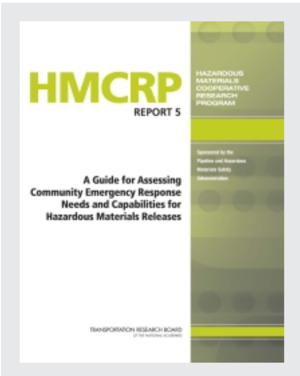

A Guide for Assessing Community Emergency Response Needs and Capabilities for Hazardous Materials Releases

DETAILS

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Transportation Research Board

HAZARDOUS MATERIALS COOPERATIVE RESEARCH PROGRAM

HMCRP REPORT 5

A Guide for Assessing Community Emergency Response Needs and Capabilities for Hazardous Materials Releases

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HAZARDOUS MATERIALS COOPERATIVE RESEARCH PROGRAM

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

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

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

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NOTICE

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The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

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Battelle Columbus, Ohio, along with team members Visual Risk Assessment and Virginia Tech University, prepared *A Guide for Assessing Community Emergency Response Needs and Capabilities for Hazardous Materials Releases* (Guide) under HMCRP Project 03. Dr. Arthur Greenberg was the project manager for Battelle. Contributing authors for this Guide are Dr. Mark Lepofsky of Visual Risk Assessment, Dr. Kitty Hancock of Virginia Tech University, and Dr. Tom McSweeney of Battelle. Battelle acknowledges the guidance and support of the HMCRP Project 03 panel members.

FOREWORD

By William C. Rogers
Staff Officer
Transportation Research Board

HMCRP Report 5: A Guide for Assessing Community Emergency Response Needs and Capabilities for Hazardous Materials Releases presents comprehensive, step-by-step guidance on assessing hazardous materials emergency response needs at state, regional, and local levels; matching state, regional, and local capabilities with potential emergencies involving different types of hazardous materials; and assessing how quickly resources can be brought to bear in an emergency. The methodology described in the Guide is designed to be scalable, allowing the implementation results to be aggregated at the local level up through regional, state, and national levels. Also, the Guide is designed to connect as many components as possible to already-established standards, guidelines, regulations, and laws, so that the Guide will remain current as these underlying components are updated. In addition, the Guide discusses appropriate means for maintaining currency of the information over time.

The Guide and accompanying spreadsheet tool (on the attached CD-ROM), which leads planners through the assessment process, will be most useful for local jurisdictions that have limited resources and expertise in hazardous materials emergency response planning.

Federal health, safety, and environmental regulations address emergency response planning and preparations in the event of a hazardous materials release. The Emergency Preparedness and Community Right-to-Know Act of 1986 (EPCRA), enacted as Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA), calls for State Emergency Response Committees (SERCs) and their designated Local Emergency Planning Committees (LEPCs) to plan and prepare for such hazardous materials releases. However, few efforts have been made at the national, state, or regional levels to identify capable response teams, to match their capabilities with potential emergencies involving different types of hazardous materials, or to assess how quickly resources can be brought to bear in an emergency.

Under HMCRP Project 03, Battelle was asked to develop a guide to address (1) conducting state, regional, and local hazardous material emergency needs assessments; (2) developing, maintaining, and sharing capability assessments; (3) aligning assessed needs with various levels of capability; and (4) identifying shortfalls where additional or different capabilities are warranted.

The Guide addresses materials that are transported commercially under the auspices of the U.S.DOT Hazardous Materials Regulations as found in Title 49 of the Code of Federal Regulations. The scope of the Guide includes the storage of materials incidental to transportation (including at facilities at both the origin and destination) as well as along any transportation corridor and the storage, handling, and processing of materials at fixed facilities.

CONTENTS

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

Introduction

This Guide is the result of a Hazardous Materials Cooperative Research Program (HMCRP) project managed by the Transportation Research Board (TRB) of the National Academies. As the project charter stated: "few efforts have been made at the national, state, or regional levels to identify capable response teams, match their capabilities with potential emergencies involving different types of hazardous materials (hazmat), and assess how quickly resources can be brought to bear in an emergency. Likewise, comprehensive guidance on assessing state, regional, or local hazmat emergency response needs, in order to achieve the appropriate level of coverage at the regional or local level, has not been provided."

This Guide is designed to assist emergency response planning organizations at all jurisdictional levels in assessing their needs for hazmat emergency response, in assessing their capabilities to respond, and in identifying and addressing any significant shortfalls in coverage. The approach is intended to be scalable and to promote implementation and integration from the local level through regional, state, and national levels. This document may be most useful for local jurisdictions that have limited resources and expertise in hazmat emergency response planning. The appropriate level of effort for implementation can be tailored to the specific types of community or jurisdiction conducting the response planning. Each response concept is formulated based upon the specific operational environment(s) in which the intended audience will be expected to operate. This Guide recognizes these legal and procedural differences and does not attempt to force each of these distinct concepts into a single framework. Each concept will be recognized and assessed separately, while acknowledging overarching and unifying concepts such as the National Incident Management System (NIMS) and the Incident Command System (ICS), which are common across all preparedness, response, and recovery efforts. In general, this Guide recognizes already established standards, guidelines, regulations, and laws, to enable the Guide to remain current as these underlying components are updated over time.

Hazmat in transit, stored, manufactured, or used at fixed facilities can create adverse consequences to the population, to the environment, and even to critical infrastructure in the event of an accidental or intentional release. Environmental, safety, and health (ESH) regulations at the federal level mandate certain planning and preparedness activities, in particular the Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA 1986; SARA 1986), which specifies requirements for State Emergency Response Commissions (SERCs) and their designated Local Emergency Planning Committees (LEPCs).

When planning for hazmat emergency response, LEPCs as well as local jurisdictions and organizations consider the full range of hazmat that may be encountered. Permanent and temporary production and storage facilities are identified in the planning process, as are other venues representing potential incident scenes, such as major land (vehicle, rail, and pipeline) and maritime transportation corridors.

The scope of materials addressed by this Guide is the materials that are transported commercially under the auspices of the U.S. Department of Transportation (U.S.DOT) Hazmat Regulations (HMRs) as found in Title 49 of the Code of Federal Regulations (CFR). This includes the storage of materials incidental to transportation (including at facilities at both the origin and destination), as well as along any transportation corridors. This Guide utilizes the nine hazard classes identified within these regulations whenever possible to delineate specific hazards or associated risks.

The HMRs include class designations and identification numbers for various chemical, biological, and radiological agents that have conventional warfare applications or that have certain characteristics that may be favorable for utilization by terrorists or criminals during an intentional act. However, these hazard classes are inherently designed from a safety perspective to support the legal and regulated storage and/or transportation of hazmat between origin and destination for lawful use by a private citizen, established company, or governmental agency or department.

Three major hazmat response concepts are currently in use within the United States, as found in the following sources:

- Hazmat Response within the Public Safety community as represented by National Fire Protection Association (NFPA) Standard 472 (2008);
- Hazardous Waste Operations and Emergency Response (HAZWOPER) codified in 29 CFR 1910.120Q; and
- Environmental Oil and Hazardous Substance (OHS) response codified in 40 CFR 300 and related parts, based largely upon the HAZWOPER standard in 29 CFR.

How to Use This Document

Each chapter of this Guide will lead you through successive steps in the process designed to determine the capabilities of the emergency response organization, to determine hazmat present in the jurisdiction, and then to compare existing capabilities to the level of capabilities needed based on the hazmat either present in the area or being transported through the area. The assessment steps will be described in the body of the Guide, with the appendices providing more in-depth information. The Guide also includes, on the attached CD-ROM, a spreadsheet designed to help the user apply the assessment methodology.

Following is a summary of the chapters and referenced appendices:

- The ***Introduction*** provides a review of the need for this Guide, defines its intended audience and scope, and provides background information on how it came to be developed.
- ***Chapter 1:*** **Overview of the Approach** provides an overview of the hazmat emergency response planning process. It presents the risk equation that drives the process and defines some important terms and how they affect the overall risk to your community.
- ***Chapter 2:*** **Assessing Emergency Response Capability** defines a hazmat emergency response team and outlines how to assess each team's response capability. Appendix D provides more detail on related efforts that were considered in developing this Guide.
- ***Chapter 3:*** **Defining Your Jurisdictional Emergency Response Objectives** presents an approach for tailoring response objectives to your specific jurisdiction, understanding that reasonable response capability and response times may differ between urban and rural areas, as one example.
- ***Chapter 4:*** **Identifying Hazardous Materials in Your Jurisdiction** focuses on determining the hazards in your planning jurisdiction for which emergency response may be needed. This includes identifying the specific materials and the concentration/volume/amount in which each is present. Appendix B provides additional detail on determining hazards and vulnerability.
- ***Chapter 5:*** **Potential Consequences of Incidents Involving the Identified Hazardous Materials** provides guidance to help you assess the potential human health and environmental consequences from releases in your jurisdiction. Appendix C describes the consequence estimation process in more detail.
- ***Chapter 6:*** **The Mitigating Effects of Emergency Response** describes how to consider the impacts of both response capability and response time as they relate to potential consequences. Appendix E provides additional detail on response time calculations.
- ***Chapter 7:*** **Aligning Hazardous Materials with Varying Levels of Capability** brings together the results of your hazard identification and emergency response capability assessments into a measure of risk that can be used by planning organizations to determine where to focus resources. Keeping these capability assessments current over time is also discussed.

- *Chapter 8:* **Identifying Shortfalls where Additional/Different Capabilities Are Warranted** provides a simple process for prioritizing mitigation efforts to improve and balance response coverage throughout your jurisdiction.
- *Chapter 9:* **Approaches for Addressing Identified Shortfalls** discusses potential approaches for filling shortfalls in desired response coverage that were identified in earlier steps.
- *Chapter 10:* **Sustaining the Process** provides strategies for keeping the assessments current over time and sharing them with other jurisdictions.

CHAPTER 1

Overview of the Approach

The approach detailed in this Guide walks you, an emergency planning organization official, through a prescribed process with discrete steps and outputs that combine to inform decision making about response planning for hazmat incidents. In following this Guide, you can:

- Identify response capabilities and their locations (Chapter 2);
- Define desired emergency response performance objectives specific to your jurisdiction (Chapter 3);
- Identify any shortfalls in response capabilities based on the performance objectives selected (identified in Chapter 3 and carried into Chapter 8);
- Identify the specific materials of concern located in or transported through your jurisdiction and the potential hazards they represent (Chapter 4);
- Estimate the potential consequences from a release of the hazmat you identified (Chapter 5);
- Establish the impacts of qualified emergency response and its proximity to the location of potential incidents (Chapter 6);
- Assess how well response coverage aligns with the location and type of hazmat (Chapter 7);
- Identify shortfalls in capabilities identified in the coverage, considering severity of release consequences (Chapter 8);
- Make decisions about how to address specific shortfalls in response coverage (Chapter 9); and
- Sustain the process over time (Chapter 10).

Use of the Risk Assessment Tool

A risk assessment tool, developed using Microsoft® Excel, has separate worksheet tabs for the steps outlined in the 10 chapters. This tool is designed to lead you through the assessment process using separate worksheets for most of the steps defined in this Guide. As described below, the process is designed to be thorough, yet flexible. The tool is designed to identify any shortfalls that result as you proceed through the process. The tool is available to emergency response planners on the attached CD-ROM.

Balancing Assessment with Planning Capabilities of a Local Emergency Response Organization

The capabilities of emergency response planning organizations vary greatly. Some have access to very detailed assessment tools at every fire station, and larger metropolitan areas have emergency response personnel with extensive training and experience in emergency response. Others are made up of volunteers with more than adequate emergency response training but little planning assessment capability. This Guide is designed to have sufficient flexibility to be usable by any organization, irrespective of their emergency response planning capabilities. The approach is designed to be comprehensive, yet flexible. For example, if you are in a state that certifies the Tier Response Level of emergency response teams, then Chapter 2 steps have already been satisfied and all that is required is to note the Tier Response Level. If your organization has established its Jurisdictional Response goals as outlined by the Department of Homeland Security (DHS), then the steps in Chapter 3 can be quickly reviewed and the results noted. If there are shortfalls identified in Chapter 3, you may decide to satisfy the gap identified before proceeding with subsequent steps. Gaps identified at this stage will probably amplify in each succeeding step.

The flexibility in the assessment process is probably best shown in the assessments outlined in Chapters 4 and 5. The text outlines an approach that attempts to comprehensively identify the hazmat in the region in Chapter 4, and then estimate the consequences of accidental materials in Chapter 5. In a comprehensive analysis, an attempt would be made to identify the classes/divisions of hazmat in the region without regard to the frequency of shipments. If the results of a thorough commodity flow survey are not available, the assessor can choose to analyze a smaller number of hazmat, perhaps considering the most commonly shipped material, typically Class 3 flammables, and then consider a suite of other classes/divisions that might have more severe consequences. For example, ammonia, a Class 2 gas, is typically transported in farming areas. Sulfuric acid, a Class 8 corrosive, may be common in urban areas. Areas with plants that produce or use highly hazardous chemicals would clearly want to select those chemicals for analysis. From year to year the response capabilities for different chemicals might be assessed.

The Chapter 5 analyses might be a place where the greatest flexibility can be realized. The chapter outlines how you could estimate consequences using plume dispersion models. While many emergency responders have access to such tools and commonly use them, others do not. Those who do not can consult the scenarios used to develop the hazard distances in the 2008 American Emergency Response Guidebook (ERG 2008). Transport Canada developed an interactive version of that guidebook (ERGO 2008) that is very easy to use. It skips a few of the materials that would not be transported in Canada, such as chemical agents, but if those materials were present in a region, they would likely be handled as a special case and not by this planning guide. The point is, the consequences of a release often can be specified without going through all the effort required to develop a plume dispersion model. Appendix A provides a list and description of many useful information sources.

Subsequent chapters go through the responses to the hazardous material spills selected in Chapter 4 and whose consequences were estimated in Chapter 5. Once the incidents have been identified, the questions in Chapters 6 through 8 address response capabilities for those selected spills. These should be relatively straightforward to address. The spreadsheet tool helps fill out the assessment results once the local response capabilities have been entered.

Chapter 4 ties the entire analysis together. The assessment results are based on the risk equation, which is defined and described later in Chapter 1. One more term is added, vulnerability, described in Appendix B. Like the consequences, the description of the vulnerability estimation process in Appendix B is comprehensive. You have the option to estimate the frequency of a spill based on experience. For example, experience might show that the area will experience three or four flammable liquid spills a year. Experience should always trump analysis when estimating vulnerabilities. The example is intended to help with the less commonly shipped materials. Rather than showing all the estimated annual shipment mileage in the region, you could simply estimate the likelihood of a release to be one or more orders of magnitude below that of the flammable liquid spill.

There are several ways of using the summary results shown in Chapter 4. Since the risk equation is the product of the numbers in all the columns, columns with high numbers for all sce-

Table 1. Risk portfolio.

Hazard [H] (Chapters 1, 4)		Vulner-ability [V] (Chapter 1)	Consequence [C] (Chapters 1, 5)		Capability [ERC] (Chapters 1, 6)	Response Time [RTF] (Chapter 1)	Risk Metric (Equation 1) (Chapters 1, 7)
Facility or Route	Description		Pop.	Env.			

narios are areas where improvements may be beneficial. Clearly, scenarios with high risk estimates would be valuable to address as well. These decisions are the responsibility of the assessor or the assessment team. The goal is to make the process more rigorous, not to make it needlessly complicated.

Developing a Hazmat Portfolio

This Guide recommends using a relative risk-based approach to support hazmat emergency response planning decisions. A risk portfolio (column headings shown in Table 1) is used to manage the results of this process. Each column in Table 1 represents one of the elements used to compute the relative risk metric, and each row represents a particular scenario for which the planning agency needs to consider the appropriate emergency response. A scenario is a unique combination of hazardous material and location, and can also include the specific quantities involved and the frequency with which the material in those quantities is present at that location. Subsequent chapters of this Guide will address specific elements of the risk equation and will build on prior sections, resulting in a complete hazmat portfolio.

Defining the Risk Metric

While a planning agency may be able to qualitatively determine broad relationships regarding the risk of certain materials and the ability of existing emergency response teams to mitigate the consequences of releases, using a defined process with as many quantitative elements as possible helps to establish a sound basis for policy decisions related to response coverage. The approach outlined in this Guide uses a relative risk metric to capture and integrate all of the elements that contribute to the community's risk and to inform those policy decisions. This Guide uses the term "metric" to emphasize that the approach does not determine an absolute value of risk, but only a measure that is suitable for supporting planning activities. Calculating the risk metric allows you to determine the response capability that would offset expected consequences from hazmat incidents. In this section, the measure of risk is defined and the overall methodology is presented.

The risk metric is given in Equation 1 and follows the standard three-term representation of risk commonly used in many industries:

$$\text{Risk Metric} = H \times V \times C \quad (1)$$

where

H = hazard,
V = vulnerability, and
C = consequence.

As with all formulations of risk, the fundamental components are the frequency of some event happening combined with the potential consequences of that event. The consequence considers the mitigating effects of response capability and its proximity to potential incidents, as shown in Equation 2:

$$C = C_u \times ERC \times RTF \quad (2)$$

where

C = consequence,
C_u = potential consequences (unmitigated),
ERC = emergency response capability, and
RTF = response time [factor].

To be most effective, you should compute the risk metric for each hazard and location, although there may be opportunities to group certain elements together.

Each element in the risk equation is discussed in more detail in the following sections and in subsequent chapters.

Hazard

For this Guide, *hazard* is a yes/no variable that indicates whether there is a threat or hazard that could be realized in the region. While there are clearly differences in the relative “hazard” posed by different materials, those differences are primarily captured in the *consequence* term in the risk equation.

Hazards (or threats when considering security issues) can be defined for both fixed facilities and transportation. The quantity of a hazardous material present in one location at any time will also affect the potential consequences.

In general, the types of hazards posed by hazmat can be arranged into the following seven categories of Incident Release Type:

- Fires;
- Explosions or BLEVEs (boiling liquid expanding vapor explosion);
- Toxic gas releases;
- Toxic liquid releases;
- Corrosives;
- Radioactive materials releases; and
- Releases of biologically active materials.

In the section where these categories are explained in more detail, it will be shown how all the U.S.DOT HM classes and divisions can be related to these seven categories. These are the seven categories that will be carried through the rest of this Guide.

Vulnerability

The *vulnerability* term is a measure of the likelihood that the population or environment will be exposed to threats produced by an incident. There are two ways to consider vulnerability. One approach considers potential release probabilities based on historical or scientific data, while the other approach considers the quantity and frequency of materials present in a given time period, usually 1 year. In this assessment, the hazards present at fixed facilities or along a transport route will be considered. The details of the approach are presented in Chapter 7.

Consequence

The *consequence* term is a measure of the potential impacts to the population or environment from a release of hazmat. There are many factors to consider when estimating these impacts. Rather than determine a specific consequence value, this Guide uses a method to assign a relative value for the two different types of consequences: population and environment.

These consequences are measured assuming no effective emergency response. This enables the effectiveness of the emergency response to be captured in the response time and emergency response capability terms in the risk equation. For each scenario in the hazardous materials portfolio, both population and environmental consequences will be estimated and the *maximum* of the two estimates will be used in the risk equation.

Emergency Response Capability

For each hazard, the capability is measured by the ability of the emergency response team to place trained individuals at the scene of the incident with the proper response equipment. The *emergency response capability* term is used to represent the capabilities of the available response teams to effectively mitigate specific incident scenarios. The capabilities of any resource are based upon how that resource is organized, trained, certified, equipped, exercised, evaluated, and sustained. For this Guide, the appropriate level of response for hazmat incidents is organized into five tiers beyond the baseline level of response that would be expected for any U.S. fire department and is consistent with Federal Emergency Management Agency (FEMA) response team classifications for the higher levels of response capability.

The appropriate level of response for a particular scenario in the hazardous materials portfolio is initially determined by the potential consequences from that scenario and the type of jurisdiction, recognizing that very rural jurisdictions need not have the same emergency response capabilities as densely populated urban jurisdictions.

Response Time

The *response time factor* has three major components. These include the time it takes for the:

- Incident to be reported;
- First responders to arrive on the scene and begin managing the incident; and
- Specialized hazmat emergency response team to arrive on the scene and take over management of the incident.

The concept is, if the appropriate response occurs later than desired, it will be less effective and will not reduce consequences as much as if it occurs more quickly.

Summary of Risk Metric Evaluation Steps

The risk metric equation terms developed in the last five subsections are developed further in the balance of this Guide with a series of steps for performing two functions. In some steps, you specify the performance goals for your assessment region. The goals are based on the population in the assessment region as modified by the types and quantities of hazmat present in the assessment region. You define the extent of the region and your performance goals and objectives. In other steps, the terms of the risk equation are evaluated and they are compared to your goals and performance objectives to determine if there are any shortfalls in the emergency response coverage in your region. The individual scenario values for the risk metric are used to prioritize any shortfalls in emergency response coverage.

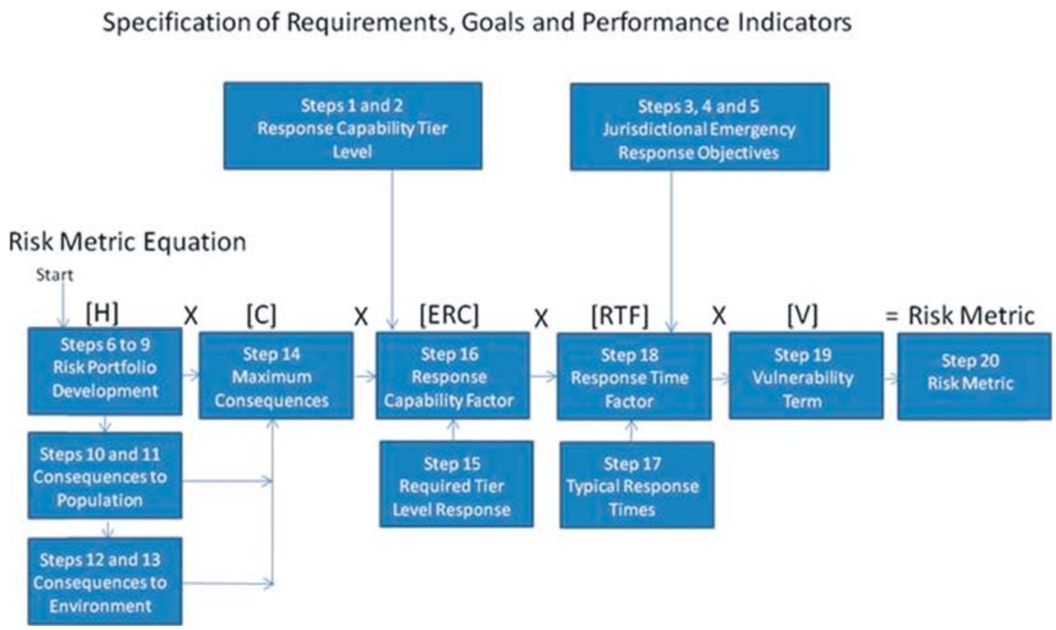


Figure 1. Steps to evaluate the risk metric and thereby identify capability shortfalls.

As can be seen in Figure 1, the first five steps define the capabilities of the emergency response region being assessed and then establish jurisdictional response objectives for the region. The next four steps, Steps 6 through 9, develop the risk portfolio for the region based on the hazard present. The remaining 11 steps develop successive terms in the risk metric equation. The terms in the risk metric equation that are defined in Chapter 1 are displayed in brackets above the steps where the terms are quantified. In subsequent sections, after the method of quantifying each term in the risk metric equation, the step number and a brief description of the step are presented.

CHAPTER 2

Assessing Emergency Response Capability

Three types of emergency response teams deal with hazmat: the traditional hazmat response from the public safety community, occupational/industrial manufacturing response, and environmental oil and hazardous substance response. This Guide uses a single framework to assess the capability for all response team types, allowing all resources to be considered equally in your planning process. The information provided in this chapter will enable you, as an emergency response planner, to assign a tier to each team.

Team Definition/Organization

The most commonly used term when referring to emergency responders is "team." A team can mean different things to different jurisdictions, and a common, consistent framework is needed to measure capability. This Guide provides flexibility in how you define your response teams, allowing you to measure response for individual fire stations, entire departments, industry partners, multijurisdictional agreements, and so on.

As an example, jurisdictions and providers may choose to share the financial and management burden of establishing, maintaining, and employing complex emergency response capabilities by integrating specific elements resident in multiple jurisdictions or providers into a strike team or task force, which can be task-organized, reinforced, and/or sustained depending upon the particular situation.

In other words, you will measure the emergency response capability for the "teams" in your jurisdiction as you see fit. If you choose to use smaller units, such as individual fire stations, you may find that you need to combine the resources of several of these units to form a "team" with the response capability needed to respond to certain types of incidents.

Terminology to Represent Emergency Response Capability

To avoid confusion with other terms, such as "levels" or "ratings," specific capabilities are defined in Response Capability *Tiers* beginning with a standard baseline of operations capabilities. NFPA Standard 472 (2008 Edition) defines Operations Level Responders as those "who respond to hazmat incidents for the purpose of implementing or supporting actions to protect nearby persons, the environment, or property from the effects of the release." Operations Level Responders are the core components of an effective response.

Beyond the baseline capability, four Response Capability Tiers are defined that advance from Tier 1, the lowest capability, to Tier 4, the highest capability. The combination of technician-level responders determines whether a hazmat response team meets the requirements of a specific tier as defined in the next section of this Guide.

As mentioned above, the capabilities of any resource are based upon how that resource is organized, trained, certified, equipped, exercised, evaluated, and sustained. The approach in this Guide is to assess capabilities against existing standards whenever possible. An analysis of existing resource typing initiatives by DHS/FEMA showed that:

- Only some elements of public safety-based hazmat response had accepted, consensus-based definitions; and
- These definitions applied to only high levels of capability and capacity that were above the established minimum standards in NFPA Standard 472 (2008 Edition) and 29 CFR 1910.120Q.

The tier concept was used to define emergency response capabilities to ensure that all levels of response were addressed consistently. This approach is consistent with the FEMA typed resource definitions for the national level, but includes other elements such as casualty decontamination and the baseline level of response capability discussed earlier. In addition, the term *tier* is not used in other contexts to denote emergency response capability. However, *class* and/or *level* are used in other contexts. For example, jurisdictional classes and levels are used to classify the capabilities of jurisdictions and technical, operational, and supervisory levels are used for assessing emergency response performance.

This Guide generally classifies environmental and occupational/industrial response teams in the baseline tier, but these teams should be assigned to a higher tier if they meet the corresponding specifications. The baseline tier would also be appropriate for traditional public safety hazmat response teams without technician-level training, certification, and supporting equipment. Appendix D contains more information on the development of the capability assessment process.

For the purposes of this Guide, a fundamental assumption is that your jurisdiction has adopted the NIMS to facilitate the common exchange of information, services, and resources across jurisdictional boundaries. This NIMS component includes the standard planning and preparedness concepts in the Comprehensive Preparedness Guide 101 (FEMA 2009) as well as the adoption of the ICS, the Unified Command System (UCS), and the Multi-Agency Coordination System (MACS). This Guide recognizes that adoption of NIMS is not consistent across federal, state, tribal, and local governments, especially not at the local level, where federal funding streams, which carry with them the mandate for NIMS compliance, may not always drive the recommended changes in the specified time period.

Defining Emergency Response Capability Tiers

Table 2 identifies requirements for the emergency response capability tiers organized by different types of testing and response equipment, training, and sustainability.

Table 2. Hazmat response team capability tiers.

Capability[1] Tier		Baseline	1	2	3	4
FEMA Resource Type (Equivalent)		N/A	N/A	III	II	I
Highest Team Certification[2] (Operations or Technician)		Ops	Ops/ Tech	Tech	Tech	Tech
Field Testing[3]						
	Presumptive Identification – Chemical		X	X	X	X
	Presumptive Identification – Radiological		X	X	X	X
	Presumptive Identification – Biological				X	X
	Presumptive Identification – Spec. Chemicals[6]					O

Table 2. (Continued).

Capability[1] Tier	Baseline	1	2	3	4
FEMA Resource Type (Equivalent)	**N/A**	**N/A**	**III**	**II**	**I**
Air Monitoring[3]					
Atmospheric Monitoring – Oxygen	X	X	X	X	X
Atmospheric Monitoring – Explosive Gas	X	X	X	X	X
Atmospheric Monitoring – CO	X	X	X	X	X
Atmospheric Monitoring – H_2S	X	X	X	X	X
Atmospheric Monitoring – Flammable Diff.[7]			X	X	X
Atmospheric Monitoring – Identify TIC[8]				X	X
Atmospheric Monitoring – Identify Conc.[9]					X
Sampling[3]					
Sampling – Solid		X	X	X	X
Sampling – Liquid			O	X	X
Sampling – Air/Vapor			O	O	X
Radiation Monitoring[3]					
Survey – Gamma		X	X	X	X
Survey – Gamma & Beta				X	X
Survey – Gamma, Beta, & Alpha					X
Personal Dosimeters[10]			X	X	X
Protective Ensembles[3]					
Liquid Splash-Protective CPC[11]	X	X	X	X	X
Vapor-Protective CPC[12]				X	X
Flash Fire Vapor-Protective CPC[13]					X
Level C PPE[14]	X	X	X	X	X
Level B PPE[14]			X	X	X
Level A PPE[14]			X	X	X
Technical Reference[3]					
Printed & Electronic	X	X	X	X	X
Dispersion Modeling with Map Overlays			X	X	X
Special Capabilities[3]					
Specialized Equipment Based upon Local Risk			X	X	X
Heat Sensing Capability				X	X
Light Amplification Capability				X	X
Digital Imaging Documentation Capability					X
Intervention[3]					
Dike, Dam, & Absorption Capability	X	X	X	X	X
Liquid Leak Intervention				X	X
Neutralize, Plug, & Patch Capability				X	X
Vapor Leak Intervention				X	X
Advanced Intervention Capabilities[15]					X

(continued on next page)

Table 2. (Continued).

Capability[1] Tier		Baseline	1	2	3	4
FEMA Resource Type (Equivalent)		**N/A**	**N/A**	**III**	**II**	**I**
Decontamination[3]						
	Team Decontamination – Known	X	X	X	X	X
	Team Decontamination – Known & Unknown				X	X
	Team Decontamination – Advanced					X
	Casualty Decontamination (100 patients/hr)			X	X	X
	Casualty Decontamination (250 patients/hr)				X	X
	Casualty Decontamination (500+ patients/hr)					X
Communications[3]						
	In-Suit, Wireless Voice	X	X	X	X	X
	Wireless Data				X	X
	Secure Wireless Voice					X
Staffing[4]						
	Hazmat Incident Commander	X	X	X	X	X
	Hazmat Safety Officer	X	X	X	X	X
	No Technician-level Capability	X				
	Minimum of 2 out, 2 in, 2 to Decon		X	X	X	X
	More than 6 Hazmat Technicians			X	X	X
Training[3]						
	Awareness Level (NFPA 472)	X	X	X	X	X
	Operations Level (NFPA 472)	X	X	X	X	X
	Technician Level (NFPA 472)		X	X	X	X
	Specialist Level (NFPA 472)					
	Incident Commander (NFPA 472)	X	X	X	X	X
Sustainability[5]						
	No Technician-level Entries	X				
	Less than 3 Entries within 24-Hour Period		X			
	3 Entries within 24-Hour Period			X		
	5 Entries within 24-Hour Period[16]				X	
	10 Entries within 24-Hour Period[16]					X
	Casualty Decon for 6-Hour Period[17]	X	X			
	Casualty Decon for 12-Hour Period[17]			X	X	
	Casualty Decon for 12+-Hour Period[17]					X

Key

X – Required minimum capability

O – Optional capability

Notes

[1]Capability Value – The value to insert into the risk equation for capability. The higher the value, the greater the capability mitigates the risk.

[2]Certification – Based upon 29 CFR 1910.120Q or NFPA Standard 472 (2008 Edition) as determined by jurisdiction.

[3]Metric – From FEMA (2005). Limitations include (1) focused solely on Hazmat Entry Team versus complete Hazmat Response Capability required to manage casualties as well as conduct testing, monitoring, and sampling and (2) focused on National-level resources *exceeding* minimum standards (hence the addition of Baseline and Tier 1 capability sets).

Table 2. (Continued).

[4]Staffing – Additional details provided due to the increase of scope to include Operations-level units, casualty decontamination operations, & Hazmat Response Teams below the FEMA Type III resource definition.

[5]Sustainability – Additional capabilities listed to include Operations-level capability & sustained entries over FEMA 508-4 minimum.

[6]Specialized Chemicals – As defined by FEMA 508-4 (20 July 2005).

[7]Flammable Gas Differentiation – As defined by FEMA 508-4 (20 July 2005).

[8]Presumptive Identification of Toxic Industrial Chemicals (TIC) – As defined by FEMA 508-4 (20 July 2005).

[9]Presumptive Identification of Hazardous Material Concentration – As defined by FEMA 508-4 (20 July 2005).

[10]Personal Dosimeters – As defined by FEMA 508-4 (20 July 2005).

[11]Liquid Splash-Protective chemical protective clothing (CPC) – As defined by FEMA 508-4 (20 July 2005).

[12]Vapor-Protective CPC – As defined by FEMA 508-4 (20 July 2005).

[13]Flash Fire Vapor-Protective CPC – As defined by FEMA 508-4 (20 July 2005).

[14]Level A-C personal protective equipment (PPE) – As defined by 29 CFR 1910.120Q.

[15]Advanced Intervention Capabilities – As defined by FEMA 508-4 (20 July 2005).

[16]Entry Capabilities – Expanded beyond FEMA 508-4 minimum.

[17]Casualty Decontamination Capabilities – Additional metric due to expansion of scope from Hazmat Entry to Hazmat Response.

Determining Your Teams' Capability Tiers

Step 1

Specify the tier level for **each** team or group of resources in your jurisdiction. Some groups might know their current tier level and, if so, there is no need to reevaluate it. If this is the case, enter the tier and proceed to the next step. If the tier level is not known, go through Table 2 row by row, and identify the tier at which the team or group performs for that row (as described in Step 2). You may wish to include mutual-aid organizations in your assessment of your emergency response capabilities.

Step 2

Start with the Tier 4 column on the right and, moving leftward, assign the response team or group of resources to the first tier for which all the listed performance measures are met. For example, moving down the rows for Field Testing, a team that has Presumptive Identification capabilities for only chemicals and radiological materials (not biological) at most would be classified as a Tier 2 team.

If you use the spreadsheet assessment tool, answer yes or no on each line. The results are automatically tabulated at the bottom of the table. The highest tier that meets all the assessment objectives for that tier is the tier level for the team. The tier level assigned in this step will be considered the current performance level for the assessment area. In Chapters 3 and 7, shortfalls in these capabilities will be identified.

CHAPTER 3

Defining Your Jurisdictional Emergency Response Objectives

To effectively quantify your jurisdiction's emergency response requirements, you should first identify the performance objectives for response appropriate for your jurisdiction. Performance objectives in this context represent a set of minimally acceptable standards for response time, capabilities, equipment, training, skill level, etc. that should be achieved in order to support the execution of a hazardous material emergency response.

To assist with establishing response performance objectives suitable for your jurisdiction, this Guide utilizes an approach that aligns the size and type of your jurisdiction with a standardized set of objectives (articulated in terms of specific personnel, training, and equipment) appropriate for response to seven different categories of hazardous material releases. This approach is based on the DHS pre-decision draft document (2009).

The following sections will assist you with determining your Jurisdictional Class (a function of your jurisdiction's size and type) and then present a set of associated performance objectives for response for your review and acceptance.

Determining Your Jurisdictional Class

Jurisdictional Class refers to the categorization of jurisdictions based on population characteristics. A jurisdiction's population demographics are correlated with its performance objectives for response (i.e., a jurisdiction with a population of less than 10,000 people would not be expected to have the same response objectives as a city with more than 1 million people).

Step 3

Utilizing Table 3, identify your Jurisdictional Class designation. When evaluating population and population density, use the extent of your planning area, whether this encompasses one or multiple jurisdictions (i.e., municipalities, areas, etc.). Adjust your population calculations to include tourist and commuter populations as you deem appropriate.

Establishing Your Performance Objectives

Tables 4 through 8 present performance objectives for response based on a specific Jurisdictional Class designation. The tables are organized such that the performance objectives are found in cells at the intersection of Target Outcome categories (rows) and Incident Release Type (columns).

Target Outcomes have been categorized into five response preparedness activities:

1. Conducting an on-scene hazard and risk **Assessment**;
2. **Managing** the hazmat rescue operations;
3. **Rescuing** the affected persons;

Table 3. Jurisdictional Classes for defining performance objectives.

Criteria	Jurisdictional Class				
	Class Five	Class Four	Class Three	Class Two	Class One
Population and Population Density Thresholds	Population of less than 10,000	Population of 10,000 to 100,000 - OR - Population of less than 10,000 and Population Density greater than 1,000 persons/sq.mi.	Population of 100,000 to 500,000 - OR - Population of 10,000 to 100,000 and Population Density greater than 2,500 persons/sq.mi.	Population of 500,000 to 1.5 million - OR - Population of 100,000 to 500,000 and Population Density greater than 5,000 persons/sq.mi.	Population of greater than 1.5 million - OR - Population of greater than 500,000 and Population Density greater than 10,000 persons/sq.mi.

4. **Controlling** the hazard; and
5. **Decontaminating** affected persons.

Performance objectives for each Target Outcome (preparedness activity) may vary depending on the material involved. For example, performance objectives for decontamination are different for a material that poses a fire hazard versus one that is radioactive. This variance in objectives is handled by utilizing the Incident Release Type categorization scheme. In general, each of the seven Incident

Table 4. Jurisdictional Class 5—performance objectives.

Target Outcome for Jurisdictional Class 5	Performance Objectives for Jurisdictional Class 5						
	Fires	Explosions or BLEVEs	Toxic Gas Releases	Toxic Liquid Releases	Corrosives	Radioactive Material Releases	Biologically Active Material Releases
Assess	▪ Respond in less than 5 minutes following initial response ▪ Begin to conduct on-scene hazard & risk assessment ▪ Analyze incident (based on quantity & quality) ▪ Select appropriate PPE (personal protective equipment)						
Manage	▪ Respond in less than 60 minutes – with branch director/group supervisor – with Tier 1 team ▪ Plan the response & implement ▪ Assign personnel duties						
Rescue	▪ Respond in less than 60 minutes – with trained and equipped personnel that can rescue and physically remove within 60 minutes						
	– 1 non-ambulatory affected person – Use PPE & safety equipment	– 5 non-ambulatory affected persons – Use PPE & safety equipment					
Control	▪ Respond in less than 90 minutes upon request (if needed) – with one Tier 1 team – with access to at least one Tier 3 or 4 team – with appropriate safety equipment, including proper respiratory protection equipment ▪ Identify control options and implement appropriate ones						
Decon (Spill or Leak)	▪ Be capable of decontaminating the emergency response entry team						

Table 5. Jurisdictional Class 4—performance objectives.

Target Outcome for Jurisdictional Class 4	Performance Objectives for Jurisdictional Class 4						
	Fires	Explosions or BLEVEs	Toxic Gas Releases	Toxic Liquid Releases	Corrosives	Radioactive Material Releases	Biologically Active Material Releases
Assess	▪ Respond in less than 5 minutes following initial response ▪ Begin to conduct on-scene hazard & risk assessment ▪ Continue to update for multiple operational periods ▪ Analyze incident (based on quantity & quality) ▪ Select appropriate PPE ▪ Select monitoring & sampling equipment						
Manage	▪ Respond in less than 45 minutes – with branch director/group supervisor – with Tier 2 team ▪ Plan the response & implement ▪ Assign personnel duties						
Rescue	▪ Respond in less than 10 minutes – with trained & equipped personnel that can rescue and physically remove within 30 minutes						
	– 5 non-ambulatory affected persons – Use PPE & safety equipment	– 10 non-ambulatory affected persons – Use PPE & safety equipment					
Control	▪ Respond in less than 60 minutes upon request (if needed) – with one Tier 2 team – with access to at least one Tier 3 or 4 team – respond with the proper personal protective equipment ▪ Identify control options and implement appropriate ones						
Decon (Spill or Leak)	▪ Be able to decontaminate hazardous material entry team and 100 patients per hour per Tier 2 Requirements per Table 2						

Release Type categories represents a potential hazard posed from a hazardous material release. Within Tables 4 through 8, the Incident Release Type categories covered by the objectives are found in the table header. Chapter 4 will provide more information on Incident Release Types.

The performance objectives for your Jurisdictional Class will ultimately be used to assess your jurisdiction's ability to execute each Target Outcome. While the performance objectives outline the goals for a response preparedness activity, the jurisdiction determines how to achieve each of these goals, and the incident commander determines how to respond to specific incidents.

Step 4

Use the Jurisdictional Class specified in Step 3 to determine the appropriate table below (there is one for each Jurisdictional Class) and review the potential performance objectives for your jurisdiction. During your review, keep in mind that your jurisdiction can deliver any given capability through a mutual-aid agreement and/or regional collaboration. You should also review the performance objectives for other Jurisdictional Classes that might be more appropriate to your situation (see Step 5).

Step 5

After reviewing the performance objectives, select the Jurisdictional Class that best fits the performance objectives you selected. The Jurisdictional Class might be higher or lower than the class you selected in Step 3, which was based solely on population. Your jurisdiction might

Table 6. Jurisdictional Class 3—performance objectives.

Target Outcome for Jurisdictional Class 3	Performance Objectives for Jurisdictional Class 3						
	Fires	Explosions or BLEVEs	Toxic Gas Releases	Toxic Liquid Releases	Corrosives	Radioactive Material Releases	Biologically Active Material Releases
Assess	▪ Respond in less than 5 minutes following initial response ▪ Begin to conduct on-scene hazard & risk assessment ▪ Continue to update for multiple operational periods ▪ Analyze incident (based on quantity & quality) ▪ Select appropriate PPE ▪ Select monitoring, sampling & plume modeling equipment						
Manage	▪ Respond in less than 30 minutes – with branch director/group supervisor – with Tier 3 team ▪ Plan the response & implement ▪ Assign personnel duties						
Rescue	▪ Respond in less than 10 minutes – with trained & equipped personnel that can rescue and physically remove within 30 minutes						
	– 10 non-ambulatory affected persons – Use PPE & safety equipment	– 50 non-ambulatory affected persons – Use PPE & safety equipment					
Control	▪ Respond in less than 45 minutes upon request (if needed) – with one Tier 3 team – with access to at least two Tier 3 or 4 teams – with the proper personal protective equipment ▪ Identify control options and implement appropriate ones						
Decon (Spill or Leak)	▪ Be able to decontaminate hazardous material entry team and 250 contaminated persons per hour – a Tier 3 requirement per Table 2						

have critical infrastructure, facilities with special populations, monuments or icons of national significance, or other community-specific factors that might warrant a higher response capability (Jurisdictional Class). Your selected Jurisdictional Class will impact the desired response capabilities in a later step.

The Jurisdictional Class selected in Step 5 can be related back to a tier-level capability requirement listed in Table 2. This relationship is shown in Table 9. For three of the five target outcomes—Manage, Control, and Decon—the requirements of the selected Jurisdictional Class can be related directly to a tier level's requirements. The exceptions are the Assess and Rescue outcomes, for which the Jurisdictional Class requirements have no corresponding tier-level requirement. Since the Jurisdictional Class target outcomes for Manage, Control, and Decon in Table 4 match the tier-level goals, the target outcomes for Assess and Rescue in Table 4 are considered target goals. Thus, to meet the Assess target outcome for a specific tier level, the emergency response team is to respond in 5 minutes, conduct on-scene hazard and risk assessments, analyze the incident, and select the appropriate PPE. The remaining Jurisdiction Classes add requirements to the baseline. Similarly, the Rescue outcome goals listed in Table 4 are considered tier-level target goals. In Table 9, because it is necessary to impose additional tier-level performance requirements for the Assess and Rescue outcomes, the tier-level assignments have been given an asterisk to indicate the augmented requirements needed to meet the Jurisdictional Class target outcomes. In Table 9 there are two criteria shown for Rescue: one for the fire hazard and the one for all other hazard classes.

In most cases, it would be expected that you would select the Jurisdictional Class based on the population in the area being assessed, as shown in Table 3. However, as noted earlier, you can

Table 7. Jurisdictional Class 2—performance objectives.

<table>
<tr><th rowspan="2">Target Outcome for Jurisdictional Class 2</th><th colspan="7">Performance Objectives for Jurisdictional Class 2</th></tr>
<tr><th>Fires</th><th>Explosions or BLEVEs</th><th>Toxic Gas Releases</th><th>Toxic Liquid Releases</th><th>Corrosives</th><th>Radioactive Material Releases</th><th>Biologically Active Material Releases</th></tr>
<tr><td>Assess</td><td colspan="7">▪ Respond in less than 5 minutes following initial response
▪ Begin to conduct on-scene hazard & risk assessment
▪ Continue to update for multiple operational periods
▪ Analyze incident (based on quantity & quality)
▪ Select appropriate PPE
▪ Select monitoring, sampling & plume modeling equipment</td></tr>
<tr><td>Manage</td><td colspan="7">▪ Respond in less than 30 minutes
– with branch director/group supervisor
– with Tier 4 team
▪ Plan the response & implement
▪ Assign personnel duties</td></tr>
<tr><td rowspan="2">Rescue</td><td colspan="7">▪ Respond in less than 10 minutes
– with trained & equipped personnel that can rescue and physically remove within 30 minutes</td></tr>
<tr><td>– 20 non-ambulatory affected persons
– Use PPE & safety equipment</td><td colspan="6">– 100 non-ambulatory affected persons
– Use PPE & safety equipment</td></tr>
<tr><td>Control</td><td colspan="7">▪ Respond in less than 30 minutes upon request (if needed)
– with one Tier 4 team
– with access to at least four Tier 3 or 4 teams
– with the proper personal protective equipment
▪ Identify control options and implement appropriate ones</td></tr>
<tr><td>Decon (Spill or Leak)</td><td colspan="7">▪ Be capable of decontaminating hazardous material entry team and 500 additional people per hour – a Tier 4 requirement per Table 2</td></tr>
</table>

choose the performance measures associated with a higher or lower Jurisdiction Class (Step 5). Once selected, if the tier-level capability for the emergency response team in the area being assessed using Table 2 is different from those shown in Table 9, then there is a shortfall in the capabilities of the area's emergency response team. This gap is identified here and discussed further in Chapter 8; this gap, if any, will be combined with the shortfalls resulting from the severity of the potential consequences initially identified in Chapter 5 and identified as a gap in Chapter 7.

Table 9 summarizes all the goals by tier level. By expanding the definition of the tier levels to include these goals, the analyses that follow will be greatly simplified. Consequently, if there is a requirement to perform at the Tier 2 level, the requirements will include both the Tier 2 goals as defined in Table 2 plus the Tier 2* goals defined in Table 9.

Step 6

Using the goals in Table 9, identify any shortfalls in the current Tier Response Level for the area's emergency response team based on the selected Jurisdiction Class. (This gap will be carried into Chapter 8.)

As described in the introduction, if you find a gap after this step, you might choose to stop the assessment at this point and work on addressing this gap. If you carry the gap into the next steps, it will likely widen with each subsequent step.

Table 8. Jurisdictional Class 1—performance objectives.

Target Outcome for Jurisdictional Class 1	Performance Objectives for Jurisdictional Class 1						
	Fires	Explosions or BLEVEs	Toxic Gas Releases	Toxic Liquid Releases	Corrosives	Radioactive Material Releases	Biologically Active Material Releases
Assess	▪ Respond in less than 5 minutes following initial response ▪ Begin to conduct on-scene hazard & risk assessment ▪ Continue to update for multiple operational periods ▪ Analyze incident (based on quantity & quality) ▪ Select appropriate PPE ▪ Select monitoring, sampling & plume modeling equipment						
Manage	▪ Respond in less than 30 minutes – with branch director/group supervisor – with Tier 4 team ▪ Plan the response & implement ▪ Assign personnel duties						
Rescue	▪ Respond in less than 10 minutes – with trained & equipped personnel that can rescue and physically remove within 30 minutes						
	– 50 non-ambulatory affected persons – Use PPE & safety equipment	– 200 non-ambulatory affected persons – Use PPE & safety equipment					
Control	▪ Respond in less than 30 minutes upon request (if needed) – with one Tier 4 team – with access to at least four Tier 3 or 4 teams – with proper personal protective equipment ▪ Identify control options and implement appropriate ones						
Decon (Spill or Leak)	▪ Be able to decontaminate hazardous material entry teams and more than 500 people per hour – a Tier 4 requirement per Table 2						

Table 9. Response Capability Tiers based on Jurisdiction Class.

Target Outcome	Response Capability Tier by Jurisdiction Class				
	Class Five	Class Four	Class Three	Class Two	Class One
Assess	Baseline	Tier 2* Baseline plus monitoring and sampling equipment, sustain over multiple operating periods	Tier 3* Tier 2* goals plus plume modeling equipment	**Tier 4*** **Tier 3* goals plus plume modeling equipment**	**Tier 4*** **Tier 3* goals plus plume modeling equipment**
Manage	Tier 1	Tier 2	Tier 3	**Tier 4**	**Tier 4**
Rescue (hazard dependent)	Tier 1* Fire: 1 Person/hr Other Hazards: 5 persons/hr	Tier 2* Fire: 5 Persons/hr Other Hazards: 10 persons/hr	Tier 3* Fire: 10 Persons/hr Other Hazards: 50 persons/hr	**Tier 4*** **Fire: 20 Persons/hr Other Hazards: 100 persons/hr**	**Tier 4*** **Fire: 20 Persons/hr Other Hazards: 100 persons/hr**
Control	Tier 1	Tier 2	Tier 3	**Tier 4**	**Tier 4**
Decon	Baseline	Tier 2	Tier 3	**Tier 4**	**Tier 4**

*Augmented requirements needed to meet target outcome.

CHAPTER 4

Identifying Hazardous Materials in Your Jurisdiction

Your goal in this chapter is to identify the set of hazmat potentially present within your jurisdiction. Effectively, you will inventory (at varying levels) hazmat at each of the facilities and along transportation routes within your jurisdiction. This process is referred to as performing a hazard survey.

Before starting the hazard survey process, the hazmat that are of concern for this assessment will be specified. Then, these hazmat will be categorized into Incident Release Types based on their associated required response characteristics. This information will be beneficial in helping you frame the layout of your hazard survey.

Hazardous Materials Covered

To provide manageable boundaries for the materials covered by this assessment process, this Guide limits the scope of materials to those that are transported commercially under the auspices of the U.S.DOT Hazardous Materials Regulations as found in 49 CFR. This scope includes the storage of materials incidental to transportation (including at facilities at both the origin and destination), as well as along any transportation corridors. Henceforth, materials of concern are referenced throughout this Guide in terms of their U.S.DOT hazard classification designation versus the use of a specific material name.

Material Categorization—Incident Release Types

The U.S.DOT hazard classification scheme (e.g., Class 1, Division 2.1, etc.) categorizes materials based primarily on packaging requirements. For the purposes of this Guide and the subsequent evaluation of emergency response requirements, materials in the U.S.DOT hazard classes and subdivisions are aggregated into the seven Incident Release Type categories defined earlier and listed below. The Incident Release Type categorization scheme focuses on the types of hazards (i.e., fire, explosion, etc.) that a material might pose if a release were to occur. The seven Incident Release Type categories are as follows:

- Fires;
- Explosions or BLEVEs;
- Toxic gas releases;
- Toxic liquid releases;
- Corrosives;
- Radioactive materials releases; and
- Releases of biologically active materials.

By grouping the materials into these hazard categories, performance objectives for response can be established based on the characteristic of each Incident Release Type.

Table 10 matches each U.S.DOT Hazard Class to its corresponding Incident Release Type(s).

Table 10. Material Incident Release Type groupings.

U.S.DOT HAZARD CLASSIFICATION	Incident Release Types						
	Fire	Explosion or BLEVEs	Toxic Gas	Toxic Liquid	Corrosives	Radioactive Material	Biological
Class 1 – Explosives	**X**	**X**					
Division 1.1 Explosives with a mass explosion hazard	X	X					
Division 1.2 Explosives with a projection hazard	X	X					
Division 1.3 Explosives with predominantly a fire hazard	X	X					
Division 1.4 Explosives with no significant blast hazard	X	X					
Division 1.5 Very insensitive explosives with a mass explosion hazard	X	X					
Division 1.6 Extremely insensitive articles	X	X					
Class 2 – Gases							
Division 2.1 Flammable gases	X	X					
Division 2.2 Nonflammable, nontoxic* gases							
Division 2.3 Toxic* gases			X				
Class 3 – Flammable liquids	**X**	**X**		**O**			
Class 4 – Flammable solids	**X**						
Division 4.1 Flammable solids	X						
Division 4.2 Spontaneously combustible materials	X						
Division 4.3 Water-reactive substances/Dangerous when wet materials	X						
Class 5	**O**	**X**					
Division 5.1 Oxidizing substances	O	X					
Division 5.2 Organic peroxides	O	X					
Class 6	**O**			**X**			
Division 6.1 Toxic* substances	O			X			
Division 6.2 Infectious substances	O			X			X
Class 7 – Radioactive materials	**O**					**X**	
Class 8 – Corrosive substances	**O**			**X**	**X**		
Class 9 – Miscellaneous	**O**						

Key:
* The words "poison" or "poisonous" are synonymous with the word "toxic."
X = Primary consequence of concern
O = Secondary consequence of concern

Note that the mapping of U.S.DOT Hazard Class to Incident Release Types is not a 1:1 relationship. For example, a U.S.DOT Hazard Class 1, Division 1.1 material described as an "Explosive with a mass explosion hazard" can present both a Fire and/or Explosion release hazard, and thus Hazard Class 1 materials are found in two different Incident Release Type categories. The following summarizes the U.S.DOT Hazard Class to Incident Release Type relationship:

- Fires (U.S.DOT Classes 1, 3, 4, Division 2.1, and some Class 5, 6, 7, and 8 materials where flammability is not the primary hazard);

- Explosions or BLEVEs (U.S.DOT Classes 1, 3, 5, and Division 2.1);
- Toxic gas releases (U.S.DOT Division 2.3);
- Toxic liquid releases (U.S.DOT Classes 6 and 8 and some Class 3 materials where toxicity is not the primary hazard);
- Corrosives (U.S.DOT Class 8);
- Radioactive materials releases (U.S.DOT Class 7); and
- Release of biologically active materials (U.S.DOT Division 6.2).

Performing a Hazard Survey

A fundamental component of the planning process is the identification of the hazmat and quantities within your jurisdiction. This involves identifying the facilities that manufacture, store, or use hazmat and the routes over which hazmat are transported.

There are numerous sources of information for acquiring information needed in the hazard survey. This Guide focuses on the information collected by the LEPCs and their higher, state-level SERCs. This includes the SARA Title III Tier I/II data submitted to the SERC and LEPCs [29 CFR 1910.119] and the Facility Risk Management Plan (RMP) [40 CFR Part 68] data submitted to LEPCs. You may be able to collect a significant portion of this information from existing products or prior efforts (such as RMP data or commodity flow surveys). Even if a facility does not have a hazmat inventory that requires it to be covered by the above regulations, many facilities share their hazardous material inventory information with the local fire marshal or fire chief so those departments can become part of the response team in the event of an emergency at the facility. Using these sources you can develop a list of hazards at area facilities.

The volumes and frequency of hazmat being transported though the region often cannot be obtained from local sources. If there is a major rail line passing through the area, the railroad typically will provide information on the hazardous material it transports, if requested. For highway transportation, if there is a weigh station along the route, the state agency performing hazmat truck inspections may be willing to tabulate the types and number of placarded vehicles being inspected. If the agency is unwilling, an alternative is to place data collectors at the weigh station or some other convenient location and tabulate the types and number of placarded shipments passing through the area.

The following is a comprehensive list of agencies and organizations outside the local area that may have relevant information to assist in preparing a hazard inventory for a jurisdiction. A detailed list of information from each type of source is included in Appendix A.

Additional Sources of Information

Regulatory Agencies

A number of federal regulatory agencies require filings and submissions on hazmat related to their regulated entities. These include reporting on stored materials, planned transportation routes (for some materials), and unintentional releases. Reports include both telephonic and paper/electronic reporting. These agencies include the Environmental Protection Agency (EPA), the U.S. Coast Guard, the Pipeline and Hazardous Materials Safety Administration (PHMSA), the National Response Center, the Department of Energy, the Nuclear Regulatory Commission, the U.S. Army Corps of Engineers, and others.

Associations and Nonprofits

Associations and not-for-profit/nonprofit organizations representing both the shipping and transportation communities can be good sources of hazmat information. These include the Association of American Railroads, the American Trucking Associations (and their state affiliates), the National Industrial Transportation League, and the Dangerous Goods Advisory Council.

State Emergency Management Agencies

Many state emergency management agencies have conducted studies to capture useful information, such as local or regional hazmat commodity flow studies. Entities considering their own commodity flow studies should consult the guidance provided by HMCRP Project 01, "Hazardous Materials Commodity Flow Data and Analysis" (Texas A&M University 2010).

Other State and Local Agencies

Many state and local agencies deal with hazmat and may be a source for additional information beyond the LEPC. These include state police or highway patrol agencies, state bomb squads, state fire marshals, state environmental protection agencies, local emergency management agencies, and local fire and emergency services agencies.

Transportation Companies

While commercial motor carriers are too numerous to contact them all directly, individual railroads, pipeline operators, and barge companies may be able to provide information on the hazmat they move through specific jurisdictions.

Documentation—Creating a Hazardous Materials Portfolio

A big question for planning agencies gathering information on hazmat in their jurisdictions is the level of detail needed to support planning efforts. Information should be captured at the specific material level, but many of the subsequent steps in the planning effort rely on aggregating specific materials into the primary Incident Release Types discussed earlier in this chapter. This allows you some flexibility in incorporating specific characteristics of the material in potential consequence assessment, needed response capabilities, etc. The key data elements needed for each material stored at each location are:

- Location where material is stored or transported (facility or route);
- Material name (such as U.S.DOT proper shipping name or trade name);
- Incident release type (principal hazard); and
- Quantity present at any given time (can record more than one level if, for example, the average is fairly low but on some occasions the amount present is quite large).

Step 7

Create a framework for capturing the hazard survey data, such as using the assessment tool or a spreadsheet with the format shown in Table 11 for the first four columns. Each row in the spreadsheet would contain a unique combination of hazardous material, location, and quantity. You may also want to capture additional information for each row, such as the source of the

Table 11. Sample spreadsheet format for collecting hazard survey data.

Facility or Route	Material	Hazard [H]	Quantity (incl. units)	Shipments per Month
Facility Y	Ethylene oxide	Fire	8,000 lbs.	20
Interstate Z	Chlorine	Toxic Gas Release	30,000 lbs.	10

information, contact information for updates, the container or packaging used, etc., although this information is not needed for the methodology used in this Guide. If the assessment tool is used, any scenarios identified with this step will be carried through all the subsequent steps. This tool can be updated easily.

The framework in Step 7 is called the hazardous materials *portfolio.* Each row in the portfolio identifies a potential hazard in the region that requires consideration in your emergency response planning.

Facilities (Fixed Sources)

When collecting data on specific facilities containing hazmat, consider the types of businesses listed in Table 12. Also consider abandoned facilities that may still contain sufficient quantities of hazmat to be a concern. A community may have many other types of fixed-location hazmat, such as dry cleaners and gas stations, among others. Knowing the specific location of each of these facilities is not as important as knowing that they are commonly found in the community. However, it is difficult to aggregate all hazmat locations of a certain type, because the potential consequences from and the response time to an incident are tied directly to the actual geographic location.

Step 8

Add new rows to the hazardous materials portfolio for each material stored at each facility in your jurisdiction. When adding hazards to Table 11 for materials at fixed location sources, the "Shipments per Month" column would be left blank. If the hazardous material were only present occasionally, a percentage of the time during the year the material might be present could be placed in a "Shipments per Year" column.

Transportation Corridors (Mobile Sources)

When considering transportation routes, the best information would be from a recent local commodity flow survey, particularly for highway transportation. If no such survey has been done, planning organizations should consider resources available to them and consider commissioning such a study. If an interstate highway falls in the jurisdiction of the LEPC, the information obtained from companies will probably have to be supplemented by such a survey because a large number of placarded vehicles would traverse the region without ever stopping. The number and quantity of material shipped across the region would be unknown without the survey.

Table 12. Facilities that may contain hazardous materials.

Industrial Facilities	Select Retailers
Chemical plants	Agricultural
Refineries	Swimming pool suppliers
Petroleum and natural gas tank farms	Home supply stores
Drinking water plants	Dry cleaners
Wastewater treatment plants	
Nuclear facilities	
Waste disposal and treatment facilities	
Refrigeration plants (ammonia)	
Hospitals and academic/government facilities	
Storage facilities/distribution centers/warehouses/tank farms	

As mentioned earlier, guidance for conducting local commodity flow surveys was prepared under HMCRP Project 01 (Texas A&M University 2010). While most jurisdictions focus on highway and rail transportation—with information on the top hazmat shipped by rail obtained directly from the railroads—it is important to consider other modes as well. Marine transportation of hazmat can be significant in some areas. Generally, one barge equals approximately 46 rail tank cars, which equals about 144 truck cargo tanks. Pipelines carry hazardous liquids or natural gas and are distributed throughout the country. Pipeline companies or U.S.DOT's Office of Pipeline Safety are good sources of information for response planning.

For specific hazards, such as shipments of Highway Route-Controlled Quantities (HRCQ) of radioactive materials, in addition to providing assistance at the technical level when the incident occurs, the national-level agencies provide specialized training and equipment to assist local emergency response organizations, especially at the planning and assessment levels. For HRCQ shipments, a state's governor is notified 24 hours prior to the shipment so state agencies are aware of the shipments and their routes. This notification alerts the SERCs of their presence in the state. The state may choose to notify local emergency responders and place them on alert as well. This negates the need to discover such infrequent shipments using commodity flow surveys.

You should also consider fixed locations where hazmat may temporarily be found during their movement from origin to destination. At these locations, the material would remain contained inside the vehicle used to transport it—distinguishing these locations from the fixed locations discussed earlier. These locations include intermodal transfer facilities, rail yards, airports, ports, docks, truck terminals, and major truck stops, as well as rest areas that trucks commonly use.

Step 9

Add new rows to the hazardous materials portfolio for each material transported along each transportation corridor in your jurisdiction. For these rows, add information on the typical quantity of hazmat in a package, the estimated number of packages transported per year, and the length of the transport link. Remember to include all modes of transportation. For pipelines, use total length, commodities being transported, diameter, and operating conditions (e.g., temperature and pressure). Initially, you might address the hazmat that are most prevalent in the area or region. Subsequent assessments might address additional hazmat, gradually making the assessment more comprehensive.

CHAPTER 5

Potential Consequences of Incidents Involving the Identified Hazardous Materials

Once you have determined which hazmat are present in your jurisdiction, either at fixed facilities or along transportation corridors, you need to assess the potential consequences that would result from an incidental or intentional release of those materials. Since you have an idea of the quantities present in each location, you can use this information to help determine the potential impacts from a complete release. The Guide builds on the hazardous materials portfolio and adds columns to address potential consequences.

Defining Consequences

The *potential consequences* term is a measure of the potential impacts to the population or environment from a release of hazmat. There are many factors to consider when estimating these impacts. Since consequences to people and the environment are typically measured in different ways, this Guide uses the CARVER method to assign a relative value for the two different types of consequences. (CARVER is an acronym for criticality, accessibility, recuperability, vulnerability, effect, and recognizability and is employed by the U.S. Department of Defense.) The CARVER method uses a range of values that approximate a logarithmic scale for each measure that needs to be estimated. For both population and environmental consequences, this Guide uses values from 1 to 5 as defined in Table 13. The next section will help you determine the consequence value for each scenario in the hazardous materials portfolio.

The method of assessing consequences should be consistent with the capability of the emergency response planner or planning team. For many areas, the emergency response teams commonly use plume modeling to identify areas where precautions to protect against the release should be directed. Others might only have the most current version of the ERG (2008). The hazard distances in the ERG can be used in lieu of modeling the release, and a realistic fraction of the people exposed to the release could be expected to require medical treatment. This number can be used in conjunction with the consequence scale to conservatively estimate impacts. The following paragraphs discuss some of the approaches to addressing the consequence term. The approach selected should be the one that best matches the capability of the emergency response planning team.

These consequences are measured assuming no effective emergency response (identified above as potential unmitigated consequences). This enables the effectiveness of the emergency response to be captured in the response time and emergency response capability terms in the risk equation. For each scenario in the risk portfolio, both population and environmental consequences will be estimated and the *maximum* of the two estimates will be used in the risk equation.

Table 13. Consequence values.

Consequence Value [C]	Population	Environmental
1	no deaths or serious injuries; only relatively minor injuries	less than $1 million
2	1 to 10 deaths or serious injuries	$1 million to $10 million
3	11 to 100 deaths or serious injuries	over $10 million to $100 million
4	101 to 1,000 deaths or serious injuries	over $100 million to $1 billion
5	more than 1,000 deaths or serious injuries	over $1 billion

Estimating Consequences

Each scenario in the hazardous materials portfolio is composed of a specific material, quantity, and location. Potential consequences are dependent on the material itself, the nature of the area around the release, and atmospheric/weather conditions, particularly for human-health effects from an airborne release of toxic materials.

Material-specific effects include the nature of danger or hazard the material poses, its chemical and physical properties, the quantities released, how well and how quickly the release is contained, and the rate of a vapor release, if present. The population that might be affected is a function of the specific release location and the population density, the presence of special populations (nursing homes, hospitals, prisons, etc.), the ability to effect a proper evacuation or other mitigation strategy (such as suitable buildings for sheltering-in-place), and the time available for evacuation or sheltering-in-place. Environmental damage will be determined by land use at the release location and the presence of specific environmentally sensitive features (e.g., reservoirs, waterways, wetlands, parks). Finally, weather conditions can determine how far and at what concentration an airborne toxic plume will travel and be dispersed. These conditions include wind speed and direction, atmospheric stability class, and temperature.

While Appendix C contains more details, the following sections outline the general process for estimating potential consequences for a scenario.

Estimating Human-Health Consequences

The human-health aspect of the consequence term is quantified by estimating the number of individuals that could suffer permanent health effects from a release. This generally involves two steps: (1) determining the potentially affected area and (2) determining how many people inside that area would be killed or seriously injured. In practice, simply measuring the number of people exposed to a hazardous material is often used as a proxy for fatalities and injuries.

Determining the affected area is dependent on the type of material involved, its hazards, and how that material behaves when released from its containment or packaging. A great deal of scientific research has gone into estimating impact areas for many types of materials, and you may wish to take advantage of this prior work. The ERG and the companion Argonne Report (Kawprasert and Barkan 2010) provide lists of specific protection action distances for responders that are based on different materials. The Argonne Report is easier to use in this instance because the tables are provided by commodity and the planner does not need to use the guide number, as is the case with the ERG. Although the distances are not specifically correlated to population exposure, they provide reasonable protection distances that could be used for this Guide. Appendix C provides information on some of the modeling tools used by the developers of the ERG that you can use to determine more detailed impact areas for different quantities and concentrations of hazmat.

Table 14. Hazard distances used in NRHM Routing Guidelines.

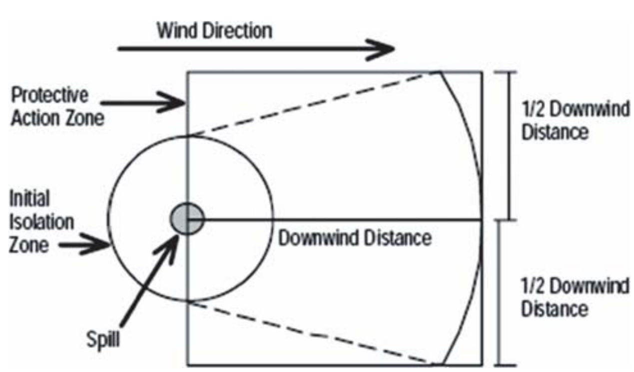
Hazmat Category	Hazard Distances (miles)
Explosives	1
Flammable Gas	0.5
Toxic Gases	5
Flammable/Combustible Liquid	0.5
Flammable Solid, Spontaneously Combustible, Dangerous when Wet	0.5
Oxidizer/Organic Peroxide	0.5
Poisonous (not gas)	5
Corrosive Material	0.5

The use of the ERG specifies protective action distances by commodity for large and small spills and for day and night releases, a total of four different distances. To use this Guide, the hazardous materials portfolio developed in Steps 7 through 9 and described in Table 11 would have to be expanded to include four different scenarios for each of the listed commodities. The users of this Guide could also use a simpler approach that was developed for the Non-Radioactive Hazardous Material Routing Guidelines (NRHM 2007). This guide uses a simpler set of hazard distances shown in Table 14. The table does not specify a distance for infectious substances or radioactive materials. Radioactive materials commonly use a 0.5-mile (800-meter) distance, and this hazard distance would also be reasonable for infectious substances.

Once you have a protective, isolation, or evacuation distance, decide how to apply that distance to determine an impact area. For initial isolation distances and for evacuations that are not focused downwind of the release, the impact area can be a circle with a radius equal to the specified distance. For protective actions and evacuations that are directed toward areas downwind of the release, you can use a square area—aligned with the release point—with a side length equal to the specified distance. This is consistent with the methodology in the ERG (2008) (see Figure 2). For a more conservative approach, you can use the larger of the initial isolation and protective action distances.

Step 10

Determine the affected area for population impacts from a potential release for each scenario in the hazardous materials portfolio. As shown in Figure 2, the affected area is the protective action distance or hazard distance squared.



Sources: ERG (2008); Brown et al. (2009)

Figure 2. Protective action area.

Determining how many people might fall within that impact area can be done in several ways. If you have detailed population data in a geographic information system, you can overlay that impact area over the population data and automatically count the population inside it. You should be aware of differences in residential (nighttime) and employment (daytime) population for the specific area. Another approach is to use average population density figures for the area (determined from Census data) and combine that with the area of potential exposure. For example, if there is a population density of 1,500 people per square mile and the protective action area or hazard area is 0.5 mile on a side, then the number of affected people would be $1{,}500 \times 0.25\ mi^2$, or 375 people. For fires, it is more appropriate to use the initial isolation zone as the impacted area, so in that case the number of affected people would be $1{,}500 \times \pi \times (50\ m/1000)^2$ or 4 individuals. Again, all of these people would not be killed or seriously injured, but this provides an estimate of potentially affected population.

Step 11

Use population density estimates or a geographic information system with population data layers to determine the potential population exposure for a potential release for each scenario. Using Table 13, specify the CARVER scale value based on the estimated number of potentially exposed individuals. Counting all the potentially exposed individuals as fatalities is very conservative, but is appropriate for this type of assessment.

Estimating Environmental Consequences

Environmental consequences can include property damage as well as land and aquatic contamination and remediation. For most hazmat incidents, the impact on the environment will be measurable but not excessively high. The emergency response planner or planning team may judge that many scenarios pose little environmental risk. These scenarios do not need to be assessed. As with population exposure, environmental consequences are determined through two steps: (1) determining the impact area and (2) determining the consequences within that area.

The impact area can be determined in the same manner as human-health consequences, by using the impact distances in the ERG. Appendix C provides additional approaches for obtaining more detailed estimates of environmental exposure areas.

Step 12

Determine the affected area for environmental impacts from a potential release for each scenario in the hazardous materials portfolio using the same methods used to estimate the affected area for population impacts.

Environmental consequences are divided into two types: property damage and land and aquatic contamination. For most materials, one of these two will be the dominant consequence category. Property damage can be assessed for hazards that have the capability of totally destroying a structure—flash fires, fires (flammable gas clouds should be considered here in addition to flammable liquids and solids), and BLEVEs or explosions—by using per-acre land values that consider the number and type of structures typically found. A fire, if not prevented from spreading, can involve nearby structures and do extensive damage. An explosion or BLEVE can do a lot of structural damage, resulting in replacement of the structure as part of the damage estimate. The hazard distance specified in the NRHM Routing Guidelines (2007) or the protective action distance specified using the ERG would provide too large an area. The initial isolation distance specified in the ERG would be more representative of the damage area from a fire or explosion. The circular area specified by this radius is the suggested area to be used to estimate damage to nearby structures. Alternatively, the dispersion code in the Areal Location of Hazardous Atmospheres model (ALOHA 2007) has an option to estimate the damage radius from fires and BLEVEs. The user only has to specify the material and the quantity present.

Table 15. Estimated per-acre values.

Area Type	Structure				Environment		
	Residential	Commercial	Industrial		Land Use	Farm Land	Wetland
Rural	$ 150,000	$ 1.2 million	$ 2.4 million		Fallow	$ 200	$ 50,000
Suburban	$ 1.2 million	$ 12 million	$ 24 million		Low-value crop	$ 1,000	$ 100,000
Urban	$ 8 million	$ 50 million	$ 80 million		High-value crop	$ 400,000	$ 400,000

For land and aquatic contamination, impacts are a concern if the released material kills plants and trees, or forms a toxic particulate that is deposited on the ground. Preventing human exposure by confiscating crops or decontaminating land or buildings would result in the greatest costs. It would be very conservative to assume that the same area used for estimating population impacts experienced some damage from the release event. The extent of land impacts is also sensitive to the type of hazard. Ammonia will do a lot of damage to a wetland because of its aquatic toxicity, but it is a beneficial fertilizer on farmland. To estimate the potentially affected area, the hazard distance from the NRHM Routing Guidelines (2007) could be used to determine the extent of the potentially affected zone and, within that zone, to estimate the fraction of the area where environmental damage could occur.

Table 15 shows representative values for different types of land use. The values shown were developed initially for a security-related assessment for another project, to estimate economic losses on a per-acre basis when the structures or habitat are essentially destroyed. These are place-holders, and you could develop your own set of land-use values for your region. Where structures would not be entirely destroyed, it might be appropriate to use 10 percent of the replacement value. This would represent replacement of windows and repair of minor structural damage. Similarly, a reasonable estimate for land and wetland contamination might also be 10 percent. Depending on the incident release type and the size of the potential incident, you may wish to adjust the percentage to a value other than 10 percent.

Step 13

Use the per-acre damage estimates in Table 15 or a geographic information system with environmental data layers to determine the potential environmental consequences for each scenario. If the risk assessment tool is used, scenarios judged to present minimal risk to structures or the environment can be shown as having a zero or low impact.

Selecting the Consequence Value

Again, the mitigating effects of emergency response coverage are not considered when determining these potential consequences. Comparing the potential population exposure and the environmental costs measured in economic terms to the values in Table 13 provides the appropriate consequence value to use. Remember to take the higher of the population and environmental values.

Step 14

For each scenario: (1) determine the consequence value in Table 13 for the potential population impacts determined in Step 11, (2) determine the consequence value in Table 13 for the potential environmental impacts determined in Step 13, and (3) record the larger value as the consequences for the scenario. If the assessment tool is being used, this step is performed automatically.

An example of the calculation sequence that begins with Step 10 and concludes with Step 14 is shown in Appendix C.

CHAPTER 6

The Mitigating Effects of Emergency Response

In the previous chapter, you determined the potential consequences for each scenario that you identified as possible within your jurisdiction. Capable and timely emergency response can help mitigate those consequences—by reducing the amount of product released, changing the nature of the release, or properly protecting the population and environment in the vicinity of the incident before they experience the full effects. In this chapter, you can apply the effects of response time to an incident and the capability of emergency responders in determining potential consequences.

Determining the Response Capability Tier

Determining the response capability tier for each incident scenario uses the information developed in Chapter 3 and the release consequence values developed in Chapter 5, based on the hazardous materials portfolio developed in Chapter 4. Table 16 is the key table used to determine the recommended response capability tier for each release scenario associated with the hazardous materials portfolio. The Jurisdictional Class column to use in Table 16 was specified in Chapter 3, Step 5. For each release scenario, the CARVER scale row to use was specified in Chapter 5, Step 14. The cell that is at the intersection of the CARVER row and Jurisdiction Class column is the recommended response capability tier for that scenario.

These tier assignments are general estimates and generally apply to larger incidents with the potential to generate significant consequences. You can modify the Tier Response Level based on local circumstances. For example, smaller jurisdictions with extremely high potential consequences will want to increase the emergency response capability beyond that listed.

Step 15

Record the desired Response Capability Tier for each scenario in your hazardous materials portfolio based on the potential consequences.

Emergency Response Capability Factor

The *emergency response capability* term is used to represent the mitigation effects of the available response teams to address specific incident scenarios. Essentially, this is the second gap analysis regarding emergency response capabilities. The first gap analysis considered the tier level capability of the team being assessed when compared with the Tier Response Level needed, based on the selected Jurisdictional Class in Step 6. This second gap analysis is based on the consequences of the release scenarios that you selected as appropriate for the region or area being analyzed. If the consequences are high, then a higher Tier Response Level is warranted, as shown in Table 16.

Table 16. Response capability tiers to offset possible consequences.

Potential Consequences	Jurisdiction Class				
	Class Five	Class Four	Class Three	Class Two	Class One
5	Tier 3	Tier 4	Tier 4	Tier 4	Tier 4
4	Tier 2	Tier 2	Tier 3	Tier 4	Tier 4
3	Tier 1	Tier 1	Tier 2	Tier 3	Tier 4
2	Baseline	Tier 1	Tier 1	Tier 2	Tier 3
1	Baseline	Baseline	Baseline	Tier 1	Tier 1

As was pointed out after Step 6, if shortfalls were identified there, they are likely to broaden when the emergency response capability factor is specified. The capabilities of any resource are based upon how that resource is organized, trained, certified, equipped, exercised, evaluated, and sustained. For this Guide, the appropriate level of response for hazmat incidents is organized into five tiers beyond the baseline level of response that would be expected for any U.S. fire department and is consistent with FEMA response team classifications for the more capable levels of response.

The appropriate level of response, termed the Response Capability Tier in the previous section, was specified in Step 15. The current response capability for the emergency response teams in the region was initially specified in Step 2. If, after Step 6, you identify a shortfall in capabilities and you choose to increase the response capabilities to eliminate this initial shortfall, then you would use the upgraded Step 2 capabilities at this point. Otherwise, any shortfalls shown here will probably increase the existing gap in capabilities. The difference between the current Tier Response Level the team can mount and the required Response Capability Tier is the basis for assigning the emergency response capability factor using Table 17.

Referring back to Equation 2 in Chapter 1, notice that the potential consequences are multiplied by the emergency response capability (ERC) term. Therefore, a higher ERC effectively increases the consequence term and shows the appropriate ERC values for differing abilities to provide the desired response capability for each scenario. The impact on consequences can increase by as much as five times, depending on the difference between the desired and available emergency Response Capability Tiers.

Step 16

Record the ERC factor for each scenario in your hazardous materials portfolio based on the values in Table 17. If you use the assessment tool, this calculation is performed automatically and no input is required.

An example of the calculation sequence associated with Step 16 is shown in Appendix D.

Table 17. Assigning values for emergency response capability.

Basis for Assigning Value	Emergency Response Capability [ERC]
Response meets Required/Desired Tier Level Response	1
Response is one Tier Level below the Required/Desired Tier Level Response	3
Response is two or more Tier Levels below the Required/Desired Tier Level Response	5

Response Time

This Guide uses the basic premise that the longer it takes for emergency responders to arrive on scene, the less effective they will be in mitigating consequences. In Step 5, you determined the performance objectives for your jurisdiction, which included desired emergency response times. In this step, you will determine how well your current response capability can meet that desired response time for the scenarios you identified. The *response time factor* (RTF) considers each of the major outcomes: assess, manage, rescue, and control. The times associated with each of these outcomes consider the time required to:

- Assess the nature of the hazmat incident;
- Transport the incident commander to the scene so he or she can start managing the scene;
- Rescue the number of individuals specified by the tier level; and
- Transport the specialized hazmat emergency response team to the scene so they can take over incident management.

This Guide focuses on the time it takes to achieve each of the four response outcomes.

Response Time Objectives

Response time objectives are included in the performance objectives tables (Tables 4 through 8) in Chapter 3 and are repeated in Table 18. Refer to the table associated with your Jurisdiction Class in Chapter 3 for more information on the elements considered as part of the four target outcomes.

Remember that when you combine resources from different locations into a team, you need to consider the time for all resources to arrive at an incident to consider that "team" on site and fully functional.

Step 17

Determine the typical response times by incident scenario for each of the outcomes listed in Table 18: assess, manage, rescue, and control. If you use the assessment tool, enter the response time for the scenario and its outcome.

Response Time Factor

If emergency responders in the appropriate capability tier for each scenario can be on scene within the desired response time, then the value for RTF will be 1. Where longer response times are expected, higher values are used. This has a multiplying effect on the estimated consequence. Table 19 shows the possible RTFs.

Based on the RTF value assigned, the impact on consequences can increase by as much as five times, depending on the difference between the desired and actual response times.

Table 18. Response time objectives (in minutes) based on Jurisdiction Class.

Target Outcome	Response Time by Jurisdiction Class (minutes)				
	Class Five	Class Four	Class Three	Class Two	Class One
Assess	5	5	5	5	5
Manage	60	45	30	30	30
Rescue	60	10	10	10	10
Control	90	60	45	30	30

Table 19. Response time factors.

Response Time Factor [RTF]	Description
1	Meets or exceeds desired response time
2	Response time is within 125 percent of desired response time
3	Response time is within 150 percent of desired response time
4	Response time is within 200 percent of the desired response time
5	Response time is more than double the desired response time

You may also want to consider response mode in your determination of the appropriate response time factor. The team or elements of the team have the option, given jurisdictional policies, to travel with lights and sirens (commonly known as Code 1), with lights only and more limited exemptions to traffic laws (often known as Code 2), and following normal traffic laws without warning lights or sirens (known as Code 3). Generally, you would want to assume a response mode of Code 1 for the best possible speed to respond to a hazmat incident.

In addition, you may also want to consider the impacts that multiple large concurrent incidents may have on your ability to respond. Mutual-aid agreements might also be considered in your approach for reducing emergency response time or in meeting emergency response time objectives.

You can use a number of tools to estimate response time for response capability (teams) to arrive at the location of potential incidents. These include online mapping tools or geographic information system (GIS) analysis. Appendix E contains a more detailed explanation of response time assessment, including how to use GIS to determine response coverage areas.

Step 18

Calculate the RTF by outcome for each scenario in your hazardous materials portfolio using the values in Table 19, based in turn on your Jurisdictional Class. Record the highest RTF. If the assessment tool is used, this step is calculated automatically from the response time entries in Step 17.

An example of the calculation sequence associated with Step 18 is shown in Appendix E.

Quantifying the Mitigating Effects

To understand how the ERC and RTF terms affect the overall consequence term in the risk equation, first consider that appropriate emergency response will have the maximum impact if it arrives within the desired time frame. If the response capability is below what is needed, then it will be less effective, and consequences will not be reduced as much. The same is true for response time; if the response arrives too late, it will be less effective and will not reduce consequences as much as if it arrived sooner.

The combination of ERC and RTF (by multiplying them together) tells you relatively how much your emergency response capability may impact the potential consequences of an incident. Reducing response time and/or increasing response capability are the two key elements that you can control at the jurisdictional level. Given that both of these improvements would incur costs, the methodology in this Guide helps you determine where it makes sense to allocate additional resources.

CHAPTER 7

Aligning Hazardous Materials with Varying Levels of Capability

This chapter brings together your prior work on filling out the hazardous materials portfolio to develop a risk metric that reflects how well your emergency response capability is aligned with the hazmat present in your jurisdiction. A new term, *vulnerability*, is added to support calculation of the risk metric.

Adding Risk to the Hazardous Materials Portfolio

Until this point, the various incident scenarios that could occur in the region have been identified and the consequences assessed without regard to likelihood or frequency. The vulnerability term, which will be discussed next, provides a way of assigning a risk level to each scenario. The measure of risk described in Chapter 1 was called the risk metric because it is not a quantitative measure of risk, for example, the risk of an incident occurring involving a hazardous material being released on a local rail line or highway. The risk metric provides a way of prioritizing the emergency response shortfalls. Given that resources are always going to be limited, it is wise to fix the shortfalls that result in the greatest reduction in risk. Addressing shortfalls that would result in only slight reductions in risk might not be worth the cost, even if funds were available.

The *vulnerability* term is a measure of the likelihood that the population or environment will be exposed to threats produced by an incident. There are two ways to address vulnerability: (1) consider potential release probabilities based on historical or scientific data, and (2) consider the quantity and frequency of materials present. In both cases, vulnerability is expressed on an annual basis. Table 20 shows the range of values used in this Guide for the vulnerability term for both of these approaches (based on likelihood of release and based on frequency of presence). These approaches apply to both fixed facilities and transportation. The frequency approach addresses how often the materials are present in sufficient quantities to be of concern at the facility, whereas the transportation approach refers to the frequency of shipments along a particular transportation corridor or through the community. These values could be assigned to Freight Analysis Framework (FAF 2010) truck volume levels and the Commodity Flow Survey (CFS 2007) hazmat percentage of truck tonnage. The vulnerability levels for a particular scenario can often be estimated from experience. For example, the history of hazmat responses can be used to assign an overall vulnerability level for the region. Typically, that level will be high or very high. If a CFS is available, assuming the same incident rate for all transport on each mode, then the vulnerability level by hazmat class and division can be obtained by multiplying the overall likelihood of a hazmat incident in the area by the class/division distribution of shipments from the CFS. If you desire to factor in the likelihood or probability of a package breach given an incident for hazmat like gasoline, the likelihood can be reduced by an order of magnitude (i.e., by a factor of 10), and for other bulk commodities the likelihood can be reduced by two orders of magnitude (i.e., by a factor of 100). The likelihood of a fire or BLEVE is at least two orders of

Table 20. Vulnerability levels.

Vulnerability Level		Approximate Range	
Value	Description	Likelihood of Release	Frequency of Presence
5	Very High	> 1 per year	many times per day
4	High	1 to 10^{-2} per year	several times per week to daily
3	Moderate	10^{-2} to 10^{-4} per year	a few times per month
2	Low	10^{-4} to 10^{-6} per year	a few times per year
1	Very Low	< 10^{-6} per year	< a few times per year

magnitude—one vulnerability level—below the vulnerability level assigned using the estimated incident frequency from historical data.

For estimating the likelihood of a release at a fixed facility, you must rely on estimates obtained through discussions with the companies that have inventories of hazmat. LEPCs will have access to the company's safety officer and planning documents for any facility that falls under EPA or Occupational Safety and Health Administration (OSHA) regulations, because hazmat are present above the prescribed threshold values. In some cases, these planning documents will include a discussion of the likelihood of a release requiring non-company emergency response support. If the documents do not include that discussion, you can estimate the likelihood based on discussions with the safety officer. The safety officer will be familiar with process upsets and near-misses, serious incident scenarios that were stopped by the intervention of safety systems or trained operators at the local facility and other similar facilities operating around the United States. The vulnerability level for a serious incident will be one or, in a few cases, two. Thus, if several facilities of similar design have been operating for a total of 1,000 plant years and there was only one known near-miss, then the vulnerability level is probably "low" because there are typically several near-misses before there is an actual release. For purposes of this example, the vulnerability will be judged as "moderate," somewhere in the range of 10^{-2} to 10^{-4} per year (or 1 in every 100 to 10,000 years). There might be more than one type of hazardous material present at a facility, and the vulnerability term could be adjusted upwards accordingly. The size and nature of the facility matters as well. If the facility was the only producer of a key product in a region or had another similar characteristic, the vulnerability level probably should be set higher from a security perspective.

The vulnerability term would also be used if the major threat was viewed to be security rather than safety. The vulnerability would be associated with iconic targets or critical infrastructure, and the fraction of the time a material could damage the targets or infrastructure would be used to assign a value to the vulnerability term. Based on the last column in Table 20, the vulnerability term would be assigned as "low" if the hazardous material that could damage the iconic structure or the critical infrastructure were present in the area only a few times a year.

When you consider vulnerability from the safety perspective, the term for a transport corridor has several components: number of vehicles carrying the hazardous material, incident rate for those vehicles, hazmat involvement, and hazmat release. While an individual skilled in risk assessment might not have any difficulty assigning values to those terms, a simpler alternative might be to just focus on traffic volume. Consider each mode separately. If the region is traversed by a Class 1 railroad, with 25 or more trains a day traversing the region, a "high" vulnerability should be assigned for all the hazards believed to be present in the area. From an incident perspective, if there were 25 trains traversing the area every day, then there are millions of rail car miles per year passing through the region, and there could be several train incidents per year. It follows that the likelihood of a hazmat release would fall in the high range. If the region has a large rail sorting yard as well, the likelihood might be increased to "very high." If CFSs show that a specific hazardous material was present as a single car on only a few trains, say less than 10 hazmat cars per day, then a "moderate" vulnerability level should be assigned. Similarly, if only a few cars per year of a specific type of hazardous material were shipped, the vulnerability could be set to "very low," less than 10^{-6} per year. Since the goal is to assign a risk metric and not a quantitatively assigned risk value to each scenario, a consistent assignment of vulnerability values is more important than calculating a quantitative value for each scenario.

In some cases, empty cargo tanks or rail cars contain sufficient residue to require hazmat placards. Emergency response personnel might not be able to distinguish the residue nature of the shipment until after initiating response actions assuming a full container.

Step 19

Record the appropriate vulnerability value for each scenario in your hazardous materials portfolio, based on the values in Table 20. Depending on the availability of information, it might be difficult to estimate the vulnerability term. You are not required to follow the formal process shown in Appendix B. If the formal process is not used, estimate the risk for the most likely release scenario. This would probably be a Class 3 flammable liquid release. Then use an order-of-magnitude scale to specify a lower vulnerability value for the less commonly shipped materials based on their shipment frequency.

Appendix B contains more detailed examples regarding vulnerability calculations.

Hazardous Materials Portfolio Example

The following discussion uses a hypothetical jurisdiction and evaluates each of the terms in the risk equation to determine a risk metric for each scenario.

Since the planning organization has been involved in developing the emergency response plan (ERP) for Facility Z, it is aware that the facility, which produces polyester resins, has several large vessels containing ethylene and receives over 20 rail tank cars of ethylene a week. Ethylene is highly flammable and will auto-decompose at temperatures as low as 150°C. It has a lower flammability limit of 3 percent and an upper flammability limit of 100 percent. The decomposition is catalyzed by iron oxide on the tank surfaces. It is shipped in insulated rail tank cars (e.g., type 105J100W or other DOT-approved tank cars) having a maximum capacity of 25,000 gallons. These characteristics make BLEVEs or other explosions a possibility at the facility and on the rail line to the facility. Gasoline is shipped on the roads in the region, so the risk of fire following a road incident must be considered. The manufacturing process also uses small amounts of chlorine, which is also shipped in by rail. This could result in a toxic gas release from both the facility and the rail line. There is a major interstate through the jurisdiction and, from a CFS that the planning agency commissioned, shipments of anhydrous ammonia (considered a toxic gas) and 37 percent hydrochloric acid are present. No identified shipments of radioactive material or etiologic/biologic agents were identified in the region. When addressing the hazards, you should consider large and small releases. Based on the above hazards, the hazard column in the risk profile can now be filled out as shown in Table 21.

The risk metric in Table 21 would suggest that no training would be needed for incidents involving etiologic/biologic agents. That would be an incorrect conclusion because at all tier levels, awareness training is required. It might not be required for the area emergency response team to have all the equipment necessary to respond effectively to incidents involving these materials. Through awareness training, everyone would be able to recognize when these materials are present and also know whom to call for assistance if an accidental release of these materials occurred.

Table 21. Completed risk portfolio.

Hazard [H]			Vulnerability [V]	Consequence [C]*		Capability [ERC]	Response Time [RTF]	Risk Metric
Facility or Route	Description	Y/N		Pop.	Env.			
Facility Z	Fire (ethylene oxide)	1	4	3	2	1	1	12
Roads u, w, x, y	Fire (gasoline)	1	4	3	1	4	1	48
Facility Z	Explosion (ethylene oxide)	1	2	5	2	1	1	10
Railroad s	BLEVE (ethylene oxide)	1	3	2	2	4	1	24
Facility Z	Toxic Gas (chlorine) (L)	1	3	5	1	1	5	75
Facility Z	Toxic Gas (chlorine) (S)	1	4	5	2	1	1	20
Railroad s	Toxic Gas (chlorine) (L)	1	3	5	1	3	5	225
Railroad s	Toxic Gas (chlorine) (S)	1	3	3	3	1	1	9
Roads x, w	Toxic Gas (ammonia) (L)	1	2	5	2	4	5	200
Roads x, w	Toxic Gas (ammonia) (S)	1	3	3	1	4	1	36
Roads x, u	Toxic Liquid (37% HCl) (L)	1	2	5	2	4	1	40
Roads x, u	Toxic Liquid (37% HCl) (S)	1	2	3	1	4	1	24
	Radioactivity	0						
	Etiologic/Biologic	0						

*The maximum of the consequence values (population and environmental) are used in the risk metric calculation.
(S) small release; (L) large release.

The vulnerability values in Table 21 are based on the discussions in Chapter 7 and Appendix B. The consequence values are based on Chapter 5 and Appendix C. Note that in this hypothetical jurisdiction, environmental consequences never exceed human-health consequences for any scenario.

Table 21 shows the ERC and RTF terms for each scenario for this hypothetical jurisdiction. It also shows the calculation of the risk metric using the risk equation. The risk metric shows that the dominant risk is from toxic gas releases. If emergency response capabilities were improved for these releases, the risk to the public could be significantly reduced.

Step 20

Multiply the values for vulnerability, the maximum of the two consequence values, the capability and response time factor to obtain the risk metric for each release sequence. The results are shown in Table 21. If the assessment tool is used, this step is calculated automatically.

CHAPTER 8

Identifying Shortfalls where Additional/Different Capabilities Are Warranted

In Chapter 3 some shortfalls were developed by comparing the current tier level capability in the region identified in Chapter 2 with the tier level capabilities required based on the Jurisdictional Class selected for the region in Chapter 3. These basic shortfalls should be addressed first. For example, when evaluating the tier level performance capabilities, the lower tier level may have been specified because the emergency response organization could not perform up to the higher tier level requirement in those few areas. Thus, to perform at the higher tier level expected for the selected Jurisdictional Class, only a few capability upgrades might be required. Since these affect the overall performance of the emergency response organization, these should be addressed as soon as resources permit.

The next part of the shortfall analysis focuses on upgrading the tier level performance for those scenarios that have the highest risk metric value. Frequently, the upgrade will affect several scenarios. Consequently, many shortfalls might be addressed by a single upgrade activity.

The first step in this part of the approach is to order the scenarios by decreasing risk metric value. For this example (refer to Table 21), a large release of chlorine is the biggest concern, followed by a BLEVE of a rail tank car carrying ethylene. While this Guide does not recommend specific thresholds above which a scenario's risk metric warrants action, each jurisdiction can easily identify the top scenarios and examine the range of values for breakpoints that could be used as threshold values. Examination of Table 21 (see Figure 3) shows possible breaks at risk metric values of 75 and 24, so either can be used as a threshold for focusing the initial remediation efforts.

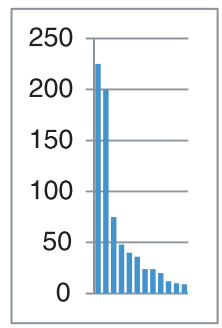


Figure 3. Chart of risk metrics from Table 21.

CHAPTER 9

Approaches for Addressing Identified Shortfalls

This chapter discusses remediating shortfalls such as those identified in Chapter 8 through (1) improving the capabilities of existing resources or adding more resources, (2) reallocating existing resources to improve response times, (3) considering agreements with additional response resources (including private entities), and (4) exploring the use of hazmat route restrictions (coordinating with the state routing agency and following the process prescribed in the Federal Motor Carrier Safety Regulations, or FMCSRs). Of course, more than one of these approaches may be implemented.

In a broad sense, the improvement of emergency response capability will offset the risk metric used in this Guide. However, this factor applies only to improvements that directly affect the tier assessment for existing response resources or teams, or that reduce the response time for qualified responders to reach the location of one or more scenarios in the risk portfolio.

Improving Emergency Response Capabilities

As the capability of each response team or unit is assessed, it will become apparent which specific elements of the requirements outlined in Chapter 4 are needed for the team to be assigned to the next-highest level. Those specific elements may include additional training or equipment for existing personnel, or the addition of new personnel. The costs of these elements can be estimated or will already be known and can be compared to the benefits of having that improved capability in the jurisdiction. Each scenario in the risk profile can be reevaluated and the ERC term adjusted as necessary to account for the new capability. Each adjustment will reduce the risk metric for that scenario.

Material solutions must always be fielded judiciously with close examination of long-term total costs of ownership. These costs include staffing, training, life cycle management, transportation, and exercise requirements associated with employing and maintaining material capabilities, such as increased protective equipment, detection capabilities, and decontamination systems. If costs to obtain the desired reduction in the risk metric are too high, then other alternatives should be considered.

Reallocating Resources

Reassigning personnel or equipment to different locations or even relocating entire response teams can have implications on the risk metric for each scenario, because the RTF term will reflect the new response time from the appropriate response teams to the location of each scenario. Care must be taken to account for any changes in actual capability of responders based on reassignment of personnel or equipment among teams.

Mutual-Aid Agreements

Mutual-aid agreements with other jurisdictions, facilities with response capabilities, private response organizations, and other entities can augment jurisdictional hazmat response capabilities. To include these in the risk portfolio, each new response capability will need to be rated and its response time to each scenario examined to determine whether it can favorably adjust the RTF term.

Hazardous Materials Route Restrictions

Where allowed by law and subject to federal preemption authority, jurisdictions can perform route risk assessments for transportation of hazmat. For highways, the governor-designated state routing agency has the authority and responsibility to oversee any such restrictions, even if they are implemented at the local level. The analysis approach is prescribed in the FMCSRs. As long as reasonable alternatives for the movement of commerce through the jurisdiction are identified, a jurisdiction may be able to justify a route restriction that requires certain hazmat shipments to avoid areas of high transportation risk.

CHAPTER 10

Sustaining the Process

Maintaining Emergency Response Capability Assessments

To make the process outlined in this Guide viable in the long term, a maintenance component is required. You could employ two approaches:

1. Periodically resurvey the response teams and key information sources to reflect new response capabilities or needs. If this approach is chosen, the data should be refreshed at least annually.
2. Perform real-time management, particularly of response capabilities, where equipment purchases and updates to responder training records would be coordinated at the planning agency level and linked to a database system that updates and records current capability levels.

Response planning organizations should require response teams to provide the necessary data to support capability assessment to be eligible for hazmat-specific response planning, training, or equipment funding through the state on an annual basis. This could include PHMSA's Hazardous Materials Emergency Preparedness (HMEP) Grant funding as well as internal state funding.

Sharing Emergency Response Capability Assessments

As for aggregating the results for larger jurisdictions, a national repository should be developed for response team information and capability data. The most appropriate location for this repository is the Hazardous Materials Fusion Center, led by the International Association of Fire Chiefs (IAFC) in cooperation with PHMSA. Such a repository was envisioned in the creation of the Fusion Center.

If the response capability assessment data discussed earlier were captured at the national level, great economies of scale would result when those data were accessed and used by a number of jurisdictions at varying levels, from neighboring counties, states, or industrial entities. A reciprocal arrangement, in which a planning agency could access the national data if the agency provided the data for its jurisdiction, would help promote wider use and utility of a national repository.

In the absence of a national repository, consider working directly with neighboring jurisdictions to share the results of your work. The hazmat stored in your jurisdiction, and particularly those moving through it, would be relevant to an adjacent jurisdiction's response planning agency. Conversely, you might learn more about what is moving from that jurisdiction into yours from the results of their hazard survey efforts.

Acronyms

BLEVE	Boiling Liquid Expanding Vapor Explosion
CFR	Code of Federal Regulations
DHS	U.S. Department of Homeland Security
EPA	Environmental Protection Agency
EPCRA	Emergency Preparedness and Community Right-to-Know Act of 1986
ERP	Emergency Response Plan
ERPG	North American Emergency Response Planning Guide
ESH	Environment, safety, and health
FMCSR	Federal Motor Carrier Safety Regulation
HAZWOPER	Hazardous Waste Operations and Emergency Response
HMCRP	Hazardous Materials Cooperative Research Program
HMR	Hazardous Materials Regulation
ICS	Incident Command System
LEPC	Local Emergency Planning Committee
NFPA	National Fire Protection Association
NIMS	National Incident Management System
OHS	Environmental Oil and Hazardous Substance
OSHA	Occupational Safety and Health Administration
PHMSA	Pipeline and Hazardous Materials Safety Administration
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SERC	State Emergency Response Commission
TRB	Transportation Research Board
U.S.DOT	U.S. Department of Transportation

APPENDIX A

Information Sources

2008 Emergency Response Guidebook

Cloutier, M., and G. Cushmac (2008). *2008 Emergency Response Guidebook,* Transport Canada, U.S. Department of Transportation, Secretariat of Communications and Transport of Mexico.

Web page:

http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/erg2008_eng.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Hazard
Fixed Source/Mobile Source	Mobile Source
Public Safety/Occupational/Environmental	Public Safety
Materials	Yes
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

This is the guidebook for first responders during the initial phase of a Hazmat Transportation Incident. It aids first responders in quickly identifying the specific or generic hazards of the materials involved in the incident and protecting themselves and the general public during the initial response phase. First responders must be trained regarding the use of this guidebook. This document is a combined effort of regulatory agencies of the United States, Canada, Mexico, Argentina, and Brazil.

CHEMTREC Guide for Emergency Responders

CHEMTREC (2008). *Guide for Emergency Responders.* Arlington, VA, Chemical Transportation Emergency Center (CHEMTREC).

Web page:

http://www.chemtrec.com/responder/resources/documents/%5B1%5D.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Response Time and Capability
Fixed Source/Mobile Source	Mobile Sources
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	None

Summary:

Assesses hazmat incidents based on material and the incident location.

The CHEMTREC guide provides emergency responders with a better understanding of its services, how it handles incidents, what assistance is provided, what information will be requested for assistance, how they prepare themselves for emergencies and a description of their training programs.

Comprehensive Preparedness Guide, March 2009

FEMA (2009). "Developing and Maintaining State, Territorial, Tribal, and Local Government Emergency Plans." *Comprehensive Preparedness Guide* (CPG 101): 172.

Web page:

http://www.fema.gov/pdf/about/divisions/npd/cpg_101_layout.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Helps state, territorial, tribal and local jurisdictions to come up with ERPs.

This document provides guidance about response and recovery planning to governments. It brings forward FEMA's recommendations to emergency/HS managers and personnel. It replaces SLG 101 (State and Local Guide).

Development of the Table of Initial Isolation and Protective Action Distances for the 2008 Emergency Response Guidebook

Brown, D. F., H. M. Hartmann, et al. (2009). *Development of the Table of Initial Isolation and Protective Action Distances for the 2008 Emergency Response Guidebook,* Argonne National Laboratory: 246.

Web page:

http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Argonne_Report.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Vulnerability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	Yes
Regulatory/Association/State/Local/Transportation Company	N/A

Summary:

Lists the initial isolation and protective action distances for various hazmat.

Protective Action Distances (PADs) is the optimum distance to protect the public and response personnel from exposure to hazmat and to minimize risks and expenses due to over-reaction. Using emission rates and atmospheric dispersion models, several scenarios were analyzed with varying chemicals, container type, location, etc., and a statistical approach was used to come up with PADs in each case. The values from this report are used in the emergency response guidebook.

The Emergency Planning and Community Right-to-Know Act Factsheet, March 2000

EPA (2000). *The Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA) Factsheet*, Office of Solid Waste and Emergency Response, United States Environmental Protection Agency.

Web page:

http://www.epa.gov/oem/docs/chem/epcra.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	None
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Environmental
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

This deals with the act, which deals with emergency planning and community right-to-know.

This is regarding the EPCRA, which establishes requirements regarding emergency planning and community right-to-know reporting on hazardous and toxic chemicals. This factsheet is made by the Chemical Emergency Preparedness & Prevention Office and covers major sections of the act.

The Emergency Planning and Community Right-to-Know Act—Full Text

Web page:

http://frwebgate.access.gpo.gov/cgi-bin/usc.cgi?ACTION=BROWSE&TITLE=42USCC116

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	None
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Environmental
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Emergency Response Assistance Plans

CANUTEC (1992). "Emergency Response Assistance Plans." Transport Canada. Retrieved 01/30/10, from http://www.tc.gc.ca/eng/tdg/erap-menu-72.htm.

Web page:

http://www.tc.gc.ca/eng/tdg/erap-menu-72.htm

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Vulnerability and Capability
Fixed Source/Mobile Source	Mobile Source
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Helps in mitigating vulnerability by having a plan, and enhances capabilities in a hazmat transport activity.

Canada's ERAP is similar to the U.S. RMP. ERAP is compulsory before transport or import of certain dangerous goods. It represents the plan of the shipper of any dangerous goods in the event of an incident. ERAP may be by the shipper fully, or partly with assistance from an external response contractor.

EPRI Implementation Report, April 2005

Hassol, A., G. Gaumer, et al. (2005). Emergency Preparedness Resource Inventory (EPRI) Implementation Report. *Bioterrorism and Other Public Health Emergencies: Tools and Models for Planning and Preparedness,* U.S. Department of Health and Human Services.

Web page:

http://www.ahrq.gov/research/epri/epriimprep.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Consequence and Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Documentation of a software package that helps in keeping an inventory of resources, which can help in responding to a hazmat incident.

EPRI is a web-based software tool for assembling the inventory of critical resources that would be useful in responding to a bioterrorist attack. Inventory of critical resources will help in an organized incident response, estimating shortfalls so as to pull external help, and in making investment decisions.

FIRESCOPE Standardized Hazardous Materials Equipment List, 2009 Edition

FIRESCOPE (2009). Firescope Standardized Hazardous Materials Equipment List. *SEL*. California, California FIRESCOPE.

Web page:

http://www.firescope.org/ics-hazmat/pos-manuals/haz-equiplist.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Local EMS

Summary:

Provides capabilities of various equipment in hazmat/WMD incident response.

SEL is a document listing standardized equipment for hazmat/WMD incident response. It should be reviewed in CA when developing equipment specs or purchase orders or working with inventory lists. It states recommended minimum standards for equipment.

General Guidance on Risk Management Programs for Chemical Accident Prevention, March 2009

EPA (2009). General Risk Management Program Guidance, Multiple documents, Environmental Protection Agency.

Web page:

http://www.epa.gov/oem/content/rmp/rmp_guidance.htm#General

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	All
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Environmental
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

These are documents on additional Risk Management Program guidance covering general RMP, Ammonia Refrigeration RMP, Propane Storage, Wastewater Treatment Plants, Warehouses, Chemical Distributors, and Offsite Consequence Analyses, and includes a Technical Background Document for Offsite Consequence Analysis for Anhydrous Ammonia, Chlorine, and Sulfur Dioxide.

Guide for All-Hazard Emergency Operations Planning, September 1996

FEMA (1996). *Guide for All-Hazard Emergency Operations Planning,* Federal Emergency Management Agency. SLG 101.

Web page:

http://www.fema.gov/pdf/plan/slg101.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

This document is obsolete.

It provides emergency managers and personnel with FEMA's concept for developing risk-based, all-hazard emergency operations plans. It clarifies preparedness, response, and short-term recovery planning elements. It has been superseded by CPG 101.

Guidelines for Hazmat/WMD Response, Planning and Prevention Training, April 2003

FEMA (2003). *Guidelines for Hazmat/WMD Response, Planning and Prevention Training*. Guidance for Hazardous Materials Emergency Preparedness (HMEP) Grant Program, Federal Emergency Management Agency.

Web page:

http://www.usfa.dhs.gov/downloads/pdf/publications/hmep9-1801.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Developed by FEMA and the Emergency Management Institute (EMI) and can give information on training for response, planning, and prevention of hazmat or WMD incidents.

It is developed as a part of the Hazardous Material Emergency Preparedness (HMEP) Grants Program and provides assistance on training responders against incidents, guidelines for preparing response plans, and initiatives to prevent such incidents. The EMI and FEMA have done work on this report. It has three curriculum guidelines: response, planning, and prevention.

Hazardous Materials Emergency Planning Guide, March 1987

National Response Team (NRT) (1987). *Hazardous Materials Emergency Planning Guide*. NRT-1.

Web page:

http://www.nrt.org/production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/A-22nrt1/$File/nrt1.pdf?Open Element

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Developed by NRT, an association of 14 Federal agencies including EPA. It deals with hazmat incident planning to satisfy congressional requirements.

NRT is formed by 14 Federal agencies. This document replaces FEMA-10 Planning Guide and Checklist for Hazardous Materials Contingency Plans. It guides communities in planning for hazmat incidents. It mainly deals with planning and does not provide details on response technique or how to train personnel to respond to incidents. It helps communities to plan using the resources available to them and to determine risk and extent of planning needed for hazmat incidents.

Hazardous Materials Emergency Planning Guide, 2001

National Response Team (NRT) (2001). *Hazardous Materials Emergency Planning Guide.* NRT-1.

Web page:

http://www.nrt.org/production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/SA-27NRT1Update/$File/NRT-1%20update.pdf?OpenElement

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Developed by NRT, an association of 14 Federal agencies including EPA. It deals with hazmat incident planning to satisfy congressional requirements.

Most recent version of NRT-1. This is developed by 14 Federal agencies. Updates include replacing few obsolete references and also addition of new legislative requirements.

Hazardous Materials Response Special Teams Capabilities and Contact Handbook

USCG (2005). *Hazardous Materials Response Special Teams Capabilities and Contact Handbook,* United States Coast Guard.

Web page:

http://www.nrt.org/production/NRT/RRT3.nsf/Resources/Jan2007ppt_4/$File/USCG_Special_Teams_Handbook.ppt

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	N/A

Summary:

This document gives an overview of the Hazardous Materials Response Special Teams under the U.S. Coast Guard. Capabilities and contacts are included in the handbook.

Hazardous Materials/Weapons of Mass Destruction Response Handbook, 2008 Edition

Trebisacci, D. (2008). *Hazardous Materials/Weapons of Mass Destruction Response Handbook,* National Fire Protection Association.

Web page:

http://www.nfpa.org/catalog/product.asp?pid=472HB08&order_src=B484&link_type=buy_box

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	All of them
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Public Safety
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

Summary:

A complete response handbook combining NFPA 472 and NFPA 473 standards.

Hazmat Action Guide, 2007

(2007). *Franklin County Hazmat Action Guide*, Franklin County.

Web page:

http://www.frcog.org/pubs/emergency/Haz_Mat_Action_Guide_Final.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Local

Summary:

Developed by a local agency, it deals with the emergency management during a hazmat release in the jurisdiction of Franklin, MA.

This is a guide which should be used in addition to ERG in Franklin, MA. It helps first responders in organizing an effective response to an emergency. It focuses on organizing response teams, communications between teams, and developing initial action plans.

National Incident Management System, December 2008

DHS (2008). *National Incident Management System,* U.S. Department of Homeland Security.

Web page:

http://www.fema.gov/pdf/emergency/nims/NIMS_core.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

A system to guide responders with regard to incidents; it might have a risk equation involved. It is developed by the Department of Homeland Security.

This document explains the National Incident Management System run by FEMA. NIMS provides a systematic guidance to agencies/departments at all levels and the private sector to work to prevent, protect against, respond to, and recover from incidents of all kinds and sizes at any location. It works with NRF. While NIMS provides a template for managing incidents, NRF provides mechanisms for incident management.

National Incident Management System Brochure, December 2008

FEMA (2008). *National Incident Management System.* Federal Emergency Management Agency. Washington, DC. FEMA B-775.

Web page:

http://www.fema.gov/pdf/emergency/nims/NIMS_brochure.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

A brochure on the NIMS published by FEMA and DHS.

This document gives an overview of the NIMS, how it works, its requirements, and its components. The main components of a comprehensive incident management system are identified as preparedness, communication and information management, resource management, command management, and ongoing management and maintenance.

National Response Framework, January 2008

DHS (2008). *National Response Framework,* U.S. Department of Homeland Security.

Web page:

http://www.fema.gov/pdf/emergency/nrf/nrf-core.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability and Response Time
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Types of responses suitable for incidents of all scales. This document is published by the Department of Homeland Security. NRF guides the nation to conduct all-hazards response and links agencies at all levels, including the government and private sectors. It captures specific authorities and best practices to manage incidents of all scales. It supersedes the NRF 2004 and 2006 versions.

NIMS Standards Case Study (L.A.), July 2008

FEMA (2008). *NIMS Standards Case Study: Los Angeles Regional Interoperability.* National Preparedness Directorate.

Web page:

http://www.fema.gov/pdf/emergency/nims/Los_Angeles_CAP_EDXL.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Fixed Source
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Simulated a hazmat incident in a chemical storage warehouse to test the NIMS system.

NIMS Case Study, Los Angeles: This study looks into the improvement of interoperability when standards are used for data sharing.

NIMS STEP Fact Sheet

FEMA (2009). "NIMS Supporting Technology Evaluation Program (STEP)." Federal Emergency Management Agency.

Web page:

https://www.nimsstep.org/files/NIMS_STEP-Fact_Sheet.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

This is a single-page brochure on NIMS STEP, a National Preparedness Directorate (NPD) developed program to assist emergency management communities to identify products that adhere to standards, concepts, and the principles of NIMS.

NIMS Supporting Technology Evaluation Program (STEP) Guide, April 2009

FEMA (2009). *National Incident Management System (NIMS) Supporting Technology Evaluation Program (STEP) Guide.* Washington D.C., Federal Emergency Management Agency.

Web page:

https://www.nimsstep.org/files/NIMS_STEP-Guide.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

NIMS maintains and shares assessments; STEP deals with the software and hardware technology used for NIMS.

This is a comprehensive guide to the NIMS Supporting Technology Evaluation Program. It mainly gives details such as vendor application requirements; product selection methods, evaluation activities, and post-evaluation review/reporting processes. This guidance is important because systems working under the NIMS should be able to interact with smoothness, interoperability, and compatibility.

Recommended Practice for Responding to Hazardous Materials Incidents, 2002 Edition

NFPA (2002). *Recommended Practice for Responding to Hazardous Materials Incidents,* National Fire Protection Association. NFPA 471.

Web page:

http://www.disaster-info.net/lideres/english/jamaica/bibliography/ChemicalAccidents/NFPA_471_Recommended PracticeforRespondingtoHazardousMaterialsIncidents.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Hazard and Vulnerability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Public Safety
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

Summary:

This document by NFPA deals with response procedures and sets performance objectives or minimum competencies.

NFPA-471 Document, not available for free, may be accessed at the disaster-info.net website. It is an American National Standard which details the recommended practice for responding to a hazmat incident. It covers planning procedures, policies, and application of procedures for incident levels, personal protective equipment, decontamination, safety, and communication and applies to all hazmat incident responders.

Recommended Practice for Responding to Hazardous Materials Incidents, 1997 Edition

NFPA (1997). *Recommended Practice for Responding to Hazardous Materials Incidents*, National Fire Protection Association. NFPA 471.

Web page:

http://www.homeland.ca.gov/pdf/nfpa471.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Hazard and Vulnerability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Public Safety
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

Summary:

This document by NFPA deals with response procedures and sets performance objectives or minimum competencies.

Presents earlier NFPA 471 standards and specifies minimum competencies for responders to hazmat incidents and aims at reducing number of incidents, injuries, and illness during response.

Risk Management Plan eSubmit Users' Manual, September 2009

EPA (2009). *Risk Management Plan (RMP) eSubmit Users' Manual*, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency. EPA 555-B-09-001.

Web page:

http://www.epa.gov/emergencies/docs/chem/RMPeSubmit_users_manual.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Vulnerability and Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Environmental
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Developing, maintaining, and sharing plans to counter incidents.

Under the Clean Air Act, facilities that produce, handle, process, distribute, or store certain chemicals are required to develop a Risk Management Program, prepare a Risk Management Plan (RMP), and submit the RMP to EPA. Covered facilities were initially required to comply with the rule in 1999, and the rule has been amended on several occasions since then, most recently in 2004. These RMPs should provide information on how to manage unexpected incidents during transportation of hazmat. RMP eSubmit is software developed by EPA to facilitate electronic submission of RMPs. This manual provides assistance in preparing and submitting RMP via this tool.

Standard on Disaster/Emergency Management and Business Continuity Programs, 2007 Edition

NFPA (2007). *Standard on Disaster/Emergency Management and Business Continuity Programs,* National Fire Protection Association. NFPA 1600.

Web page:

http://www.nfpa.org/assets/files/pdf/nfpa1600.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Public Safety
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

Summary:

NFPA document dealing with training support personnel.

This supersedes the 1995 NFPA Standard on Disaster Management. It establishes a common set of criteria for disaster/emergency management and business continuity programs and applies to all public, nonprofit, and private entities in this business.

Standard for Professional Competence of Responders to Hazardous Materials Incidents, 2002 Edition

NFPA (2002). *Standard for Professional Competence of Responders to Hazardous Materials Incidents,* National Fire Protection Association. NFPA 472.

Web page:

http://www.esd.uga.edu/hart/Web%20Page/Publications/NFPA472.PDF

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	Public Safety
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

Summary:

Gives performance objectives for response teams and is an NFPA document.

American National Standard, NFPA472:2002 version, identifies levels of competence required of responders to hazmat incidents. Sets minimum competencies for those who respond to hazmat incidents. Aims to reduce incidents, injuries, and illnesses during response to hazmat incidents.

Standard for Professional Competence of Responders to Hazardous Materials Incidents, 1997 Edition

NFPA (1997). *Standard for Professional Competence of Responders to Hazardous Materials Incidents,* National Fire Protection Association. NFPA 472.

Web page:

http://www.homeland.ca.gov/pdf/nfpa472.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

Summary:

Gives performance objectives for response teams and is an NFPA document.

This document has been superseded.

Standard for Professional Competence of Responders to Hazardous Materials Incidents, 2008 Edition

NFPA (2008). *Standard for Professional Competence of Responders to Hazardous Materials Incidents,* National Fire Protection Association. NFPA 472.

Web page:

none

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both

Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

Summary:

N/A

Superfund Amendments and Reauthorization Act

Web page:

http://frwebgate.access.gpo.gov/cgi-bin/usc.cgi?ACTION=BROWSE&TITLE=42USCC103

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Association

What Do You Need to Know When You Transport Hazmat Internationally?

PHMSA (2005). *What do you need to know or do when you transport hazardous materials internationally?* U.S.DOT, Pipeline and Hazardous Materials Safety Administration.

Web page:

http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/International_Transport.pdf

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	N/A
Fixed Source/Mobile Source	Mobile Source
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

Gives a general overview of regulations by PHMSA about international transport of hazmat.

This is a brochure published by PHMSA regarding the laws and regulations on international transport of hazmat and deals with air and maritime hazmat transportation. International Civil Aviation Organization Technical Instructions for the Safe Transport of Dangerous Goods by Air (ICAO TI) and International Maritime Dangerous Goods Code (IMDG Code) are the regulations referenced in this document.

What is EMAC?

NEMA (1996). *Emergency Management Assistance Compact,* National Emergency Management Agency

Web page:

http://www.emacweb.org/?9

Annotation:

Hazard/Vulnerability/Consequence/Capability/Response Time	Capability
Fixed Source/Mobile Source	Both
Public Safety/Occupational/Environmental	None
Materials	N/A
Regulatory/Association/State/Local/Transportation Company	Regulatory

Summary:

EMAC is a mutual-aid system and is hence an approach for addressing the shortfalls in emergency planning.

Emergency Management Assistance Compact is a system that enables mutual aid between member states for emergency management. EMAC operations manual is password-protected on its website. Steps in EMAC: governor declares emergency, affected state asks assistance, member states assist affected state, assisting states get reimbursement.

APPENDIX B

Estimating Vulnerability

Detailed Discussion

Regarding the techniques used to evaluate the vulnerability term, it is possible to develop some rough, order-of-magnitude estimates of the vulnerability level to be assigned to each scenario in the hazardous materials risk portfolio. For a rail line that transports 20 rail cars of ethylene per week, there would be approximately 1,000 rail cars per year. The total distance in the region traveled by these cars can probably be estimated by just watching the trains as they come into the region. The cars might travel 20 miles in the region on their way to a classification yard, where they are broken out of the train and then transported an additional 10 miles from the classification yard to the facility, which means that the loaded cars will travel a total of 30,000 rail car miles per year. A commodity flow survey might find that there are an additional 500 cars of ethylene per year that are transported through the region with a total shipment distance of 20 miles. These rail cars represent another 10,000 rail car miles per year. Therefore, the region is exposed to 80,000 rail car miles per year. The Bureau of Transportation Statistics (BTS 2008) publishes an annual report, the latest of which is titled "2008 National Transportation Statistics." In that report, based on the number of incidents and train miles of travel, the frequency of an incident is 3×10^{-6} per train mile. Assuming 60 cars per train, obtainable from the AAR report titled "Train Facts," and based on statistics published by the FRA, there are 6 to 10 rail cars involved in a typical train incident. Thus, the probability of an incident per rail car mile is 3×10^{-6} incidents/train mile ÷ 60 cars/train × 10 damaged cars or 5×10^{-7} per car mile. If there are 80,000 car miles of ethylene being transported per year, a conservative estimate, then the probability of an ethylene rail car being involved in an incident is 4×10^{-2} per year. Looking at the rail car incident statistics for the years 1997 through 2004, there were 37 rail cars of ethylene involved in an incident and there was one fire and one explosion, assumed to be a BLEVE. Thus, the approximate estimate for a BLEVE involving ethylene traveling on the rail line through the region is approximately 1×10^{-3} per year. Based on this rather approximate analysis, the vulnerability level for a BLEVE involving ethylene is "moderate," or in numerical terms, is assigned a value of 3. Since the frequency estimate is exactly mid-range for "moderate" (see Table 20), it is probably quite accurate.

For the truck mode, if there is one or more major interstate highways traversing the jurisdiction, each with truck average annual daily traffic (AADT) above 10,000, then the vulnerability level should be set at "high," unless it can be shown that the sum of all the hazmat shipments in the region is less than 100 per day, which would justify a "moderate" rating. The rationale for assigning "high" to the vulnerability is based on the recognition that if there are 10,000 daily truck shipments over a roadway 30 to 40 miles long, then there are hundreds of millions of truck miles annually and, as a result, there will be more than 10 serious truck incidents each year and there will probably be one hazardous material release every few years. Based on the information in Table 20, the likelihood of a hazardous material release would be in the "high" range for commonly shipped flammables and combustible materials, the most commonly shipped hazmat. For materials that make up only a small percentage of the shipments, like toxic liquids and gases, the vulnerability level might be assigned "low," and even less commonly shipped materials can reasonably be assigned a level of "very low." All these assignments are based on traffic flow data and a reasonably complete picture of the hazardous material flows through the region.

For rail transport, if the typical train consist contains several cars carrying the same flammable material, say alcohol or propane, the common practice would be to place these cars together. In an incident, when the consist derails and forms an accordion type configuration, which is common, then all the flammable cars are in proximity to each other. If one of the cars is ruptured and a fire breaks out, then the possibility of a BLEVE is quite high. This configuration seldom occurs for truck transport. About 5 percent of the truck incidents involve multiple trucks, and if only 5 percent of the trucks carry hazmat, then the probability that two hazmat trucks would be involved in an incident is less than 0.3 percent. The probability that both will be carrying flammable materials reduces that probability to less than 0.2 percent and the probability of a fire involving one of them reduces the probability to less than 0.05 percent. Thus, if the vulnerability of a fire in a region is considered "moderate" for truck transport, it would be reasonable to assign the vulnerability of an explosion to be "low."

If pipelines traverse the region, then the vulnerabilities are more difficult to characterize because the risk appears to be very low. The data in the "2008 National Transportation Statistics" report published by BTS can be used to obtain the annual risk of a pipeline incident to be 1.8×10^{-9} per mile of pipeline. This is a generic number obtained by taking the total number of pipeline incidents (404 in 2007) and dividing by the total miles of liquid and gas pipelines (229,962 million miles). This is an unreasonably low number because it is certainly much higher in earthquake-prone areas and in urban areas where ground disturbance is much more likely. If the region has product or gas pipelines but is not in an earthquake-prone area and is not urban, then it would be reasonable to assign a vulnerability level of "very low" to the pipeline. If it were in an urban area, then it would be reasonable to assign a vulnerability level of "moderate" to the pipeline. In a region with significant earthquake risk, it would be reasonable to assign a vulnerability level of "high." A vulnerability level of "very high" may be reasonable if the region has an active fault and the pipeline crosses the fault.

For one final example, consider a hypothetical facility with a large quantity of ethylene. The facility would fall under both OSHA and EPA regulations governing the handling of highly hazardous chemicals. One of the EPA requirements is that the facility's ERP estimates the consequences for their most limiting hazardous material incident, which is assumed here to be an explosion of a vessel containing ethylene. While the plan is not required to estimate the probability of that limiting incident, the safety officer at the facility must list the company's past incident history and should be knowledgeable of incidents at similar facilities. From these incidents, which may not include an explosion of an ethylene vessel, the safety office will likely be able to identify near-miss incidents that can be used to estimate the vulnerability term for an explosion of an ethylene vessel at the facility. If that vulnerability—based on the most limiting incident—was judged to be "low," it might be reasonable to raise the vulnerability for the entire facility to "moderate."

Example Risk Metric Evaluation of the Vulnerability Term

This appendix will work through the process of evaluating the terms in the risk metric equation. The example shown here is more exact, and order-of-magnitude estimates similar to those shown in the body of the report could be substituted for some of the semi-quantitative estimates shown here.

A typical analysis will start with a map of the region (Figure B-1) that shows the location of the major facilities, highways, and railroads where hazmat are likely to be encountered in the region being evaluated. This analysis will consider a plant, labeled Facility Z, which uses coal and water to generate low-molecular-weight hydrocarbons using the Fischer-Tropsch process. From the low-molecular-weight hydrocarbons produced, some propane is separated out and the remaining straight-chain hydrocarbons are cracked to produce ethylene and vinyl. The ethylene is then converted to ethylene oxide, which is shipped offsite by railroad. Some of the propane is cracked to form vinyl, which is then reacted with chlorine to produce vinyl chloride monomer. The process also produces approximately 37 percent HCl, a byproduct of the vinyl chloride production for use in a facility in the neighboring community, labeled City K. The vinyl chloride monomer is used onsite to produce vinyl chloride plastic components. To produce the vinyl chloride monomer, rail cars of chlorine are shipped to the facility. The facility has sufficient inventories of highly hazardous chemicals to fall under both the OSHA regulations for Process Safety Management of Highly Hazardous Chemicals (29 CFR 1910.119) and the EPA regulations for Chemical Accident Protection Provisions (40 CFR Part 68). To meet the EPA regulations, the facility emergency response organization must coordinate with the local emergency responders as it develops its Emergency Response Program. It is through this coordination that the local community emergency responders are made aware of the worst case incident that could occur at Facility Z. Assume that the worst-case incident has been found to be an explosion of a large tank of ethylene oxide. In addition to the facility, hazardous chemicals are transported on the area roadways, shown in Figure B-1.

The process of evaluating the risk metric for the region depicted in Figure B-1 requires some form of survey to identify the types and number of shipments on the region's transportation

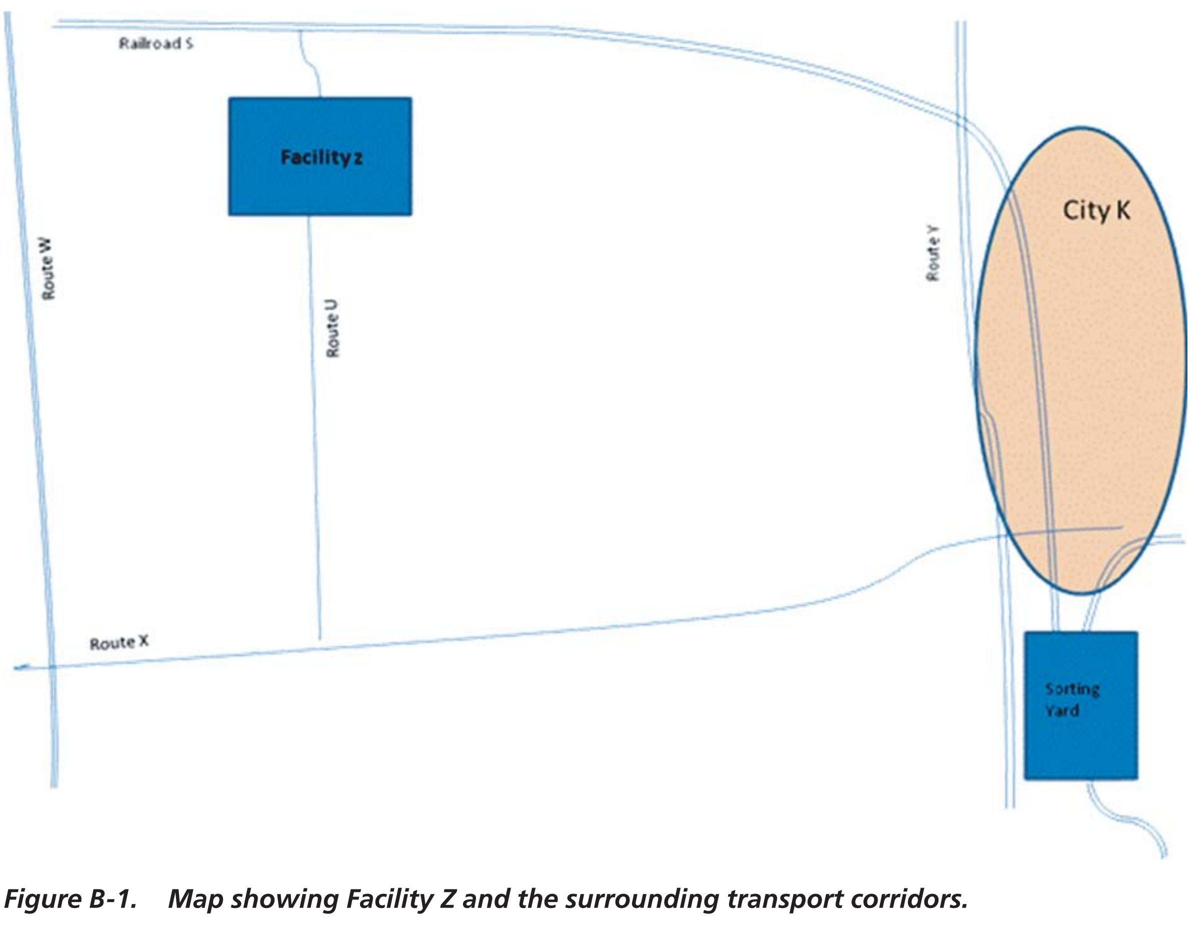


Figure B-1. Map showing Facility Z and the surrounding transport corridors.

networks. Ideally, it would be a formal commodity flow survey, but if the resources are not available for such a survey, tabulations of hazardous material shipments can be made by setting up observation points on each of the highways, not necessarily at the same time, to tabulate hazmat flows. Discussions with local railroad managers, particularly at the sorting yard, might be sufficient to identify the flow of hazmat on the railroad.

Once information is available on the types of hazmat present at Facility Z, the next step is to estimate the types of hazards that might be present and then the likelihood that these hazards will be realized. The Risk Management Plan developed to meet EPA regulations identified an ethylene oxide fire and explosion and chlorine release as the limiting accidents at the facility. The chlorine release was divided into a small release and a large release because of the different emergency response situations they present. To an emergency responder, a small release has the potential for continuing for a long time, taxing the resources of the emergency response community. Through discussions with the safety staff at the facility, the frequency of these accidents was roughly estimated and is shown in the fourth column in Table B-1. Since the vulnerability levels represent accident or release frequencies that differ by factors of 100, it is often easy to estimate the vulnerability level by recalling similar accidents at other facilities. For example, a keen observer might recall that there seems to be an explosion at a petrochemical plant several times a year. If there were only 100 petrochemical facilities in the country, then the hazard from an explosion at those facilities would be quite high, probably a 4 or a 3 on the vulnerability scale. Note that there would have to be 10,000 or more such facilities to justify assigning a 2 as the vulnerability level, indicating the estimated accident frequency for the facility to be between 10^{-4} and 10^{-6} per year. The fire frequency for ethylene oxide was assigned a vulnerability value of 4 largely because the material is highly flammable; its flammable range is between 3 and 100 percent. The frequency of leaks in the case of small chlorine or ethylene oxide leaks followed by fires was considered to be 1 per 10 years because both chlorine and ethylene oxide tank cars must be connected and disconnected almost 100 times per year. The probability of a single human error will be a significant factor in the accident frequency for those activities.

Table B-1. Facility vulnerability assessment.

Facility or Route	Hazard	Y/N	Accident Frequency	Vulnerability
		[H]	1/year	[V]
Facility Z	Fire (Ethylene Oxide)	1	1.00E-01	4
Facility Z	Explosion (Ethylene Oxide)	1	1.00E-05	2
Facility Z	Toxic Gas (Chlorine) (L)	1	1.00E-03	3
Facility Z	Toxic Gas (Chlorine) (S)	1	1.00E-01	4

APPENDIX C

Estimating the Consequence Term in the Risk Metric Equation

Human-Health Consequences

The human-health aspect of the consequence term is quantified by estimating the number of individuals that could receive permanent health effects from a release as well as the severity of environmental consequences. A facility with processes that fall under 40 CFR Part 68 Subpart G, the facilities Risk Management Plan (RMP), must make the plan available to local emergency response personnel and use the toxic endpoints defined in 40 CFR 68.22 to identify the number of off-site individuals who could be exposed to the listed hazards. When assessing the consequences along a transport corridor, the techniques used to estimate the population that is potentially exposed to the release for a fixed facility could also be used for a release along the transport route. Since the release could occur at any point along the route, the number of individuals that could be exposed can be estimated by overlaying the threat area—defined using the endpoints listed in 40 CFR 68.22 or the ERPG-2/TEEL-s endpoints—onto the average (or worst-case) residential population density along the route. In order to establish the residential population that could be affected, an "impact distance" must be selected. Clearly, the distance would vary according to the type of hazard involved in an incident. For example, the Emergency Response Guidebook (ERG 2008) lists a number of protection distances for responders that are based on different materials. Although the distances are not specifically correlated to population exposure, they provide reasonable distances that can be used for this Guide. Eight hundred meters (approximately one-half mile) has been selected because it represents a distance that encompasses the endpoints of the great majority of hazmat releases and related events.

The residential population could be estimated by either using a GIS with population and route layers, where the average population density can be calculated by using the average population density within 800 meters from the hazmat route or fixed facility, or by dividing the region's residential population by the region's land area to obtain an average per unit of land area density. Using normal atmospheric dispersion parameters in the ALOHA (2007) dispersion model and using the PROBIT (probability estimates) equations for estimating fatalities (CCPS 2000), the plume area inside the 2 percent fatality line for a release from a bulk shipment of 20,000 kilograms of chlorine in 8 minutes results in a plume area of 0.65 km^2.

A corresponding scenario for ammonia, which is not a dense gas, results in an area of 0.04 km^2, and for acrolein, another toxic heavy gas, an area of 2.3 km^2. One of the reasons why the acrolein area is so much greater is because once released, it forms a pool that takes much longer—30 minutes—to evaporate. Since the probability of a fatality for acrolein using the PROBIT coefficients is a function of the concentration times the exposure time, the longer exposure time results in more fatalities. For chlorine and ammonia, the probability of a fatality is a function of the concentration squared times the exposure time, which makes the concentration a more determining parameter in the PROBIT equation. The 50 percent contour obtained from ALOHA using average meteorological conditions is considered to provide a reasonable estimate of fatalities if no effort were made to protect the population from the release. Once the area inside the contour is estimated, the area can be expressed in individuals/km^2 area and multiplied by the population density to estimate the number of fatalities. The number of fatalities can then be translated into a consequence measure using the CARVER scale (0 = 1 to 10 fatalities; 1 = 11 to 100 fatalities; etc.).

ALOHA is the logical tool to estimate impact areas, as it was designed to be an emergency response planning tool. It has a library that contains the properties of numerous hazmat as well several commonly used endpoints. Regarding the toxic endpoints, the ALOHA library provides several choices. The default concentrations endpoints are the 60-minute Acute Exposure Guideline Levels [AEGL (60 min)]. However, you can select ERPG or TEEL concentrations. The ERPG concentrations are developed and formally adopted by the American Industrial Hygiene Association (AIHA). The TEELs (Temporary Emergency Exposure Limit) values have been developed by The Subcommittee on Consequence Assessment and Protective Actions (SCAPA) that is part of the Comprehensive Emergency Management System funded by the U.S. Department of Energy/National Nuclear Security Administration. ALOHA also estimates the damage area for three other potential concerns for emergency response planners: fires, BLEVEs, and the plume area where flash fires are possible because the lower flammable limit might be exceeded. The extent of the impact is judged by determining the number of people within the impact zones that may receive a significant exposure. Where sheltering-in-place is a feasible option, the fraction of the people normally outside or inside with the windows open can be used to reduce the number of people estimated to receive significant exposures, which is typically only a small percentage of the potentially exposed population. It is reasonable to assume that everyone within the hazard zone will be affected for fires and explosions/BLEVEs. In addition, if the toxic release is preceded by a fire or explosion that caused structural damage, the effectiveness of the structures to shelter people might be compromised.

Since the goal is to use the CARVER scale, whatever measure used must be translated into fatalities. If one of the ERPG or AEGL limits is used as an estimate of fatalities, a large number of fatalities would be projected. These limits assume everyone within the contour, say the EPRG-2 contour, will be a fatality. In actuality, while people exposed at the ERPG-2 level might become disorientated after a 30-minute exposure, many will be able to walk from the plume prior to becoming disorientated. PROBIT curve for 50 percent fatality will result in a much smaller number. Even this curve will result in a large number of fatalities, but is considered more realistic given the assumption that no protective measures are taken. The resulting estimate of fatalities for three postulated rail accidents in the region are shown in Table C-1. On the CARVER scale, these three accidents have [C] values of 2, 5, and 3, respectively.

Environmental Consequences

For the environmental damage estimates, the goal will be to determine, for each type of hazard, which economic damage category is appropriate. For most, it will be Level 1, less than a million dollars. One way to estimate the environmental damages for hazards that have the capability of totally destroying a structure—flash fires, fires, and BLEVEs or explosions—is to use ALOHA to estimate the damage radius and then use Table C-2 to estimate which level of loss is appropriate. A fire, if not prevented from spreading, can involve nearby structures and do extensive damage. An explosion or BLEVE can do a lot of structural damage, resulting in replacement of

Table C-1. Estimated fatalities from postulated railroad accidents.

Facility or Route	Hazard	Quantity of Material	Damage Radius or Radii for Ellipse	Damaged Area	Population Consequence
		kg	meters	acres	people
Railroad s	BLEVE (Ethylene Oxide)	40,000	80	1.24	2
Railroad s	Toxic Gas (Chlorine) (L)	20,000		1630.23	3,057
Railroad s	Toxic Gas (Chlorine) (S)	20,000		44.53	83

(S) small release; (L) large release.

the structure as part of the damage estimate. The damage radius is estimated using models like ALOHA, and then the value of houses or businesses that might be within the damage radius is then used to estimate the costs. Table C-2 was developed for another project to estimate economic losses on a per-acre basis when the structures or habitat are essentially destroyed. The estimates were developed predominately for security risks, but should be equally valid for addressing safety risks. The endpoints for damage to structures should use the ALOHA endpoints for flash fires, explosions/BLEVEs, and the extent of flammable gas clouds. Since the structures would not be entirely destroyed, it might be appropriate to use 10 percent of the replacement value. This would represent replacement of windows and repair of minor structural damage.

Land contamination impacts are a concern if the released material kills plants and trees or forms a particulate that is deposited on the ground. For example, if arsine (AsH_3) is released into the atmosphere, it will react to form arsenic oxide (As_2O_3) that will deposit on the ground. You can obtain an estimate of the ground concentration at any location by multiplying the maximum airborne concentration in mg/m^3 by the duration of the release in seconds and the particle deposition velocity expressed in meters/sec. Preventing human exposure by confiscating crops or decontaminating land or buildings would result in the greatest costs. It would be very conservative to assume the same area used for estimating population impacts experienced some damage from the release event. However, since the damage would not be complete, it would be unreasonable to use the values in the second part of Table C-2 for land and aquatic contamination. The extent of the land impacts is also sensitive to the type of hazard. Ammonia will do a lot of damage to a wetland because of its aquatic toxicity, but it is a beneficial fertilizer on farmland. Again, 10 percent of the land and aquatic land contamination numbers shown in Table C-2 might be a reasonable estimate.

The emergency response planning organization should use Table C-2 as a guide and adjust the level of impacts as appropriate for their region. It would be reasonable to increase or decrease the estimates shown in Table C-2 based on the cost of living in the region. For example, if the scenario of concern is a security risk to a structure of national significance, commonly termed

Table C-2. Estimated per-acre values.

Area Type	Residential	Commercial	Industrial	Land Use	Farm Land	Wetland
Rural	$ 150,000	$ 1.2 million	$ 2.4 million	Fallow	$ 200	$ 50,000
Suburban	$ 1.2 million	$ 12 million	$ 24 million	Low-value crop	$ 1,000	$ 100,000
Urban	$ 8 million	$ 50 million	$ 80 million	High-value crop	$ 400,000	$ 400,000

Table C-3. Estimated infrastructure damage from BLEVEs and releases on railroad.

Facility or Route	Hazard	Quantity of Material	Typical Type Infrastructure Damaged	Land Area Damaged	Number of Infrastructure Units in Hazard Zone	Infra-structure Damage
		kg		acres	#	$
Railroad s	BLEVE (Ethylene Oxide)	40,000	Residential / Rural	1	2	300,000
Railroad s	Toxic Gas (Chlorine) (L)	20,000	Residential / Rural	0.92	2	300,000
Railroad s	Toxic Gas (Chlorine) (S)	20,000	Residential / Rural	0.09	0	0

(S) small release; (L) large release.

"iconic structures," whose replacement value might be much higher than any number in the above table, then a higher damage estimate might be used. Just to show the extent of possible damages, the failure of the I-35 Bridge in Minneapolis was estimated to result in economic costs to the community that exceeded $300 million. Clearly this would have been classified as a "very high" economic cost, one much higher than any value shown in Table C-3.

The next damage estimate is for land damage. This estimate is shown in Table C-4. The possible land values for the region are shown in Table C-2 depending on the type of land damaged.

Consequence measures for each of the accidents considering population impacts and infrastructure and land damage from the postulated accidents are shown in Table C-5; the maximum impact from each of the consequence measures should be carried forward.

The same technique would be used for all the accident scenarios in the region. The results of this assessment are shown in Table C-6.

Table C-4. Estimated damage to land values from postulated railroad accidents in region.

Facility or Route	Hazard	Quantity of Material	Land Area Damaged	Typical Type of Land Damaged	Environmental Consequence
		kg	acres		$
Railroad s	BLEVE (Ethylene Oxide)	40,000	1	Low Crop Value	1,000
Railroad s	Toxic Gas (Chlorine) (L)	20,000	0.92	Low Crop Value	917
Railroad s	Toxic Gas (Chlorine) (S)	20,000	0.09	Low Crop Value	92

(S) small release; (L) large release.

Table C-5. Consequence measures for postulated accidents on rail line s.

Facility or Route	Hazard	Population Consequence	Infrastructure Damage	Consequence Environmental	Maximum Consequences
		[C]	[C]	[C]	[C]
Railroad s	BLEVE (Ethylene Oxide)	2	1	1	2
Railroad s	Toxic Gas (Chlorine) (L)	5	1	1	5
Railroad s	Toxic Gas (Chlorine) (S)	3	1	1	3

(S) small release; (L) large release.

Table C-6. Risk portfolio—H, V, and C terms.

Hazard [H]		Vulner-ability [V]	Consequence [C]*		Capability [ERC]	Response Time [RTF]	Risk Metric
Facility or Route	Description		Pop.	Env.			
Facility Z	Fire (ethylene)	3	4	2			
Roads x, y	Fire (gasoline)	3	2	1			
Facility Z	Explosion (ethylene)	2	3	2			
Railroad s	BLEVE (ethylene)	4	2	1			
Facility Z	Toxic Gas (chlorine) (L)	3	4	1			
Facility Z	Toxic Gas (chlorine) (S)	4	2	2			
Railroad s	Toxic Gas (chlorine) (L)	3	5	1			
Railroad s	Toxic Gas (chlorine) (S)	4	3	1			
Roads x, w	Toxic Gas (ammonia) (L)	1	4	2			
Roads x, w	Toxic Gas (ammonia) (S)	2	2	1			
Roads x, u	Toxic Liquid (37% HCl) (L)	2	2	2			
Roads x, u	Toxic Liquid (37% HCl) (S)	3	1	1			

*The maximum of the consequence values (population and environmental) are used in the Risk Metric calculation.
(S) small release; (L) large release.

APPENDIX D

Additional Details on Capability Assessment

Development of the Emergency Response Capability Approach

Much has been done by federal and state governments since 2002 to standardize the resource typing and definitions of all existing and required capabilities necessary for homeland security and emergency management operations. The Department of Homeland Security's (DHS) Federal Emergency Management Agency's (FEMA) publication 508-4 Typed Resource Definitions for Fire and Hazardous Materials Resources (2005) provides three types of hazmat entry teams, based upon a combination of existing standards and based against identified hazards identified at the national level. It is important to note that the Typed Resource Definitions contained within FEMA 508-4 address only National Tier One assets which are utilized under the Emergency Management Assistance Compact (EMAC). These Tier One assets are limited to only the most capable resources maintained by select local, state, and/or federal sponsors, such as New York City (NY), Houston (TX), Los Angeles (CA), and other equivalent areas with a sufficient tax base for establishing, training, certifying, equipping, exercising, and maintaining teams and associated personnel on full-time or near full-time availability. The methodology used for this Guide incorporates Tier Two standards for Hazmat Response Teams at the state and local levels. These assessments have tended to focus on planning effective emergency responses to WMD attacks on large metropolitan areas. The focus here is on the smaller communities grouped under Tier 5, fewer than 10,000 individuals, in the draft DHS document.

Based upon a review of the National Planning Scenarios and the National Response Framework Incident Annexes, the hazards identified at the national level predominately focus on terrorist or criminal use of specific toxic or dangerous materials during an intentional act, instead of the accidental releases associated with the inter/intra-state, multimodal storage and/or transportation of all hazmat. In addition, these federal efforts, such as FEMA 508-4, do not include resource typing criteria for the entire resource set necessary to successfully manage a release of hazmat in storage, use, or transportation. For example, FEMA 508-4 provides typing criteria for the Hazardous Materials Response (Emergency Support Function #10) Hazmat Entry Team (pages 13–17) without the inclusion of parallel, coordinated typing criteria for casualty decontamination (reference to decontamination within FEMA 508-4 is solely for decontamination of the entry team personnel), incident command, and similar supporting elements. A review of the FEMA 508 Typed Resource Definitions series fails to locate any equivalent effort for casualty decontamination; this determination is supported by notes in the draft document listed below requiring the development of a typed resource or mission package to support incident assessment, casualty rescue, and casualty decontamination.

DHS (2009) is also in the process of developing a Target Capabilities List (TCL) specific to the *Response Capability* [for] [Weapons of Mass Destruction] *WMD/Hazardous Materials (Hazmat) Rescue.* In the existing draft document, the TCL employs a five-class risk system based predominately upon jurisdictional population with additional risk factors for various types and kinds of storage, use, and transportation capabilities. These risk factors do not address pipelines, maritime facilities or transportation, or nonchemical (e.g., biological, radiological, explosive, etc.) storage facilities or industrial manufacturing or use of such nonchemical hazard classes, except under the term "large quantities of hazardous materials." In developing the methodology for this Guide, the use of two systems defined by "class," such as the 2008 Emergency Response Guidebook and the draft TCL, poses additional challenges for successful employment and ease of use for the methodology.

Therefore, the methodology used in this Guide does not represent verbatim application of these approved or draft documents, but rather incorporates the applicable, approved elements of these documents into the methodology. Risk management is often strongly influenced by the perceived political and social implications of a particular methodology as well as anticipated reactions and bias by specific user communities. This methodology is focused on the scope identified within the project charter to address all hazmat response operations to all identified hazard classes across all applicable modes of transportation and use, which is a scope not addressed by any single regulation, guide, or document approved at the Federal level.

Calculating the Risk Metric Equation

Table D-1 shows the further development of the terms in the Risk Metric equation. In this case, the ERC value has been calculated and added to each of the hazard scenarios.

Table D-1. Further development of the risk metric equation—adding the capability value.

Hazard [H]		Vulnerability [V]	Consequence [C]*		Capability [ERC]	Response Time [RTF]	Risk Metric
Facility or Route	Description		Pop.	Env.			
Facility Z	Fire (ethylene)	3	4	2	1		
Roads x, y	Fire (gasoline)	3	2	1	4		
Facility Z	Explosion (ethylene)	2	3	2	1		
Railroad s	BLEVE (ethylene)	4	2	1	4		
Facility Z	Toxic Gas (chlorine) (L)	3	4	1	3		
Facility Z	Toxic Gas (chlorine) (S)	4	2	2	1		
Railroad s	Toxic Gas (chlorine) (L)	3	5	1	3		
Railroad s	Toxic Gas (chlorine) (S)	4	3	1	1		
Roads x, w	Toxic Gas (ammonia) (L)	1	4	2	4		
Roads x, w	Toxic Gas (ammonia) (S)	2	2	1	4		
Roads x, u	Toxic Liquid (37% HCl) (L)	2	2	2	4		
Roads x, u	Toxic Liquid (37% HCl) (S)	3	1	1	4		

(S) small release; (L) large release.

APPENDIX E

Estimating Emergency Response Times

For community-wide hazmat emergency response assessments or where planning agencies have limited funds to support more detailed analysis, a representative response time can provide a qualitative measure to incorporate in planning activities. For example, the 85th percentile of response times across the jurisdiction could be estimated (i.e., the time within which appropriate response could reach 85 percent of the jurisdiction).

Where resources permit, a five-step geospatial approach is desired:

1. Create a geospatial layer of responder location(s) for the jurisdiction. For higher response Tiers, the responders are probably dispersed and the planners need to determine how to define the critical mass. One option is to measure initial response time from the location of the hazmat response vehicle(s).
2. Create geospatial layer of hazard locations.
   a. For facilities, this is a point layer with the type of business, hazardous material, hazmat class, isolation distance, etc. Each jurisdiction can determine which facilities are included.
   b. For transportation networks, this is a road/rail/pipe/waterway centerline layer(s) with the class of network link (freeway, arterial road, mainline rail, etc.) and a measure of expected hazmat flow (high, medium, low).
3. Perform a network "service area" analysis as shown in Figure E-1.
   a. The bands reflect impedance values, typically distance, which can be converted to response times based on posted speed limits or a related factor.
   b. Traditional "shortest path" routing algorithms can be used to determine the expected travel time from each capability to any other point in the transportation network. For a relatively small number of hazard sites, this can be done using on-line mapping tools such as Google Maps or MapQuest. For large areas, a GIS software package is desirable.
   c. Response time values corresponding to the different bands are based on policy and should reflect the type of jurisdiction (urban, suburban, rural, or remote).
4. Use the adjusted consequence value from Step 14 in the risk equation instead of the previously determined value. Note: These are representative values and not based on any analyses.
5. Figure E-1 can help identify facilities that exist outside a set response time for a more detailed evaluation to determine if additional mitigation strategies should be implemented for those locations. Color-coding them by hazard class would give a quick prioritization for this evaluation.

Figure E-2 provides a representative map showing response times to link segments for materials transported through a jurisdiction. The process is similar to that defined in Figure E-1, except that the response time is added as an attribute to each transportation link. As response times along each road segment can be stored as network attributes in a GIS, a planner can visually examine all network segments (with color-coded highlighting) to see where the response times for a

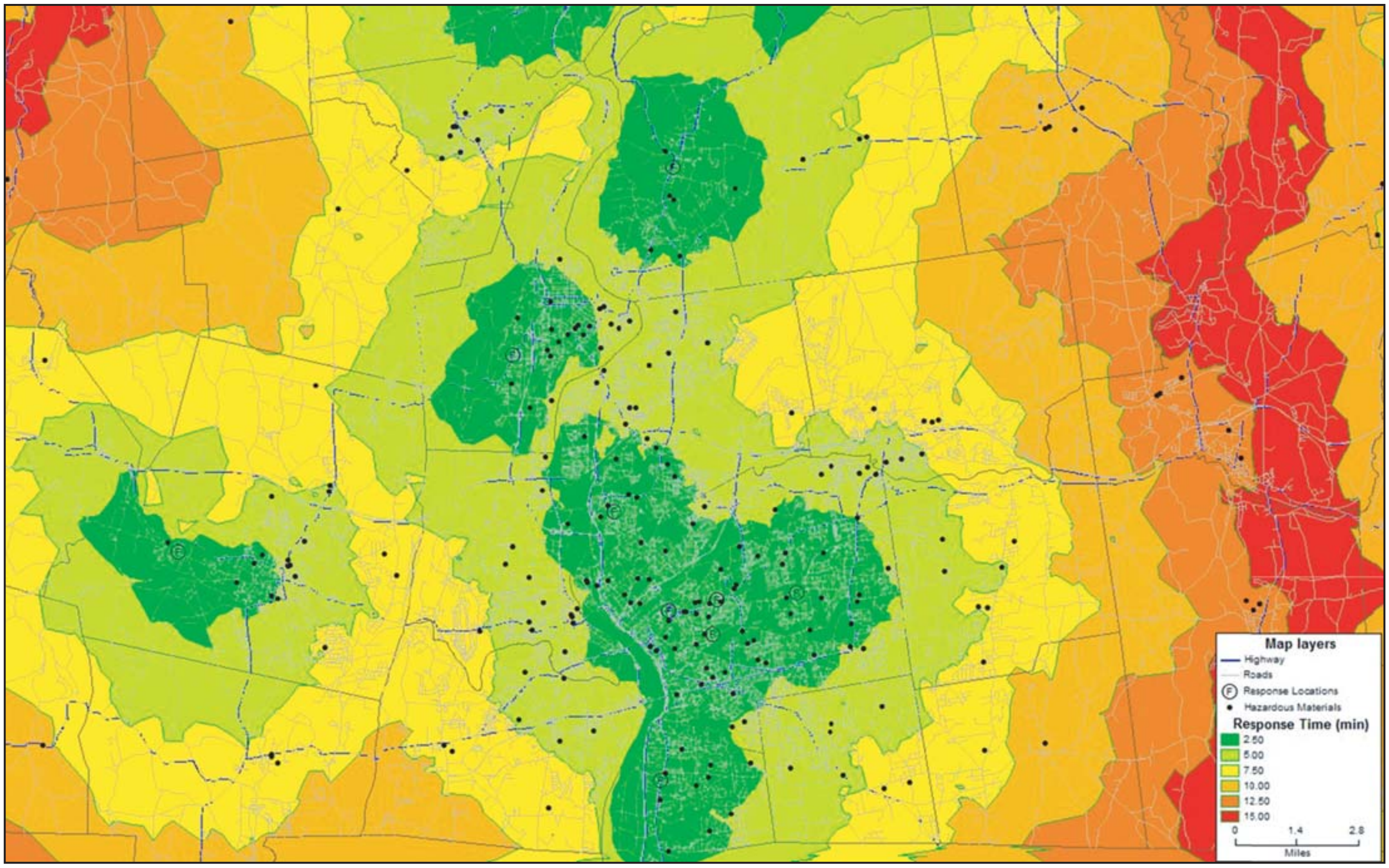


Figure E-1. Network service area analysis.

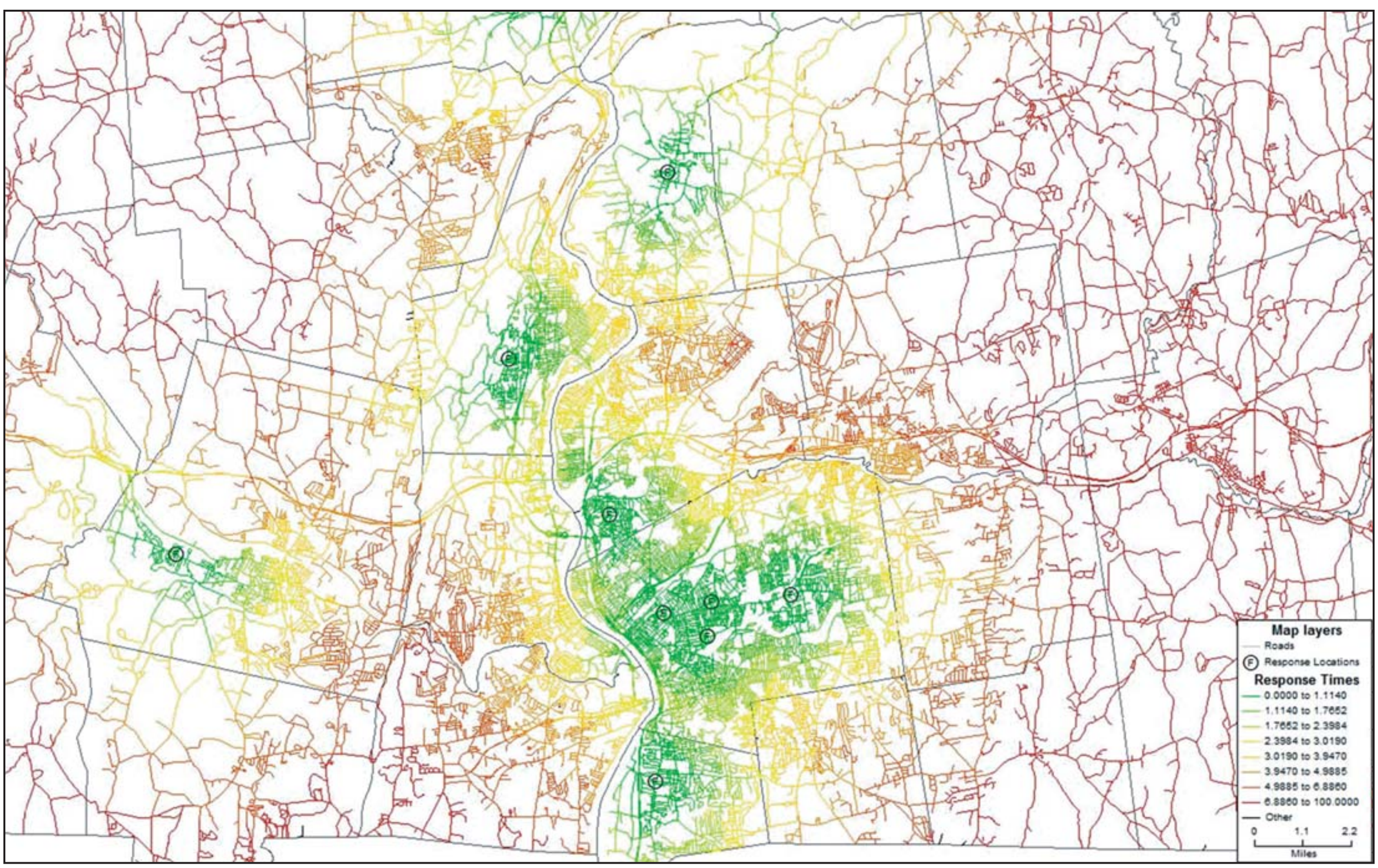


Figure E-2. Example network response time display.

Table E-1. Continued development of the risk metric equation, adding the Response Time Factor [RTF].

Hazard [H]		Vulner-ability [V]	Consequence [C]*		Capability [ERC]	Response Time [RTF]	Risk Metric
Facility or Route	Description		Pop.	Env.			
Facility Z	Fire (ethylene)	3	4	2	1	1	
Roads x, y	Fire (gasoline)	3	2	1	4	1	
Facility Z	Explosion (ethylene)	2	3	2	1	1	
Railroad s	BLEVE (ethylene)	4	2	1	4	1	
Facility Z	Toxic Gas (chlorine) (L)	3	4	1	3	5	
Facility Z	Toxic Gas (chlorine) (S)	4	2	2	1	1	
Railroad s	Toxic Gas (chlorine) (L)	3	5	1	3	5	
Railroad s	Toxic Gas (chlorine) (S)	4	3	1	1	1	
Roads x, w	Toxic Gas (ammonia) (L)	1	4	2	4	5	
Roads x, w	Toxic Gas (ammonia) (S)	2	2	1	4	1	
Roads x, u	Toxic Liquid (37% HCl) (L)	2	2	2	4	1	
Roads x, u	Toxic Liquid (37% HCl) (S)	3	1	1	4	1	

(S) small release; (L) large release.

specific capability level exceed a threshold value such as that defined in Chapter 6 based on jurisdictional characteristics.

The assignment of a value for the Response Time Factor [RTF] uses the performance objectives in Step 5 with the actual response times for each of the four target outcomes—Assess, Manage, Rescue, and Control—shown in Table 18. For each scenario, the ratio of the actual average response time to the goal response time for each target outcome is calculated and the value for the RTF is assigned using Table 19. For each scenario the maximum value for RTF is entered in the Risk Metric Table. The result of this calculation is shown in Table E-1.

The final step is to multiply all the values for each scenario, using the maximum of the consequence estimate, to get the Risk Metric for each scenario. This is shown in Table 21 in the main body of the report.

APPENDIX F

Bibliography

(Note: Additional sources are listed in Appendix A.)

ALOHA (February 2007). ALOHA (Areal Locations of Hazardous Atmospheres) User's Manual. The CAMEO Software System. U.S. Environmental Protection Agency and National Oceanic and Atmospheric Administration. http://www.epa.gov/swercepp/web/docs/cameo/ALOHAManual.pdf.

Brown, D. F., H. M. Hartmann, W. A. Freeman, and W. D. Haney (June 2009). Development of the Table of Initial Isolation and Protective Action Distances for the 2008 Emergency Response Guidebook, Argonne National Laboratory, Decision and Information Sciences Division, ANL/DIS-09-2. http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/Argonne_Report.pdf.

BTS (2008). National Transportation Statistics 2008. U.S. DOT, Research and Innovative Technology Administration, Bureau of Transportation Statistics. http://www.bts.gov/publications/national_transportation_statistics/2008/pdf/entire.pdf.

CCPS (2000). Guidelines for Chemical Process Quantitative Risk Analysis, 2nd Edition. Center for Chemical Process Safety. Wiley. ISBN: 0-8169-0720-5.

CFS (2007). Commodity Flow Survey. Website of U.S. DOT Research and Innovative Technology Administration and Bureau of Transportation Statistics. http://www.bts.gov/publications/commodity_flow_survey/.

DHS (February 17, 2009). DRAFT Response Capability: WMD/Hazardous Materials (HazMat) Rescue. No sponsor or performing organization given. Published by National Association of State EMS Officials (NAESMO). http://www.nasemso.org/Projects/DomesticPreparedness/documents/WMDHazMatCapability-17February09.pdf

EPCRA (October 17, 1986). Emergency Planning and Community Right-to-Know Act of 1986. 42 U.S.C. §11001 et seq. Authorized by Title III of the Superfund Amendments and Reauthorization Act (SARA). www.epa.gov.

ERG (2008). Emergency Response Guidebook: A Guidebook for First Responders During the Initial Phase of a Dangerous Goods/Hazardous Materials Incident. Developed jointly by U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico (SCT). Available via Pipeline and Hazardous Materials Safety Administration. http://www.phmsa.dot.gov/staticfiles/PHMSA/DownloadableFiles/Files/erg2008_eng.pdf.

ERG 2008 Training Package (2008). Emergency Response Guidebook 2008 Training Package (English Version, PowerPoint), CAUTEC, Transport Canada, page 32. http://www.tc.gc.ca/eng/canutec/guide-training_ppt-229.htm.

ERGO (2008). Emergency Response Guidebook. CANUTEC software version. Transport Canada. http:// www.tc.gc.ca/eng/canutec/guide-ergo-221.htm.

FAF (November 2010). Freight Analysis Framework. Website of U.S. DOT Federal Highway Administration, Freight Management and Operations. http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm.

FEMA (March 2009). Comprehensive Preparedness Guide (CPG) 101: Developing and Maintaining State, Territorial, Tribal, and Local Government Emergency Plans. U.S. Department of Homeland Security, Federal Emergency Management Agency. http://www.fema.gov/pdf/about/divisions/npd/cpg_101_layout.pdf.

FEMA (July 2005). Typed Resource Definitions: Fire and Hazardous Materials Resources, FEMA 508-4, U.S. Department of Homeland Security, Federal Emergency Management Agency. http://www.fema.gov/pdf/emergency/nims/fire_haz_mat.pdf.

FMCSR Federal Motor Carrier Safety Regulations. 49 CFR Part 397, U.S. DOT, Federal Motor Carrier Safety Administration. http://www.fmcsa.dot.gov/rules-regulations/administration/fmcsr/fmcsrguidedetails.aspx?rule_toc=766&section_toc=766 (accessed October 2010).

HAZWOPER Hazardous waste operations and emergency response, U.S. Department of Labor, Occupational Safety and Health Administration, 29 CFR Part 1910.120. www.osha.gov. http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=9765 (accessed October 2010).

Kawprasert, A., and C. P. L. Barkan (2010). Effect of Train Speed on Risk Analysis of Transporting Hazardous Materials by Rail. Transportation Research Record, No. 2159, pp. 59–68. http://ict.illinois.edu/railroad/CEE/pdf/Kawprasert%20&%20Barkan%202010.pdf.

NFPA Standard 472 (2008). Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents, National Fire Protection Association. www.nfpa.org.

NRHM Routing Guidelines (October 2007). Routing of non-radioactive hazardous materials. 72 FR 55703. 49 CFR Part 397.69. U.S. DOT, Federal Motor Carrier Safety Administration.

OHS National Oil and Hazardous Substances Pollution Contingency Plan, U.S. Environmental Protection Agency, 40 CFR 300. www.epa.gov. http://www.elaw.org/system/files/us.nationalcontingencyplan.pdf (accessed October 2010).

RMP (June 20, 1996). Risk Management Plan. 61 FR 31726. Title 40 CFR Part 68, Protection of the Environment: Chemical Accident Prevention Provisions, Subpart G, §68.150–195.

SAFETEA-LU (August 10, 2005). The Safe, Accountable, Flexible and Efficient Transportation Equity Act: A Legacy for Users, H.R. 3, Section 4126, Commercial Vehicle Information Systems and Networks Deployment, 109th U.S. Congress, First Session.

SARA (October 17, 1986). Superfund Amendments and Reauthorization Act of 1986. www.epa.gov.

Texas A&M University (May 2010). Hazardous Materials Commodity Flow Data and Analysis, Revised Final Report. HMCRP Project 01. http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1603.

U.S.DOT Hazardous Materials (Hazmat) Regulations. Transportation, Title 49 of the Code of Federal Regulations, Subtitle B, Chapter I, Subchapter A—Hazardous Materials and Oil Transportation. http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&tpl=/ecfrbrowse/Title49/49cfrv2_02.tpl (accessed October 2010).

APPENDIX G

Final Report for HMCRP Project 03

CONTENTS

G.1 Introduction

The Final Report Objectives

The objective of this project was to develop a guide for assessing community emergency response needs and capabilities for hazardous materials (hazmat) releases. This final report documents all project tasks, including those in Phase 1 already documented in the Interim Report submitted to the HMCRP Project 03 oversight panel in March 2009. This final report discusses the test of the draft Guide, including the development of the test plan, its implementation, and any issues or problems that were encountered during the test to assist future researchers to avoid them. The final report also discusses the changes made to the Guide based on the results of the test.

Problem Statement

The Guide addresses four elements:

1. Conducting state, regional, and local hazardous materials emergency response needs assessments;
2. Developing, maintaining, and sharing capability assessments;
3. Aligning assessed needs with various levels of capability; and
4. Identifying shortfalls where additional/different capabilities are warranted.

The Guide addresses approaches for identifying and recording changes in response capability over time to allow for ongoing implementation. The Guide has been prepared, tested by planners in the field, and revised based on this feedback.

Research Approach

The research approach for this project was as follows.

Literature Review

The study team conducted a thorough literature review to identify approaches to emergency response planning and to assessing and maintaining information on local emergency response needs and capabilities. In addition, the study team conducted interviews with various stakeholders and experts in the field to determine the range of practices related to hazardous materials emergency response planning and to identify best practices. A summary of the literature review and the stakeholder interviews is presented in Section G.2 of this report.

Assessment Methodology

The key methodologies required for the Guide were developed in Tasks 2 through 4 and as noted above addressed:

1. Conducting state, regional, and local hazardous materials emergency response needs assessments;
2. Developing, maintaining, and sharing capability assessments;
3. Aligning assessed needs with various levels of capability; and
4. Identifying shortfalls where additional/different capabilities are warranted.

The literature review and interviews conducted for this project made it clear that the most difficult task was related to hazardous materials emergency response capability assessments. The range of potential responders—from the public fire service, to facility employees, to private contractors—required a flexible approach to retain a connection to the requirements and standards that each type of responder is familiar with and under which they operate. This approach must also include an integrated view of the response capability available to a community or jurisdiction.

A further challenge was to retain the concepts adopted for classifying response at the interstate and national levels, yet still address the local responders that deal with the vast majority of hazardous materials incidents.

These methodologies are presented in Section G.3 of this report in an integrated format.

Updated Phase 2 Work Plan

The information and lessons learned from Phase 1 were used to slightly modify the approach for conducting Phase 2. The revised Phase 2 Work Plan was transmitted to HMCRP on March 31, 2009.

Updated Task 8 Test Plan

The knowledge gained during Phase 1 did not suggest any necessary revisions to the specific implementation of Task 8 to test the use of the Guide. The test plan is presented in Section G.4 of this report.

G.2 Literature Review

Introduction

The study team conducted searches for relevant literature, focusing on information related to developing a Guide for planning organizations to inventory the hazardous materials within their jurisdictions, determine the response capabilities and gaps based on their inventory, and provide guidance on how to best allocate their resources for the hazardous materials emergency response needs within their communities. As a result, a variety of sources were identified and subsequently reviewed. The remainder of this chapter describes the results of that process.

Synopses of Relevant Information

The discussion below contains synopses of the most important relevant literature that were obtained and reviewed. The synopses appear in no particular order.

Several hazardous materials response guides have already been established, and the methodologies and Guide being developed for this project are designed to complement them. In addition to looking at these emergency response guides, it is important to seek ways in which communities have developed (or are developing) a comprehensive methodology to build their own hazardous materials guides. This includes discussions on assessing baseline needs, assessing capabilities, and aligning needs with capabilities.

Established Hazardous Materials Response Guides

There are four well-known, established hazmat response guides developed by the National Response Team (NRT), Federal Emergency Management Agency (FEMA), and the Department of Health and Human Services (HHS). In addition to guides in the United States, several international guidelines were also researched.

The NRT's *Hazardous Materials Emergency Planning Guide* (NRT-1) was developed to help local communities prepare for incidents that may involve hazardous materials. It describes how to form a local planning team, find a team leader, identify and analyze hazards, identify existing response equipment and personnel, write a plan, and keep a plan up-to-date.

FEMA developed the National Incident Management System (NIMS) so that responders from different jurisdictions and disciplines can work together better to respond to natural disasters and emergencies. This system provides a consistent nationwide template to enable federal, state, tribal, and local governments, the private sector, and nongovernmental organizations to work together to prepare for, prevent, respond to, recover from, and mitigate the effects of incidents regardless of cause, size, location, or complexity. Based on the interviews, it has been suggested that the emergency responders' response should be tied into NIMS, and that it should be used as a baseline template that states can build upon.

FEMA has also developed the *Guide for All-Hazard Emergency Operations Planning (EOP)* as a state and local guide to provide emergency managers and other emergency services personnel with information on FEMA's concept for developing risk-based, all-hazard emergency operations plans. This Guide clarifies the preparedness, response, and short-term recovery planning elements that warrant inclusion in state and local EOPs. It offers recommendations on how to deal with the entire planning process—from forming a planning team to writing the plan. It also encourages emergency managers to address all of the hazards that threaten their jurisdiction in a single EOP instead of relying on stand-alone plans. This Guide should help state and local emergency management organizations produce EOPs that: serve as the basis for effective response to any hazard that threatens the jurisdiction; facilitate integration of mitigation into response and recovery activities; and facilitate coordination with the federal government during catastrophic disaster situations that necessitate implementation of the Federal Response Plan.

The Emergency Preparedness Resource Inventory (EPRI), which was developed by HHS, is a web-based tool for local, regional, and state planners to develop an inventory of resources in the event of a bioterrorist attack. It is a software tool that allows users to create an inventory for any region, state, or locality and can create automated reports for use in preparedness, planning, and incident response.

The *Emergency Response Guidebook 2008* is an international guide for use by first responders to quickly identify and respond to hazmat incidents. This guide was developed jointly by Transport Canada, the U.S. Department of Transportation, Mexico's Secretariat of Transport and Communications, and Argentina's Centro de Información Química para Emergencias. It was established to assist first responders to an emergency scene and helps to identify hazardous materials and the dangers of the hazmat.

Transport Canada, which is the Canadian emergency response organization, has established guidelines for dangerous goods. In Canada, Emergency Response Assistance Plans (ERAPs) are required by the Transportation of Dangerous Goods Regulations for certain dangerous goods that require special expertise and response equipment. The plans are intended to assist local emergency responders by providing them with technical experts and specialized equipment at the accident site.

Development of a Comprehensive Methodology

These hazmat response guides delve into detail on how to help communities assess their baseline needs and capabilities, and to align those needs with capabilities. In addition to the information from these response guides, interviews with experts who are working with or on emergency response groups have provided valuable information on developing a response guide from the community level. They have emphasized the importance of training and equipping teams for the work that they would be doing the most and the issues they face most frequently. While an overarching response guide might be useful, it is important that needs of different communities be recognized so that they do not have to use their resources for situations that may not affect them.

National Fire Protection Association (NFPA) 471, *Recommended Practice for Responding to Hazardous Materials Incidents,* was established to outline the minimum requirements that should be considered when dealing with hazmat incidents. This document reviews planning procedures, policies, and application of procedures for incident levels, personal protective equipment (PPE), decontamination, safety, and communications. It also indicates the importance of developing an incident response plan.

Assessing Baseline Needs

According to the NRT-1, a hazards analysis is a critical planning component for handling hazmat incidents. The information developed in a hazards analysis provides the basis to set priorities for planning and also the necessary documentation for supporting hazardous materials planning and response efforts. A hazards analysis may include vulnerability analysis and risk analysis, or it may simply identify the nature and location of hazards in the community. The planning team must determine the level of thoroughness that is appropriate. In any case, planners should ask local facilities whether they have already completed a facility hazards analysis. The Emergency Planning and Community Right-to-Know Act (EPCRA) requires facility owners or operators to provide to local emergency planning committees (LEPCs) information needed for the planning process. This provides guidance on how to develop the hazards analysis, including hazards identification, vulnerability analysis, and risk analysis.

The California FIRESCOPE Standardized Equipment List was established as a standardization and interoperability document for the State of California in order to describe a minimum level of standardization for first responders. The document is available for first responders to review when developing equipment specifications, purchase orders, creating or updating local master hazardous materials equipment inventory lists, and reviewing requirements for hazardous materials/weapons of mass destruction (WMD) chemical-biological response equipment grants. However, this reference document was not developed specifically for use with this Guide, and consequently, it should be used carefully.

NFPA 1600, *Standard on Disaster/Emergency Management and Business Continuity Programs,* 2007 edition, provides a standardized basis for disaster/emergency management planning and business continuity programs. NFPA 1600 targets private and public sectors and provides common program elements, techniques, and processes for both arenas. The 2007 edition focuses on prevention, in addition to mitigation, preparedness, response, and recovery.

Under the Canadian system, the development of an ERAP begins with a potential accident assessment to identify potential problems that could be encountered in the transportation cycle and determine which resources will be needed to mitigate the incident. This section must include a general analysis of how an accidental release could occur, the physical and chemical properties and characteristics of the chemical involved, a general description of the potential consequences of an accidental release, and what actions the plan holder is expected to take in case of an accident, including description of any agreements entered into with third parties to assist in remediation.

Assessing Capabilities

The EPRI, described in Section G.2, is a web-based tool for local, regional, and state planners to develop an inventory of resources in the event of a bioterrorist attack. The tool allows users to create an inventory for any region, state, or locality and can create automated reports for use in preparedness, planning, and incident response.

Component III of NIMS encompasses resource management and includes guidance on planning, use of agreements, categorizing resources, resource identification and ordering, and the effective management of resources. This process involves accurately identifying what and how much is needed, where and when it is needed, and who will be receiving or using it. This includes equipment, facilities, and personnel and/or emergency response teams. Specific resources for critical infrastructure/key resources may need to be identified and coordinated through mutual-aid agreements and/or assistance agreements unique to those sectors, and should be accessible through preparedness organizations and/or multiagency coordination systems.

The NIMS sets forth the requirement for interoperability and compatibility to enable public and private organizations to conduct well-integrated and effective incident management operations. The NIMS Supporting Technology Evaluation Program (STEP) supports NIMS implementation by providing an independent, third-party evaluation of supporting technologies to enable the use and incorporation of new and existing technologies to improve efficiency and effectiveness in all aspects of incident management. The NIMS Integration Center recognizes the need to add the capacity to recognize "Tier One" and "Tier Two" resource typing definitions. "Tier One" will continue to be national in its scope and consist of the current resource typing definitions. "Tier Two" will be those resources defined and inventoried by the states, tribal, and local jurisdictions that are specific and limited to intra-state mutual aid requests and to limited specific regional mutual aid assistance. This includes first responder resources that would not be deployable nationally, or are so common that national definitions are not required as they can be ordered using common language.

The U.S. Coast Guard's *Hazardous Materials Response Special Teams Capabilities and Contact Handbook* includes a "Hazardous Materials Entry Team Typing Guidance" section. This provides specific minimum requirements for three different levels of hazmat response teams, using the following comprehensive categories: field testing, air monitoring, sampling, radiation monitoring/ detection, protective clothing, technical reference, special capabilities, intervention, decontamination, communications, personnel, and sustainability.

The United States Fire Administration (USFA) has established the *Guidelines for Response, Planning and Prevention Training for Incidents involving Hazardous Materials and Weapons of Mass Destruction (WMD)* to recommend curriculum for training courses for personnel who will respond, plan for, and prevent hazmat/WMD incidents. This assists in the assessment, implementation, and development of guidelines in place at the various levels of government in the event of a hazmat or WMD incident. This document reviews the scope of personnel who need training, bridges technical differences between current editions of Occupational Safety and Health Administration (OSHA) and NFPA definitions of response competencies, and examines the training measurements and competencies.

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents,* 2008 edition, establishes a standard to identify the minimum levels of competence required by responders to emergencies involving hazardous materials/WMD. The 2008 update has changed the term "awareness level responders" to "awareness level personnel" in order to acknowledge that those first on scene may not necessarily be emergency responders. NFPA 472 covers general competencies for individuals that respond to the scene during the emergency phase, including firefighters and emergency medical technician (EMT) personnel. This covers core competencies required of emergency responders and optional mission-specific competencies.

The NRT-1 capability assessment section contains sample questions to help a planning team evaluate preparedness, prevention, and response resources and capabilities. The section is divided into three parts. The first part covers questions that the planning team can ask a technical representative from a facility that may need an emergency plan. The second part includes questions related to transportation. The third part addresses questions to a variety of response and government agencies, and is designed to help identify all resources within a community. This information will provide direct input into the development of the hazardous materials emergency plan and will assist the planning team in evaluating what additional emergency response resources may be needed by the community.

CHEMTREC is a 24-hour resource for obtaining immediate emergency response information for accidental chemical releases. CHEMTREC is linked to the largest network of chemical and hazardous material experts in the world, including chemicals and response specialists within the American Chemistry Council (ACC) membership, response specialists within the carrier community, public emergency services, and private contractors. A useful resource is the CHEMTREC database CHEMNET, which contains a listing of support contractors with specific response capabilities. A specialist can go down the list, which provides a phone number and contact person for any of the companies, to determine which company best can respond to the current need. CHEMTREC will only provide the information in response to an actual emergency and is not available for centralized preplanning. However, any planning organization could individually contact the organizations and develop mutual agreements for the company to meet a specific emergency response need.

Under the Canadian system, the ERAP resources section should provide an up-to-date list of contacts including those in CANUTEC, Transport Canada, and contractor and technical specialists that can be contacted if deemed necessary. The preparedness section should outline a comprehensive training policy aimed at providing a thorough emergency response. It should also describe the frequency of tests, at least annually, and the plans for incident and investigative follow-up after an accident. This section should also specify the preventive maintenance needed to maintain the response equipment, tests to be performed to ensure its proper functioning, and inventory control. Maintenance records must be maintained on all emergency response equipment. The final subsections under the Preparedness section list the formal process for updating the ERAP and the required distribution list for the plan.

Aligning Needs with Capabilities

The National Emergency Management Association (NEMA), in coordination with the U.S. Department of Homeland Security (DHS)/FEMA and a number of emergency responders, developed a tool to assist state and local governments to prepare legislation to streamline the sharing of assistance and resources between communities during a disaster. The Emergency Management Assistance Compact (EMAC) is a congressionally ratified organization that provides form and structure to interstate mutual aid. Through EMAC, a disaster-impacted state can request and receive assistance from other member states quickly and efficiently.

NRT-1 includes a sample outline of a hazardous materials emergency plan. This chapter presents and discusses a comprehensive list of planning elements related to hazmat incidents. Communities that are developing a hazmat plan should review these elements thoroughly. Also included in the NRT-1 is an appendix titled, "Criteria for Assessing State and Local Preparedness." The criteria in this appendix, an adaptation of criteria developed by the Preparedness Committee of the NRT, represent a basis for assessing a state or local hazardous materials emergency response preparedness program. These criteria reflect the basic elements judged to be important for a successful emergency preparedness program, which are separated into six categories: hazards analysis, authority, organizational structure, communications, resources, and emergency planning. These criteria may be used for assessing the emergency plan as well as the emergency preparedness program in general. Resource limitations and the results of the hazards analysis will strongly influence the necessary degree of planning and preparedness.

With CHEMTREC's CHEMNET, the alignment of needs and capabilities is done over the phone by the emergency support specialist. The specialist can find contractors who have the required resource as well as their location and service area. Based on distance, the minimum response time could be estimated, but a phone call to the contractor would be required to verify the actual response time based on the location of the contractor and the location of the incident.

Somewhat analogous to Canada's ERAP is the United States' Environmental Protection Agency (EPA) Risk Management Plans prepared for facilities that have highly dangerous chemicals. These plans identify the emergency response capabilities of the facilities and whether agreements were made that could be incorporated into local planning documents. If it were determined that these materials were widely shipped in the region, those capabilities could be allocated to the region. If the equipment were truly specialized, it could be documented as a state resource and other regions in the state could enter into agreement with the facility to provide emergency assistance when needed. By first identifying the resources and rolling them up to the state level, they could thereby be reallocated downward to meet the needs of smaller and more remote emergency response teams.

Synopses of Stakeholder Interviews

The study team conducted 16 interviews with stakeholders representing the hazardous materials and emergency response communities. Both large and small jurisdictions were represented. This section summarizes the key information gathered during these interviews, organized by the three methodology areas. The questions used to structure the interviews are included in Attachment 1.

One knowledgeable individual indicated that quantitative approaches to risk assessment and planning were too unreliable and that qualitative approaches were highly recommended. Appropriate minimum levels of response are not possible to identify and would be nearly impossible to meet if they were. There is always the very-large-consequence, very-low-probability event that is often beyond the reach of most jurisdictions to be fully prepared for.

Needs Assessment

One interviewee stated that response needs are based on the perception of risk. Generally, formal risk analyses are rarely performed for capability assessment—mostly, this is a matching of PPE against chemicals that may be encountered.

There was a universal opinion that generic community characteristics were not a good way to establish a baseline level for the presence of hazardous materials; each community was different. One individual mentioned the NFPA 1620 Standard, Pre-Incident Planning, as relevant but that it is focused on specific occupancies and properties. This would be appropriate as many large fire departments do create plans for certain facilities with hazardous materials. It was noted that transportation incidents are not currently a major focus for the NFPA.

The need to update needs assessments annually was expressed by most interviewees. In California, planning is done for all hazards—and not just hazardous materials—and is updated every three years.

Fixed Sources. For fixed sources, most jurisdictions rely primarily on the EPCRA Tier II reports that indicate where threshold quantities of hazardous materials are being stored. Clean Air Act Section 112 reports were also cited. One noted that these sources provide information only on the stored chemical and not the chemical that is actually released, which can differ due to reactions. One LEPC member indicated that he accessed these sources at least weekly.

One local official indicated that his state identifies all facilities with "extremely hazardous substances," derived from the U.S. EPA. They plan specific responses for each of these facilities, which cover the top 10 percent of all facilities with hazmat in his region. They acquire Material Safety Data Sheet (MSDS) information for these materials and obtain the appropriate resources to respond to incidents involving them. For example, one facility contains cyanide, and the local responders have acquired a new drug that can treat cyanide exposure.

Some cited the importance of institutional knowledge in augmenting their information. For example, knowing that a company produces agricultural products can provide good insight into the materials that would be used as raw materials for their manufacturing process. One regional entity (part of a large county) continually surveys industry to ensure that they are aware of the materials to which they need to respond.

In California, the Office of Emergency Services pushes down identified needs to the LEPCs.

Mobile Sources. For mobile sources, many jurisdictions the study team spoke with had not conducted any commodity flow surveys to identify specific hazardous materials moving through their areas, although a couple have made use of such surveys. Of those that did, most were done some time in the 1990s. One state-level official indicated that they supported local police departments in conducting some commodity flow surveys. One individual expressed a concern about seasonal differences and the geographic variability of many types of material transportation. As examples, he indicated that ammonia and liquefied natural gas are more common in rural areas and there would be less home heating oil in the Midwest than in other parts of the country.

One interviewee indicated that other than information from railroads, there is no useful source of information. Another indicated that his organization gets annual updates of the chemicals transported in their area from the two Class I railroads.

Other identified sources included knowledge of the location of ports and terminals and state hazardous materials transportation routes. In some states, these routes are specific to certain materials and in others they can be more generic, applying to all hazardous materials.

Capability Assessment

A consistent theme from those interviewed was that the focus of response capability should be on the most likely hazards in their communities and not necessarily on the worst case. For example, one person stated that communities without a rail line should not need a chlorine kit. Another individual indicated that they do not train all teams for all the hazards they might face.

A baseline definition of a team is problematic, stated one individual, because most jurisdictions—large cities being the exception—do not have dedicated hazmat teams. Their "teams" are composed of a number of responders from different stations that come together in the event of a hazmat release. One Pipeline and Hazardous Materials Safety Administration (PHMSA) official indicated that there were approximately 1,100 hazmat teams in the United States.

Some jurisdictions keep a list of resources that might be called upon to respond to certain types of incidents. Examples include soda ash, portable air compressors, and corrosive transfer capabilities. In one case, the jurisdiction would call chemical companies to locate needed items.

One state indicated that they assign all teams to one of three capability levels based on their equipment, with the difference between the highest and next-highest levels being the purchase of very expensive equipment that is rarely used.

There was a time, said a number of interviewees, when industry teams had more capability than public teams, but now some industries rely almost exclusively on local response. For example, one large bulk fuel storage facility only has two staff on-site at night.

Some states, such as California, have very detailed emergency response capability assessment methodologies, whereas others have no statewide guidelines for rating teams at all. The California system is very similar to FEMA's Hazardous Materials Typing. In California, fire companies submit an application to the Office of Emergency Services, which performs an on-site audit, inspecting equipment and personnel records. They are in their second year of performing these inspections. To date, approximately two-thirds of all applicants fail to meet the minimum requirements. Of 127 reported hazmat teams in California, it is estimated that only about 60–70 will ultimately be certified at one of the three hazmat type levels. Applicants can be a single fire company or contain personnel and resources from multiple companies.

One person indicated that any rating system should come from the International Association of Fire Chiefs (IAFC), which is an organization that all jurisdictions would listen to. NPFA standards were cited as common reference point for assessing personnel and training levels.

One jurisdiction assessed emergency response capability through full-scale exercises rather than through checklists or surveys. They believed this was the only effective way to comprehensively assess capability. NIMS should be a part of these exercises. Another jurisdiction has just begun to develop a methodology to conduct a survey and an assessment of local response capability.

The interviewees stated that the different types of response teams (public, industry, for-hire) should be assessed differently. Facility response, for example, is focused on situations with few unknowns. For-hire responders are unlikely to be acting as first responders and will most often be involved in cleanup activities. In California, all teams would be evaluated under the same inspection parameters. One responder indicated that it would be very difficult to assess industry and contractor capability, as it is so fluid. He indicated that the local fire service responsibility was to stabilize the incident and not to clean it up. That is the responsible party's job, with the local fire service overseeing it to ensure that it is done safely.

Some states provide statewide response support and will assist any local jurisdiction that asks. A representative quote was, "all of us are better than one of us." Where outside resources are considered in response planning, the management for them should also be considered. In many cases, the LEPCs ensure that agreements are in place with neighboring jurisdictions.

Alignment

Response teams are forming and disbanding all the time, according to one respondent. There is no standard way to identify them; it is done mostly through personal relationships across jurisdictions. There is no obligation for locals to answer questions about hazardous materials response teams, so the information is hard to obtain.

Very few jurisdictions allocate resources based on risk and almost never on hazardous materials. Depending on the jurisdiction and their needs, it is possible that only two responders and a trailer with equipment would suffice—even if they could benefit from additional resources. Also, limited resources do not support tools such as geographic information systems in most small communities, limiting their ability to conduct detailed assessments.

One interviewee stated that his state required the formation of regional response teams even though some parts of the state do not warrant that level of response; in other words, their determination of response capability was independent of need at that level.

When considering additional resources for a response team, it is important to consider the sustainability of new equipment. Most equipment requires trained operators and ongoing maintenance, both of which continue to cost money. Jurisdictions should work together through mutual-aid agreements to share some equipment, such as detection equipment used very infrequently, to ensure adequate operator proficiency through routine use. Where mutual aid is utilized, it is important for the teams to have worked together for the response to be effective. There are many liability issues with mutual aid, and these need to be addressed in a broad fashion. In addition, problems can arise when immediately adjacent jurisdictions respond to large incidents, particularly in urban areas. This leaves a vacuum of response for routine hazardous materials incidents, and perhaps a better solution would involve pulling in support for the large incident from farther away where some capability would be retained.

One state indicated that they thought they needed only three to six teams of the highest level to cover their entire (large) state. This level would be capable of responding to WMD incidents.

Expert Working Group

From those interviewed, the project team identified seven individuals to serve on an Expert Working Group. This group provided key input into the development of the methodologies described in Section G.3. The list of Expert Working Group members is included in Attachment 2.

G.3 Assessment Methodology

Introduction

As stated in the project charter for this project: "Federal health, safety, and environmental regulations address emergency response planning and preparations in the event of a hazardous materials release. The Emergency Preparedness and Community Right-to-Know Act of 1986 [EPCRA, enacted as Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA)] calls for State Emergency Response Commissions (SERCs) and their designated Local Emergency Planning Committees (LEPCs) to plan and prepare for such incidents; however, few efforts have been made at the national, state, or regional levels to identify capable response teams, match their capabilities with potential emergencies involving different types of hazardous materials, and assess how quickly resources can be brought to bear in an emergency. Likewise, comprehensive guidance on assessing state, regional, or local hazmat emergency response needs, in order to achieve the appropriate level of coverage at the regional or local level, has not been provided."

The methodology described in this section is designed for local emergency response planning organizations to assess their needs for hazardous materials emergency response, to assess their capabilities to respond, and to identify and address any significant gaps in coverage. This methodology forms the basis of a detailed assessment process. A corresponding Guide has been prepared separate from this report. The Guide includes additional detail that leads local planning officials through each step. In addition, the methodology discusses appropriate means for maintaining currency of the information over time. Whenever possible, this document capitalizes on previous and current efforts at the local, state (i.e., California), and federal (i.e., DHS) levels.

The methodology consists of four primary considerations: (1) defining the scope, (2) understanding the risk, (3) assessing capabilities, and (4) assessing results and impacts. These are discussed in more detail in the following sections. In addition, the methodology discussion concludes with considerations for further development.

The methodology is designed to be scalable, allowing the implementation results to be aggregated from the local level up through the regional, state, and national levels. The identified risk in the community or jurisdiction can be used to determine the appropriate level of effort for implementing the methodology.

The approach is to connect as many components as possible in this methodology to already-established standards, guidelines, regulations, and laws. In this way, the methodology will remain current, as these underlying components are updated over time.

This methodology incorporates the results of *commodity flow study* guidance currently being developed under another project for the HMCRP, Project 01, "Hazardous Materials Commodity Flow Data and Analysis." The following methodology does **not** attempt to define the process for conducting these underlying studies, but does build upon the results of such studies. The methodology also draws on recognized sources for determining the hazardous materials at fixed locations (referred to herein as *facilities studies*).

Scope

Jurisdictions need to understand both the potential hazards that are in or could pass through their area and available existing response resources. This methodology assumes that jurisdictions conduct the necessary supporting commodity flow studies and facilities studies as a foundation for employing this risk management methodology. To enable the most effective use of this methodology, it is necessary to define the scope of materials and activities that should be included.

When planning for hazardous materials emergency response, local organizations consider the breadth of hazardous materials they may encounter in their jurisdictions, including at production and storage (permanent and temporary) facilities and along the major land (vehicle, rail, and pipeline) and maritime transportation corridors.

This project limits the scope of materials to those that are transported commercially under the auspices of the U.S. Department of Transportation (U.S.DOT) Hazardous Materials Regulations (HMRs) as found in Title 49 of the Code of Federal Regulations (49 CFR). This includes the storage of materials incidental to transportation (including at facilities at both the origin and destination) as well as along any transportation corridors. This project utilizes the nine hazard classes identified within these regulations, whenever possible, in order to delineate specific hazards or associated risks.

These regulations include class designations and identification numbers for various chemical, biological, and radiological agents that have conventional warfare applications or those that have certain characteristics that may be favorable for utilization by terrorists or criminals during an intentional act. However, these hazard classes are inherently designed from a safety perspective to support the legal and regulated storage and/or transportation of hazardous materials between origin and destination for lawful use by a private citizen, established company, or governmental agency or department.

Three principal hazardous materials response concepts are currently in use within the United States:

- Hazardous Materials Response within the Public Safety community as represented by NFPA Standard 472 (2008 Edition);
- Occupational/Industrial response as represented by HAZWOPER codified in 29 CFR 1910.120Q; and
- Environmental Oil and Hazardous Substance (OHS) response codified in 40 CFR and based largely upon the HAZWOPER standards in 29 CFR.

Each response concept is formulated based upon the specific operational environment(s) in which the intended audience will be expected to operate. This methodology recognizes these legal and procedural differences and does not attempt to force each of these distinct concepts into a single framework. Each concept will be recognized and assessed separately while recognizing overarching and unifying concepts, such as the NIMS and the Incident Command System (ICS), which are common across all preparedness, response, and recovery efforts.

As detailed in Section G.3, there are multiple approved and draft documents representing efforts to categorize resources by a variety of determining factors, capabilities, and risk. Therefore, this methodology does not represent verbatim application of these approved or draft documents, but rather incorporates the applicable, approved elements of these documents into the methodology outlined below. Risk management is often strongly influenced by the perceived political and social implications of a particular methodology as well as anticipated reactions and bias by specific user communities. This methodology is focused on the scope identified within the project charter to address all hazardous materials response operations to all identified hazard classes across all applicable modes of transportation and use, which is a scope not addressed by any single regulation, guide, or document approved at the federal level.

Defining the Risk Metric

While a planning agency may be able to qualitatively determine broad relationships regarding the risk of certain materials and the ability of existing emergency response teams to mitigate the consequences of releases, using a defined process with as many quantitative elements as possible helps to establish a sound basis for policy decisions related to response coverage. The approach outlined in the Guide uses a relative risk metric to capture and integrate all of the elements that contribute to the risk to the community and to inform those policy decisions. The Guide uses the term "metric" to emphasize that the approach does not determine an absolute value of risk, but only a measure that is suitable for supporting planning activities. Calculating the risk metric allows one to determine the response capability that would offset expected consequences from hazardous materials incidents. In this section, the measure of risk used in the Guide is defined and the overall methodology is presented.

The risk metric is given in Equation 1 and follows the standard three-term representation of risk commonly used in many industries:

$$\text{Risk Metric} = H \times V \times C \tag{1}$$

where

H = hazard,
V = vulnerability, and
C = consequence.

As with all formulations of risk, the fundamental components are the frequency of some event happening combined with the potential consequences of that event. The consequence considers the mitigating effects of response capability and its proximity to potential incidents as shown in Equation 2:

$$C = C_u \times ERC \times RTF \tag{2}$$

where

C = consequence,
C_u = potential consequences (unmitigated),
ERC = emergency response capability, and
RTF = response time [factor].

To be most effective, planning organizations should compute the risk metric for each hazard and location, although there may be opportunities to group certain elements together.

Each element in the risk equation is discussed in more detail in the sections below. Note that since the development of this methodology earlier in the project, the risk methodology was simplified for its application in the draft Guide.

Sources of Information

There are numerous sources of information for the various elements in the risk equation. This methodology will focus on the information collected by the LEPCs and their higher, state-level SERCs. This includes the SARA Title III Tier I/II data submitted to the SERCs and LEPCs and the Facility Risk Management Plan (RMP) data submitted to LEPCs.

However, multiple sources are available, from which additional relevant information may be drawn upon request. These additional sources include:

- Regulatory agencies. Many of these required filings and submissions on hazardous materials related to their regulated entities. These include:
  - The U.S. Coast Guard (USCG)—marine hazardous materials transportation;
  - EPA—Toxic Release Inventory (TRI) data;
  - National Response Center (NRC)—incident data [note this was previously referred to as the Emergency Response Notification System (ERNS)];

  - PHMSA
    - Hazardous Materials Incident Reporting System (HMIRS) data
    - Office of Pipeline Safety (OPS) incident data; and
  - Department of Energy and Nuclear Regulatory Commission—nuclear waste shipment routes.
- Associations and nonprofits. Representatives of the shipping and transportation communities such as the American Trucking Association, the American Association of Railroads, the National Institutional Transportation League, and the Dangerous Goods Advisory Council.
- State Emergency Management Agencies (EMAs). These agencies have conducted many studies to capture useful information, such as local or regional hazardous materials commodity flow studies. Entities considering their own commodity flow studies should consult the guidance provided by HMCRP Project 01.
- Other state and local agencies:
  - State Police or Highway Patrol;
  - State Fire Marshal;
  - State Bomb Squads;
  - State Environmental Protection Agencies;
  - City/County/Town Emergency Management Agencies; and
  - City/County/Town Fire and Emergency Services.
- Transportation companies:
  - Railroads will provide information on the top hazardous materials transported through communities;
  - Pipeline operators (both hazardous liquid, gas, and multi-use pipelines); and
  - Barge companies.

Hazard Survey

A fundamental component of the planning process is the identification of the hazardous materials and quantities that are present in the jurisdiction. This involves identifying the facilities that manufacture, store, or use hazardous materials and the routes over which hazardous materials are transported. For areas with active LEPCs, that organization may be the best place to start. Section G.3 includes a comprehensive list of agencies and organizations that may have relevant information to assist in preparing a hazard inventory for a jurisdiction.

When collecting data on specific facilities containing hazardous materials, consider the types of businesses listed in Table G-1. Also consider abandoned facilities that may still contain sufficient quantities of hazardous materials to be a concern. A community may have many other types of fixed locations, such as dry cleaners, gas stations, and others, that contain hazardous materials. Knowing the specific location of each of these facilities is not as important as knowing that they are commonly found in the community.

When considering transportation routes, the best information would be from a recent local commodity flow survey. If no such survey has been done, planning organizations should consider their available resources and consider commissioning one. Guidance for conducting local commodity flow surveys was prepared under HMCRP Project 01. While most jurisdictions focus on highway and rail transportation, it is important to consider other modes as well. Marine transportation of hazardous materials can be significant in some areas. Pipelines carry hazardous liquids or natural gas and are distributed throughout the country. Pipeline companies or the OPS are good sources of information for response planning.

Also consider fixed locations where hazardous materials may temporarily be found during their movement from origin to destination. At these locations, the material would remain con-

Table G-1. Facilities that may contain hazardous materials.

Industrial Facilities	Select Retailers
Chemical plants	Agricultural
Refineries	Swimming pool suppliers
Petroleum and natural gas tank farms	Home supply stores
Drinking water plants	Dry cleaners
Wastewater treatment plants	
Nuclear facilities	
Waste disposal and treatment facilities	
Refrigeration plants	
Hospitals and academic/government facilities	
Storage facilities/distribution centers/warehouses/tank farms	

tained inside the vehicle used to transport it—distinguishing these locations from the fixed locations discussed above. These locations include intermodal transfer facilities, rail yards, airports, ports, docks, truck terminals, and major truck stops. This would also include rest areas that trucks commonly use.

While it may be important to understand the potential for variation in quantity of hazardous materials identified in the survey, the methodology described in the next section focuses primarily on whether the hazard is present. Jurisdictions are unlikely to restructure their emergency response capability to match seasonal variation in materials present, such as the increase in home heating oil in the winter months in cold climates.

Methodology

This methodology does not require or attempt to determine relative risk for the purposes of resource allocation. Therefore, the discussion is specifically focused on determining the relative Consequence values to determine Capability offsets specific to Consequence. This methodology does not intend to diminish the importance of the complex risk management challenges faced by state and local jurisdictions as well as private companies or the extraordinary efforts to which these jurisdictions and companies have gone to identify and manage these risks.

Whenever possible, this process encourages and supports jurisdictions and companies to leverage existing risk management products as input into this methodology. A key source of risk management data will be the existing hazard and vulnerability assessments completed by each State EMA. The following bullets provide the methodology for establishing each of the values in the risk equation.

- **Hazard:** This methodology recommends treating the hazard as always being present or always being absent based upon the hazard survey, which would assign this term a value of 0 or 1 for this element. The hazards present at fixed facilities or along transportation routes are considered. While there are clearly differences in the relative "hazard" posed by different materials, those differences are primarily captured in the consequence term in the risk equation. In general, the types of hazards posed by hazardous materials can be arranged into the following seven categories:
  - Fires;
  - Explosions or BLEVEs (boiling liquid expanding vapor explosion);
  - Toxic gas releases;
  - Toxic liquid releases;

- Corrosives;
- Radioactive materials releases; and
- Releases of biologically active materials.

- **Vulnerability:** This term is a measure of the likelihood that the population or environment will be exposed to threats produced by an incident. The Guide considers two ways to evaluate vulnerability. One approach considers potential release probabilities based on historical or scientific data, while the other approach considers the quantity and frequency of materials present in a given time period, usually one year.
- **Consequence:** Rather than estimating a specific number of serious injuries or deaths that might result from the release of a specific hazardous material, the Guide recommends the use of a qualitative scale such as is commonly used by the CARVER methodology. This methodology is employed by the U.S. Department of Defense. CARVER is an acronym for criticality, accessibility, recuperability, vulnerability, effect, and recognizability:

  Population
  1 = no deaths or serious injuries; only relatively minor injuries
  2 = 1 to 10 deaths or serious injuries
  3 = 11 to 100 deaths or serious injuries
  4 = 101 to 1,000 deaths or serious injuries
  5 = more than 1,000 deaths or serious injuries

  The Guide considers the following scale to estimate environmental consequences. To consider environmental consequences instead of human-health consequences, a qualitative scale such as this one could be used.

  Environmental (includes remediation costs)
  1 = less than $1 million
  2 = $1 million to $10 million
  3 = over $10 million to $100 million
  4 = over $100 million to $1 billion
  5 = over $1 billion

  The Guide recommends that planners consider the specific nature of the hazardous materials they have identified in their communities at fixed locations and along transportation corridors in determining the likely consequences of a release. Good sources of hazard information include:

  - Lewis, Richard J. “Sax’s Dangerous Properties of Industrial Materials” [latest edition]. J. Wiley & Sons.
  - “NIOSH Pocket Guide to Chemical Hazards” [latest edition]. U.S. Department of Health and Human Services.
  - “Guide to Occupational Exposure Values” [latest edition]. American Conference of Governmental Industrial Hygienists.
  - “North American Emergency Response Guidebook” [latest edition]. U.S. Department of Transportation (also called the “Orange Book”).

  Note that while all of these sources generally apply only to single compounds, as opposed to mixtures or multiple hazards, techniques have been developed for mixtures and multiple hazards; see *HMCRP Report 2: Assessing Soil and Groundwater Impacts of Chemical Mixture Releases from Hazardous Materials Transportation Incidents.*
- **Emergency Response Capability:** The capability to respond to different hazardous materials incidents is measured by the ability of the emergency response team to place trained individuals at the scene of the accident with the proper response equipment. It is further defined in Section G.3. The appropriate level of response for hazardous materials incidents is organized into five tiers: a baseline tier any U.S. fire department would be expected to meet and four

higher level tiers, 1 through 4. The higher tier levels are consistent with FEMA response team classifications for the more capable levels of response capability.

- **Response Time:** This term represents the concept that if the appropriate response arrives later than desired, it will be less effective and not reduce consequences as much as if it arrived more quickly.

Ultimately, the process involves connecting the hazard and consequences in each location with the response capability. These can then be ranked to see the highest priority risks for more detailed evaluation.

Risk Mitigation

In many traditional risk analysis methods, risk is mitigated through a combination of removing the hazard (or threat) and/or increasing the physical, structural, or engineering safeguards to change the vulnerability of a community, mission, or infrastructure to the identified risk. In the methodology proposed in the Guide, the options of removing the hazard completely, dramatically reducing the quantity/type of hazards present, and/or implementing additional physical/engineering safeguards (above those already employed/mandated), frequently have significant impacts on the national economy and industrial capabilities. Hazardous materials are a necessary and vital component of our nation's industrial, economic, and socioeconomic environments constituting billions to tens of billions of U.S. dollars in exports each year.

As elimination of the hazard is not economically feasible, the intent of the Guide is to identify the response capabilities necessary to quickly identify and manage accidental and criminal releases of these hazards. The Guide approaches risk mitigation by evaluating each of the terms in the risk metric equation and then looking for opportunities to reduce either the overall risk or the risk-dominant hazards. If the overall risk level as measured by the risk metric is judged to be too high, the Guide suggests ways of reducing the risks for all hazards—for example, by increasing the tier level response one level. Alternatively, if one hazard dominates the risk, improving the emergency response capabilities for that hazard might have the effect of significantly improving the region's safety.

Emergency Response Capability Assessment

Background

Capability assessment is performed in an integrated manner for each of three distinct concepts: environmental pollution response, industrial manufacturing response, and traditional public safety response.

NFPA Standard 472 (2008 Edition) represents clear, measurable, and detailed guidance to which many elements of the Public Safety community train and certify their personnel and which guide associated planning efforts. This methodology, however, recognizes that adherence to NFPA Standard 472 is not the minimum legal standard to which these agencies and departments must operate, but that 29 CFR 1910.120Q represents the common denominator across all response agencies and departments. This methodology recognizes that many rural or remote agencies and departments may employ different interpretations of these consensual standards or implement only specific portions of them. Although this methodology does not recommend or promote the disregard of these standards, this methodology must provide a process to capture the presence and capabilities of such agencies and departments.

Another recognized challenge is that the required capabilities associated with hazardous materials response may be organized and provided in the form of a strike team or task force instead of a single team resource provided solely by one provider or jurisdiction. Jurisdictions and providers may instead choose to share the financial and management burden of establishing, maintaining, and employing these complex capabilities by integrating specific elements resident in multiple jurisdictions or providers into a strike team or task force, which can be task-organized, reinforced, and/or sustained, depending upon the particular situation.

Much has been done by federal and state governments since 2002 to standardize the resource typing and definitions of all existing and required capabilities necessary for homeland security and emergency management operations. The DHS FEMA publication 508-4 Typed Resource Definitions for Fire and Hazardous Materials Resources (dated 20 July 2005) provides three Types of Hazardous Materials Entry Teams based upon a combination of existing standards and listed with respect to identified hazards identified at the national level. The Typed Resource Definitions contained within FEMA 508-4 appear to address only the most capable resources maintained by select local, state, and/or federal sponsors, such as New York City (NY), Houston (TX), Los Angeles (CA), and other equivalent areas with a sufficient tax base for establishing, training, certifying, equipping, exercising, and maintaining teams and associated personnel on full-time or near full-time availability.

Based upon a review of the National Planning Scenarios and the National Response Framework Incident Annexes, the hazards identified at the national level predominately focus on terrorist or criminal use of specific toxic or dangerous materials during an intentional act versus the inter-/intra-state, multimodal storage and/or transportation of all hazardous materials. In addition, these federal efforts, such as FEMA 508-4, do not include resource typing criteria for the entire resource set necessary to successfully manage a release of hazardous materials in storage, use, or transportation. For example, FEMA 508-4 provides typing criteria for the Hazardous Materials Response (Emergency Support Function #10) HAZMAT Entry Team (pages 13–17) without the inclusion of parallel, coordinated typing criteria for casualty decontamination (reference to decontamination within FEMA 508-4 is solely for decontamination of the entry team personnel), incident command, and similar supporting elements. A review of the FEMA 508 Typed Resource Definitions series fails to locate any equivalent effort for casualty decontamination, and this determination is supported by notes in the draft document listed below requiring the development of a typed resource or mission package to support incident assessment, casualty rescue, and casualty decontamination.

DHS is also in the process of developing a Target Capabilities List (TCL) specific to the *Response Capability* [for] *WMD/Hazardous Materials (HazMat) Rescue.* In the existing draft document, the TCL employs a five-class risk system based predominately upon jurisdictional population with additional risk factors for various types and kinds of storage, use, and transportation capabilities. These risk factors do not address pipelines, maritime facilities or transportation, or nonchemical (e.g., biological, radiological, explosive, etc.) storage facilities or industrial manufacturing or use of such nonchemical hazard classes, except under the term "large quantities of hazardous materials." In developing this methodology, the use of two systems defined by "class," such as the Emergency Response Guidebook (2008 Edition) and the draft TCL, poses additional challenges for successful employment and ease of use for the methodology. The current draft of this document is dated 17 February 2009 and, once the identified gaps in addressing all hazardous materials hazards have been closed, the TCL will be incorporated into this methodology as it becomes an approved, official resource.

Therefore, this methodology does not represent verbatim application of these approved or draft documents, but rather incorporates the applicable, approved elements of these documents into the methodology.

Process

To avoid confusion with other terms, specific capabilities are being defined across these groups in *Tiers,* rather than levels or ratings, beginning with a standard **baseline** of operations capabilities. NFPA 472 (2008 Edition) defines Operations Level Responders as those "who respond to hazardous materials incidents for the purpose of implementing or supporting actions to protect nearby persons, the environment, or property from the effects of the release." Operations-level Responders are the core components of an effective response.

Beyond the baseline capability, four Response Capability Tiers are defined that advance from Tier 1 with the lowest capability to Tier 4 with the highest capability. The combination of technician-level responders determines whether a hazardous materials response team meets the requirements of a specific Tier.

Tiered Capability Assessment

The capabilities of any resource are based upon how that resource is organized, trained, certified, equipped, exercised, evaluated, and sustained. The intent of the Guide is to assess capabilities against existing standards whenever possible. As detailed in Section G.3, a thorough survey of existing resource typing initiatives by DHS/FEMA results in accepted, consensus-based definitions for only specific elements of a public safety-based hazardous materials response and only at the highest levels of capability and capacity above the established minimum standards presented within NFPA Standard 472 (2008 Edition) and 29 CFR 1910.120Q.

The Guide incorporates baseline categories traditionally used by traditional public safety hazardous materials response teams without technician-level training, certification, and supporting equipment. The Guide was developed recognizing that many rural or remote agencies and departments may employ different interpretations of these consensual standards or implement only specific portions of these consensual standards.

In the Guide a fundamental assumption is that each of the jurisdictions in question has adopted the NIMS to facilitate the common exchange of information, services, and resources across jurisdictional boundaries. This NIMS component includes the standard planning and preparedness concepts in the Comprehensive Preparedness Guide 101 as well as the adoption of the ICS, the Unified Command System (UCS), and the Multi-Agency Coordination System (MACS). However, the methodology in the Guide recognizes that adoption of NIMS is not consistent across federal, state, tribal, and local governments, especially at the local level where federal funding streams, which carry with them the mandate for NIMS-compliance, may not always drive the recommended changes in the specified time period. Since this methodology does not evaluate the overall, comprehensive, and integrated preparedness, mitigation, prevention, response, and recovery capabilities, but rather focuses on the response to hazardous materials incidents only, the expectation of NIMS compliance did not significantly skew methodology outputs and products to any noticeable degree.

G.4 Guide Development and Testing

Introduction

Phase 2 activities for this project included developing a draft Guide; testing its use in actual, working environments; finalizing the Guide; and preparing and submitting a final project report.

Draft Guide

As proposed, the study team developed a Guide that is as simple and easy-to-follow as possible. Where additional details, background, or advanced concepts are warranted, they are presented in appendices to keep the main body and content as concise as possible.

The primary sections of the Guide contains guidance on

- Conducting needs assessments at state, regional, and local levels;
- Developing, maintaining, and sharing capability assessments;
- Aligning assessed needs with varying levels of capability;
- Identifying shortfalls where additional/different capabilities are warranted;
- Approaches for addressing identified shortfalls.

While the first four bullets cover the methodologies developed in Phase 1, the fifth bullet was not addressed in the original scope of work for this project. The study team believes that full realization of the value of this entire project hinges on the ability of response planning organizations to not only determine whether their resources are allocated appropriately for their own needs, but that they also make appropriate adjustments if the allocation is lacking in any way. Only then will the entire jurisdiction achieve the hazardous materials emergency response coverage that it needs. Due to the limited funding for Phase 1 tasks, this component of the Guide was fully developed in Phase 2.

In addition, the Task 3 methodology calls for maintenance components to be included, while the Task 2 methodology does not. Additional effort to determine the appropriate frequency of and procedure for refreshing the baseline needs assessment was conducted as part of Task 7, due to the funding limitations imposed on the entire Phase 1 effort.

Develop Detailed Test Plan

The first step was the completion of a test plan at a very detailed level. The initial version of the test plan identified the types of planners and agencies that should participate in the test, but the detailed test plan included agencies and specific individuals (or job positions) within each planning agency targeted for participation. The participants were chosen to ensure representation that approximates the membership diversity of the Expert Working Group. To ensure an appropriately unbiased test, no Working Group member (neither the individual nor their agencies) was selected to participate in the test.

Guide Testing

One of the important tasks for this project is to ensure that the methodologies developed in Phase 1 and the Guide developed to assist emergency response planners in implementing the methodologies actually work in practice. This was accomplished through tests of the draft Guide conducted by practitioners with experience planning for effective emergency response to hazardous materials incidents. The goals of the tests of the draft Guide were to determine problem areas, errors, and omissions within the Guide by recruiting emergency response planners and experts in the field to test the draft Guide. The objective was to solicit feedback on several important aspects of the Guide from individuals with practical experience in developing plans. Thus, the foci of the test were on receiving feedback from practitioners on various aspects of the Guide so that the Guide could be revised to enhance its overall effectiveness as an aid in planning for hazmat transportation incident response. The basic components of effectiveness include:

- Ease of use of the Guide (needed improvements in organization, writing style, or illustrations that would improve the Guide);
- Accuracy of materials in the Guide (needed corrections to materials in the Guide); and
- Completeness of the Guide (materials that are missing but should be included).

The collected data and observations from the testers were collected so that the study team could evaluate these inputs and make the needed corrections and modifications to the Guide to improve its effectiveness.

Selected Participants

The study team identified a pool of planners, planning agencies, and emergency response officials that are responsible for a broad range of emergency response capabilities and located in diverse jurisdictions. Diversity included considerations such as industrial/nonindustrial, urban/rural, and small/medium/large communities; populated/sparsely populated state; and poorly/well-funded organizations. Although a diverse group of testers was selected, there was no attempt made to select a random sample. Part of the selection process included choosing candidates based on their familiarity with the contractor and/or members of the study team. As stated above, the participants excluded any individuals/organizations who participated in the "developmental process" in Phase 1. Thirteen organizations were selected to participate in the test. The following locations and organizations were selected to test the Guide:

- State of Massachusetts Hazardous Materials Emergency Response;
- Madison County, Ohio/Environmental Protection Agency (EPA);
- Franklin County, Ohio CEPAC (local emergency planning committee);
- Yellowstone County, Montana Emergency Response;
- NYFD Training Center Hazmat Response;
- Benton County, Washington Emergency Response;
- Duxbury, Massachusetts LEPC;
- Fulton Co., NY LEPC;
- Onondaga County, NY LEPC;
- Greater Houston, Texas LEPC;
- Tampa Bay, Florida (LEPC);
- County of San Diego Hazmat Division (LEPC); and
- Hand County, South Dakota LEPC.

Conducting the Tests

Tests were implemented to gauge the Guide's effectiveness and accuracy in achieving the desired results in (a) conducting hazardous materials response needs assessments, (b) conducting capabilities assessments, (c) aligning hazardous materials response needs with existing capabilities, and (d) identifying and providing means to correct shortfalls and inefficiencies in the capabilities as compared to the needs. The specific testing addressed two issues: (1) whether the information is presented in an understandable way (i.e., is editing required?) and (2) whether the concepts and methodologies were sound and usable.

A user survey was developed to capture feedback on specific operational concepts and contexts. The questions in the survey were developed by the study team and then reviewed by a human factors expert for objectivity and clarity, and especially to ensure that any hidden bias was uncovered. The questions were then modified based on the review by the human factors expert. The questions are included in Attachment 3.

Testing Feedback

As of the end of September 2010, six of the locations/organizations had conducted tests of the document and returned the questionnaire to the study team. These were the following: Madison County, Ohio/Environmental Protection Agency (EPA); Franklin County, Ohio CEPAC (local emergency planning committee); NYFD Training Center Hazmat Response; Benton County, Washington Emergency Response; Onondaga County, NY LEPC; and the Greater Houston, Texas LEPC. In general, the planners who tested the Guide assessed it to be a very useful document for assessing hazmat emergency response capabilities, determining gaps, and making decisions to fill in those gaps.

The major criticism related to the complexity involved with following the Guide. Simply following the assessment steps included in the Guide could be difficult for the user. Other testers expressed the desire to improve the Guide by including clearer definitions. Some of the comments from planners in the largest areas related to the concern that if they implemented the Guide as written, the number of hazardous material facilities and the amount of hazardous material being transported throughout the metropolitan area would make completion of the assessment a daunting task.

Changing the Guide

Following the tests of the Guide, a number of modifications to the Guide were made that were either based on recommendations by the test participants or identified by the study team during the test. These changes were incorporated in the draft Guide that was provided to the panel.

A major change to the Guide involved adding a spreadsheet-based tool that the assessor could employ to facilitate the use of the Guide. This file is designed to follow the 20 steps outlined in the Guide. Separate tabs were developed for the major steps, and cell equations perform most of the calculations. Therefore, the assessor using the Guide is only required to follow instructions but not actually perform any calculations. For example, Steps 1 and 2 help the assessor determine the current tier level of their Emergency Response organization. Steps 3 through 6 assist the assessor in selecting the proper Jurisdictional Class. The Jurisdictional Class selected determines a minimum tier-level response, and if the current tier-level capability is lower than required, this is the first gap identified in this assessment. The assumption is made that this gap would be addressed before proceeding with the balance of the assessment. All of these calculations are performed automatically, with the planner responsible for following the instructions associated with the spreadsheet tool and entering correct data. The tool is provided on the attached CD-ROM so that an emergency response planner using the Guide can easily access the tool and use it to complement the Guide.

Definitions and instructions for use of the Guide have been improved and, in some cases, added to the Guide. In other cases, instructions have been simplified to facilitate using the Guide. In response to comments from testers in large places concerned about handling the complexity of hazmat in their areas, instructions in the Guide were modified to accommodate these concerns. Planners in the biggest cities are now told that they might choose not to include all hazmat locations and types in their analysis. Rather, they might want to focus on only those materials with the greatest concern to their communities. These could include: highly hazardous materials that, although uncommon, if involved in an incident could result in severe consequences and necessitate specialized equipment and/or training for the emergency responders; hazmat where past planning may have been inadequate; and hazmat that, as demonstrated by the presence of many past incidents in the area, require special attention.

Attachment 1

Initial Interview Questions

Project Overview

This project will develop guidance for local communities to help them assess and understand their needs for and capacity to respond to hazardous materials incidents, whether they originate from fixed facilities or from en route events.

Needs Assessment

1. *For those that plan for emergency response* to hazmat incidents: Please describe your process for assessing where emergency response capabilities are needed.
2. What sources do you think are best for identifying fixed locations where hazardous materials are produced, used, or stored?
   - What types of locations are included in your analyses? [Types of fixed sources are listed on page 9 of working plan.]
   - Do you think these are good sources? Why? How can they be improved?
   - Do you identify the quantity and type of hazmat at these locations? If yes, how do you accomplish this?
3. What sources do you think are best for identifying the hazardous materials being transported through a community?
   - How have you identified the quantity and type of hazmat traversing your region?
   - What data sources did you use? [Refer to the mobile sources on page 9 of the work plan and discuss with the interviewee why other data sources were not used.]
4. Do you think that standardized "community characteristics" can be used to represent a baseline for the presence of hazmat? If not, what characteristics do you think make your community unique? How would you characterize different communities?
5. When considering both safety and security, how much of a security focus should this methodology take (for example, when dealing with the security of an iconic structure)?
6. If you perform a needs assessment, how often do you update it?
   - Is it periodic or does some change trigger the update? If not periodic, what are the triggers?
   - Do you update data on both fixed and mobile sources of hazmat during each update?

Capability Assessment

1. *For those that plan for emergency response to hazmat incidents:* Please describe your process for assessing the capability level of emergency response resources.
2. What should be the focus or basis for assessing hazmat emergency response capability?
   - For example, the hazardous materials classifications defined in the DOT regulations or types of hazards (fire, explosion, toxicity, radioactivity, and reactivity).
3. What do you think are the appropriate levels of personnel, training, and equipment for assessment?
   - Should the InterAgency Board for Equipment Standardization and Interoperability's (IAB) Standardized Equipment List (SEL) and the DHS Office of Grants and Training's Authorized Equipment List be considered?
   - Have you established your own standards? If yes, what are these standards and how did you develop them?
4. What do you think is the appropriate level of aggregation for a capability assessment (e.g., individual teams or some combination of nearby teams)?
   - Do you find it most appropriate to train all teams for all hazards they may face?
   - Do you distribute response capabilities across several teams? If so, what criteria do you use to assign the emergency response capabilities among the teams?

5. There are several types of response teams, including public, industry (facility and carrier), and for-hire contractors. Would you conduct capability assessments differently for these different types? If so, how would each differ?
6. How should remote response capability that can be moved on scene as appropriate for critical needs be considered (e.g., specialized for-hire or industry teams)?
7. Besides the minimum requirement for each response team to be linked to the jurisdictional boundaries within which it is willing to serve, what factors should be included in multi-jurisdictional response and mutual aid agreements?
8. How should the National Incident Management System (NIMS) fit into the capability assessment?
9. How often do you think the response teams and key agencies should be resurveyed to keep this methodology up to date?

Alignment

1. *For those that plan for emergency response to hazmat incidents:* Please describe the process used to distribute your emergency response resources.
2. What hazardous materials response teams are you aware of? How can we find these teams, and where are they? Do you rely on any national or regional level teams with specific capabilities that are on call?
3. What factors do you consider necessary to determine the appropriate minimum level of response for a particular area?
4. Do you think a quantitative approach is preferred to best match response capability to the areas in communities where they are most needed or can a more qualitative approach work just as well? [An example quantitative approach is using a GIS to compute or minimize the travel time from qualified responders to all locations on the road network in a community.]
    - Would a different approach be warranted for agencies that had different sized budgets or existing resources (such as GISs) for hazmat emergency response planning?
5. What is an appropriate minimum level of response for a given:
    - Community
    - Region
    - State
6. What do you think an organization needs to look at when considering spending additional resources on improving existing teams, creating new teams, or relocating existing teams to better align with their needs?
7. How do you think investment across jurisdictions be addressed? [For example, it may be cheaper to buy some equipment for a nearby team in a neighboring jurisdiction to bring them up to a needed capability level than it would be to create a new team.]

End of Interview

- Is there anyone else that we should talk to or be aware of?
- Are there any other communities or groups that you recommend we talk to?

→ Is this person a good candidate for the Expert Working Group? If so, ask if he/she would be interested (not a commitment) to help review interim work products, etc. We are only looking for interest at this point, so we can select candidates and have the Project Panel approve them.

Attachment 2

Expert Working Group

This attachment lists the members of the Expert Working Group assembled to assist the project team to develop the key methodologies in Tasks 2 through 4 of the project.

Expert Working Group Member	Rationale
James Bowden Emergency Management Specialist ResponseForce1 Nashville, TN	Served as the Deputy Director for the City of Nashville Office of Emergency Management and as an Emergency Management Specialist for General Physics Corp (part of the Katrina recovery). He is also currently a subject matter expert for Previstar.
Jan Dunbar Assistant Chief—Special Operations Fire / Rescue Branch California Office of Emergency Services Sacramento, CA	Was involved with the creation of California's FIRESCOPE Standardized Equipment List (SEL). His current duties at OES include conducting inspections/audits of applicant hazmat teams in order to assess their capabilities and resources against the state's hazmat team typing criteria.
James Field Hazardous Materials Control Manager University of Massachusetts Environmental Health & Safety Amherst, MA	Member of two LEPCs in Massachusetts as well as Hazmat Control Manager at UMass.
Dick Hopkins Hazmat Coordinator International Association of Fire Fighters Washington, DC	Fire Captain for many years in Hagerstown, MD, valuable for his smaller community perspective. In his current position as hazmat coordinator for IAFF, he is aware of the latest hazmat training courses and requirements for fire departments.
Greg Noll Program Manager South Central Task Force and Senior Partner Hildebrand Noll Associates Lancaster, PA	He serves as the Program Manager for the South Central Pennsylvania Regional Counter-Terrorism Task Force as well as the Hazmat/WMD Manager for the PA Task Force-1 urban search and rescue unit. Greg served as the Hazardous Materials Coordinator with the Prince George's County, MD, Fire Department where he managed the Level III Hazardous Materials Team.
Bill Pintorak Captain Liberty Township Fire Department Liberty, OH	Head of the Northwest Strike team, composed of fire departments in the vicinity of Columbus, OH, that have banded together for hazmat response. This team demonstrates how smaller satellite communities can contribute their own hazmat response specialties, resulting in a team that is much stronger and more versatile than its individual members.
Alan Williams Program Manager Emergency Response & Planning Program Maryland Department of the Environment Baltimore, MD	Leads response planning at the state level and is also very involved with South Baltimore Industrial Mutual Aid Plan (SBIMAP), which fosters chemical emergency preparedness, renders mutual aid in the event of an emergency, and facilitates cooperation between citizens groups, public agencies, and industry.

Attachment 3

Survey Questions for Guide Testers

Questions for Guide Testers

1. Please provide the following information:
   - Name ____________________
   - Title ____________________
   - Agency ____________________
   - Area Covered ____________________
   - Contact Information ____________________
     - Phone ____________________
     - Email ____________________
     - Mailing Address ____________________

       ____
2. Is the purpose of the Assessment Guide clear to you? Yes___ No___
3. Did you find the content of the Guide useful? Yes___ No___
4. Will the information in the Guide help you assess your community's emergency response needs and capabilities? Yes___ No___
5. Did you find the overall process clearly described and easy to follow? Yes___ No___
6. Were any parts of the process difficult to follow? Yes___ No___
   If yes, which parts were difficult to follow?

   ____

   ____

   ____

   ____
7. For those parts that were difficult to follow, how do you think they could be improved?

   ____

   ____

   ____

   ____
8. Did you have any trouble understanding the instructions for any of the steps?
   Yes___ No___
   If Yes, list the steps you think need improvement. Include a list of any steps that are unclear or incomplete and explain what you think are the shortcomings.

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____
9. When reading the Guide, did you need to look up terms using outside sources?
   Yes___ No___
   If Yes, which terms did you look up?

   ____

   ____

   ____

   ____

10. Are there any additional procedures or steps that you think should have been included in the Guide? Yes___ No___
If Yes, list the additional procedures or steps you think should be included and in what section of the Guide you think they should appear.

11. Were you able to use the Guide to quantify/categorize the hazardous material being transported in or through your region and/or were present at fixed facilities?
Yes___ No___
If No, explain what you are unable to complete and why?

12. Using the Guide, could you identify the capabilities needed to respond to incidents in your area based on the hazardous material present? Yes___ No___
If No, what difficulties did you encounter?

13. Using the Guide, do you feel you could identify the needed capabilities of response teams for your area and the information necessary to assess their response capabilities? (this would include such elements as equipment, number of trained personnel, medical surveillance, and site planning) Yes___ No___
If No, what impediments did you find?

14. Does the Guide identify capabilities that exceed or are less than what is needed for successful emergency response in your area? Yes___ No___
If No, what steps should be included in the Guide to provide this information?

15. Are there operationally relevant capabilities or situations in your region that do not fit into the capability categories described by the Guide? Yes___ No___
If Yes, list and describe these capabilities and/or situations.

16. For gaps in the hazardous material emergency response coverage that you identified, were you able to successfully use the Guide to identify the additional capabilities needed to provide complete coverage? Yes___ No___
If No, please describe those areas where the Guide was inadequate.

17. Are you able to use the Guide to successfully create a complete record for your response team's capabilities? Yes___ No___
    If No, please describe any areas where the Guide fell short.
18. Is the overall process described in the Guide too complex? Yes___ No___
    If Yes, please provide your suggestions for simplifying it?
19. If you were asked to perform a hazard response assessment, is there any information or data that you would find difficult to obtain? Please list the steps that would be difficult to complete and provide a description of specific information or data needs.
20. Were the terms used to calculate the Risk Metric clearly defined? Yes___ No___
21. Are there any terms in the Risk Metric that you feel are not needed? Yes___ No___
    If Yes, please list.
22. Are there additional terms that you think should have been included in the Risk Metric? Yes___ No___
    If Yes, please describe what terms were missing.
23. Would worksheets designed to walk the reader through the steps in the Guide be of value? Yes___ No___
    If Yes, would worksheets designed to automatically calculate the Risk Metric once all data were entered help you follow the steps in the Guide? Yes___ No___
24. Once you used the Guide and had developed a complete record of all hazardous material locations and transport corridors, emergency response locations and capabilities, jurisdictional performance objectives, etc., do you think that the structure provided by the Guide would facilitate regular (perhaps annual) update and review cycles? Yes___ No___
    If No, please describe where the Guide fell short.

25. Do you think the structure provided by the Guide would facilitate sharing the data and information on the presence of hazardous materials and response capabilities with other neighboring jurisdictions? Yes___ No___
If No, please describe where the Guide fell short.
____
____
____
____

26. Do you have a process already in place to determine the information requested in the Guide? Yes___ No___
If Yes, Please describe this process.
____
____
____
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Abbreviations and acronyms used without definitions in TRB publications:

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