toxicology, Occupational Medicine, etc. Also contains CHRIS, HSDB, IRIS, NJ HAZ substance, NIOSH book, OHM/TADSSAFER FMP -- dispersion modeling with topographic map
- Microsoft Automap Streets
- CONFODISC--Contains different databases, including CESARS, CHEMENDEX, CHRIS, CHEMINFO, DSL/NDSL, NIOSH Pocket Guide, RIPA, LI/EDS, HSDB (R), CHEMINFO (MSDS disc A), RIPP, TRANSPORT 49cfr, TRANSPORT TDG.
- Weather Instrumentation--WEATHER PAK mobile weather station and two remote units to deploy at the incident site

INSTRUMENTS USED FOR CHEMICAL IDENTIFICATION

- National Dragger Inc. detection devices (tubes, chip analyzer, etc.)
- LEL (lower exposure levels), CO, Oxygen and H_2S meters. (All meters go through gas calibration once a month -- they are bump tested and gas calibrated at the local fire station housing each of the TOMs.)
- CO-H_2S-02-LEL monitors, Photo Ionization Device, pH, spill and waste classifiers, Alpha/Beta/Gamma radiation detectors
- FOXBORO unit for organic materials
- Spotting scope mounted on a tripod
- Radiation meters

TOMS COMMUNICATION STATION

Radio Bands

- UHF 453-488 MHz range - handles 80 different frequencies – for communications with Medical (CMED 10 frequencies)

Smart Routes (traffic reports)

Various fire departments

- 800 MHz - trunked and conventional for in-suit communication, 8 channels - for communications with

  Fire Department

  Police

  Other TOMs

  In-suit radios

- Low Band - 30-36 MHz - handles 32 frequencies
- Low Band - 42-50 MHz - handles 32 frequencies - for communications with

  Massachusetts State Police

  Mass Highway Department

  Red Cross

  Various fire departments

- VHF 146 - 174 MHz - handles 104 frequencies - for communications with

  Massachusetts Emergency Management Agency

  National Fire

  US Coast Guard

  Army National Guard

  Various fire departments

Other Communications Equipment

- In-suit communications – "bone" microphone and adapter for communications
- Seven cellular phone lines and connections for line (wire) phones

OTHER ITEMS

- Video - 72 hr. recording, hold, and print
- Portable radios
- Flip charts and white boards mounted on cabinets for in-vehicle briefings, meetings, etc.

Exhibit B-1: TOMs Vehicle Specifications and Equipment

TECHNICAL OPERATIONS MODULES SPECIFICATION
VEHICLE
• Length – 30 ft • Width – 8 feet • Height – 11'6" • Fuel Capacity – One 50 gallon tank Approximate running time 12 hours plus on one full tank • Generator Hydraulically driven to allow "pump and roll" power generation 20 KW output, @ 12 KW at idle
CAB
• All truck cabs are keyed the same • Intercom • AM/FM weather radio • Tower light Lights up if either video camera or Lighting tower is out of storage position • Fast idle switch Truck has governor that automatically throttles up to meet power demands • Sequencer Manages lighting load and brings up lights in sequence at 1 second intervals in normal operation Override switch located on front of "doghouse" • Chains In addition to chains the trucks have ATC (Automatic Traction Control) that should reduce the need for chain system • Transmission Control Six forward speed transmission Electronic – "fly by wire" control of transmission
INSIDE FRONT SECTION
• Two Computers • Two Printer/Fax/Scanner units • Weather Station display • Cellular phones Data/Voice Voice • Video Camera system Camera Monitor Camera Controls VCR Video Printer • Circuit Break Panel • Outside Compartment lock • CO Monitor
INSIDE MIDDLE SECTION
• Power Inverter

- Refrigeration
- Hand Lights
- Portable radios
- Waterpak
- Site lighting remote control
- Meters

INSIDE REAR SECTION

- Radios
  Low band 30 36 mh
  Low band 42 50 mhz
  VHF 1476 – 174 mhz
  UHF 453 – 488 mhz
  800 MZ -- Trunked and Conventional
- Repeater (Removable)
- Video Monitor
- Climate Control
- CO Monitor
- Intercom

EQUIPMENT DETAILS--

POWER INVERTER

- Mounted on wall of interior center compartment
  Indicator lights show inverter functions
- Functions to provide emergency power to computers
  Only supplies certain circuits

CELLULAR TELEPHONES

- Seven cellular phones lines
- Truck master battery switch must be on to power phones

RADIOS

- Portable radios

COMPUTERS

Two 133mhz Tower Units with
32 MB RAM memory
3 gigabyte Hard Drive Storage
8 X CDROM
Tape drive for backup
Two Floppy disk drives (3.5 inch and 5.25 inch)
Video Boards with 4 MB RAM onboard
28.8 kps FAX/Modem
17" Color Monitors

SOFTWARE

- Windows for Workgroups Version 3.11
- DOS Version 6.22
- CAMEO for Windows
- ALOHA (Windows)
- MARPLOT
- Landview Mapping
- CCINFO (MSDS)
- Paging
- System software

PRINTER/FAX/SCANNER

- Multi-function unit that provides
  - 300dpi Laser printer
  - Copier
  - Fax
  - Scanner

CLOSED CIRCUIT CAMERA

- Color Camera mounted on 34-foot telescopic mast
- Minimum required illumination = 3 lux
- Attached motorized zoom lens
- Both camera and zoom lens inside weatherproof housing w/heater/defroster
- Features
  - Equipped w/pan/zoom/tilt
  - Controls in forward wall
  - "Joystick" directional control
  - Manual, Auto and random pan modes

VIDEOTAPE RECORDER

- Time Lapse Video Recorder
- Time modes enable long duration recording
  - 2-6-12-18-24-48-72-84-120-180-240 and 480 hour modes

OTHER VIDEO EQUIPMENT

- Monitors for VCR in forward and rear compartments
- Video Printer

WEATHER STATION

- WeatherPAK 400 from Coastal Environmental Systems
- Measures
  - Air temperature
  - Wind speed
  - Wind direction
  - Stability Class of the wind
- Data sampled every 2 seconds and computed into a 5 minute running average

APPENDIX C
MASSACHUSETTS HAZ MAT DISTRICT TEAMS: FUNCTIONS OF HAZ MAT TEAM MEMBERS

(Source: The Commonwealth of Massachusetts, Executive Office of Public Safety, Department of Fire Services, Hazardous Materials Response, "Standard Operating Guideline," May 1, 1998.)

Team Leader

- Responsible for the planning, directing, and controlling all hazardous materials operations
- Reports to the Incident Commander
- Shall be a qualified Hazardous Materials Technician
- A Technician serving as the Team Leader at an incident in his community may pass command to another technician
- Ensure that the new Team Leader is thoroughly briefed whenever transferring command to another technician
- Shall follow and complete the Team Leader checklist
- Shall maintain communications with the Incident Commander and keep the IC informed of Team operations
- Shall appoint the Branch Officers and coordinate their activities
- Shall develop the HAZ MAT Operations Plan
- Consult with Branch Officers to keep each adequately informed of operational needs
- Conduct a briefing with the Incident Commander and Branch Officers to present an operational plan for the incident
- Coordinate with the Safety Officer to ensure that field operations are conducted safely
- Ensure that all necessary records regarding the incident are completed.

Team Leader Aide

- Be a qualified Hazardous Materials Technician
- Meet with the Team Leader and received assignments as required
- Consult with the Team Leader for Branch Officer assignments
- Record the arrival of team members and their assignments
- Perform all duties required of the Staging Officer
- Establish a staging/rehabilitation area for the team
- Assign members to team positions
- Maintain a record of members in staging, and make assignments as required
- Maintain a posted table of organization (on a white board) at the TOMs Unit

- Record the departure of team members from the incident
- Assist the Science Branch in keeping a chronological record of operations during the incident.

Science/Information Branch

- Responsible for gathering and analyzing all data about the incident. The Science branch staff shall receive and transmit all information to all other branches of the Response Team.
- Shall be a qualified Hazardous Materials Technician.
- Be positioned in the TOM Unit with access to all data and resources of the unit.
- Using the Science checklist(s) as a guide, develop an incident profile and site safety plan including the materials involved, the nature of the release or potential release, and all site information.
- Conduct a remote reconnaissance of the site from the warm and cold zones.
- Brief recon, entry, and decon teams before deployment.
- Monitor operations and evaluate the mitigation plan.
- Debrief the recon and entry teams as they return from deployment.
- Receive periodic reports from the safety, recon, decon, entry, and medical officers.
- Provide accurate and timely updated information to safety recon, decon, entry and medical officers to keep them current on the status of the incident.
- Maintain a record of the incident status, prepare reports to estimate the progress of the incident and to be used in formulating the operation plan.
- Remain in constant contact and relay all operational information to the Team Leader.

Medical Branch Officer

- Be a qualified Hazardous Materials Technician
- Be responsible for monitoring the medical condition of all Entry and Decon members.
- Select an appropriate site to conduct medical screenings
- Employ local EMTs to perform medical screenings
- Assign and supervise personnel performing pre-entry and post-entry screenings
- Coordinate care for members injured during an incident
- Complete the medical branch officer checklist
- Have the authority to remove any member from duty if he believes, for medical reasons, that the team member is unfit for entry operations
- Have the authority to see that any entry team member be transported to a medical facility if he deems it necessary
- Complete records of all entry and decon members
- Complete exposure records on all team members
- File all required reports.

Entry Team Officer

- Be a qualified Hazardous Materials Technician.
- Select an appropriate site to stage for entry team personnel in consultation with the Team Leader and/or Team Leader Aide.
- Follow and complete the Entry Officer Checklist.
- Assign support personnel to assist entry personnel donning PPE.
- Receive reports from the Safety Branch Officer.
- Receive from the Science Branch Officer appropriate information about the incident.
- Receive from the Science Officer status reports to prepare personnel for operations.
- Make reports to the Team Leader concerning the status of entry resources.

Decontamination Branch Officer

- Decontamination Branch Officer (Decon officer) will be assigned by the Team Leader on all incidents involving entry operations or when personnel may be exposed to hazardous materials.
- Assume the responsibility for safe and acceptable methods of decontamination for the incident.
- Shall be a qualified Hazardous Materials Technician.
- Obtain an identification vest, portable radio, and a Decon Team Checklist packet.
- Receive from the Science Branch Officer information concerning the materials involved and appropriate decontamination methods.

Logistics Branch Officer

- Shall be a qualified Hazardous Materials Technician.
- Select a site for the ORU in consultation with the Team Leader.
- Select a site to stage equipment supplied by outside agencies in consultation with the Team Leader and the Incident Commander.
- Coordinate with the Team Leader and Science Branch Officer to determine the type of operation to be conducted and possible equipment needed.
- Coordinate with the Liaison Officer for contact with outside agencies.
- Deliver to a staging area in the warm zone all tools and equipment required for operations.
- Maintain a record of all equipment and supplies issued.
- Account for all tools, equipment, and supplies used during the incident
- Forward to the Team Leader a list of tools, equipment and supplies that were expended and used and need to be replaced
- Assure that any equipment utilized by First Responders is appropriately decontaminated or isolated.
- Coordinate with the on-site representative from contractor's and outside agencies.

- Complete the Hazardous Materials Logistics Checklist.

Staff Officer

- The Staff Liaison shall position to be available to the Incident Command Post staff.
- Work with the Logistics Branch to establish a staging area and check in point for outside agencies and contractors
- Maintain an up-to-date list of resources available and forward copies to the Logistics Branch Officer.
- Remain in contact with the Team Leader and the Incident Commander.
- Be in contact through the agency representatives with all agencies participating in or available to the emergency operation.
- Respond to requests from incident personnel for inter-organizational contacts.
- Monitor incident operations to identify current or potential inter-organizational problems.
- The Liaison will complete the Liaison checklist.

Safety Officer

- Shall be a qualified Hazardous Materials Technician
- One Safety Monitor shall be assigned to each entry team
- Be positioned in the warm zone at the entry point into the hot zone
- Restrict entry into the hot zone to hazardous materials technicians who have been briefed and cleared for operations
- Follow and complete the Safety Monitor checklist
- Retain the authority to halt operations and order personnel back to the warm zone if unsafe conditions are observed
- Review safety procedures with their assigned entry team in cooperation with the Entry Branch Officer
- Record and monitor "on air time"
- Maintain visual contact with entry team during operations if possible
- Monitor entry team radio to detect any safety problems
- Secure from logistics necessary equipment (binoculars, spotting scope, portable radio, stopwatch)

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