The First Responder's Field Guide to

Hazmat & Terrorism Emergency Response

(2010 Edition)

Jill Meryl Levy

Firebelle Productions

Based on Nationally Recognized Standards and Practices for Responding to Hazmat Incidents and Terrorist Events

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fifth edition of the book formerly published under the title
The First Responder's Pocket Guide to
Hazardous Materials Emergency Response

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How to Use This Book

If you think you may be faced with a potential hazmat incident or terrorist event, refer to the appropriate chapters for guidance.

1. The **Quick Reference Guide** contains a concise overview of your responsibilities as a first responder.

2. **Recognizing and Responding to a Hazmat/WMD Incident** has detailed explanations and guidelines on each of the tasks listed in Chapter 1.

3. **Labels, Placards, and Other Marking Systems** provides key points on each of the UN/DOT hazard classes and information on various other marking systems.

4. **Container Recognition** provides clues about the types of products found in various containers and how these containers behave in an emergency. Look at both the general information about the type of container (nonbulk package, cargo tank, rail car, etc.) and specific information about the particular container(s) in question.

5. **Assessing the Hazards** contains information on how hazardous materials cause harm, toxicological terms and exposure limits, properties of flammable liquids, chemical and physical properties, and guidelines for dealing with special hazmat situations.

6. **Medical Management of Hazmat Exposures** has information on the risk of secondary contamination, patient decon, triage, health effects of hazardous materials commonly encountered, EMS treatment protocols, and medical support of hazmat response personnel.

7. **Introduction to Terrorism** provides information on distinguishing a terrorist event from an accident and distinguishing between chemical and biological warfare agents.

8. **Explosives Incidents** has information on how to recognize common explosives and initiation devices and guidelines on what to do upon discovery of a device or after detonation of an explosive.

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How to Use This Book (continued)

9. **Chemical Warfare Agents** has general information on how to deal with incidents involving chemical warfare agents, as well as more detailed information on nerve agents, blister agents, blood agents, choking agents, and riot control agents.

10. **Biological Warfare Agents** provides general information on dealing with incidents involving biological warfare agents, as well as more detailed information on specific biological agents.

11. **Nuclear Events** has information on dealing with incidents (intentional or accidental) involving radioactive materials.

12. **Tactical Considerations** provides more information on defensive options and the use of foam.

13. **Additional Considerations** includes guidelines on dealing with the media, minimizing liability, developing protective action messages, preserving evidence, and dealing with children.

14. **Resources for Information and Assistance** provides information on various agencies that can help you manage a hazmat incident or terrorist event. This chapter includes important national phone numbers and provides space for you to write in local and state phone numbers you might need.

Take time to familiarize yourself with this field guide *before you need it at an emergency*. Use it during drills and training to become proficient with it. The more you use it, the easier it will be for you to quickly locate the information you need.

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Foreword

By Ronny J. Coleman

When the first edition of this book was published, the fire service was just beginning to mature as a major participant in the handling of hazardous material events. The experiences of Kingman, Arizona, and Waverly, Tennessee, resulted in a higher level of and competency in those responding to hazardous material incidents. The fire service was prepared for the role of response better than ever at the close of this century.

Little did any of us know that our lives would be impacted in a whole new fashion by the catastrophic events of September 11, 2001. That single incident catapulted the first responder into an entirely new role. It was a role we were only partially prepared to cope with. However, we have always been prepared to respond no matter what the threat by building upon our knowledge of the past. New words have entered our vocabulary, mostly associated with weapons of mass destruction. New techniques have been formulated and tested to improve the safety of firefighters and other emergency responders. But make no mistake; it is a dangerous new world out there.

Jill Levy has performed admirably on building up this increasing body of knowledge. The new edition is something every incident commander should have in his or her command vehicle. As it is with all tools of the trade, this book should be supported by trained, well-qualified personnel, infused with a strong sense of the burden of their responsibility in protecting both their emergency responders and the public.

As always, Jill's attention to detail provides you with a document that you can easily use with a high level of confidence.

Stay safe in the service.

Ronny J. Coleman
California State Fire Marshal, Retired
(2003)

Foreword (continued)

By Douglas Sporleder

It's the nature of emergency responders to rush in and help when lives are endangered. We're the ones running into burning buildings when everyone else is running out. The public counts on us to protect not only their lives but their property and the environment as well.

Some of the hazardous materials in our communities are so dangerous, even to emergency responders, that we need to approach an incident with an entirely different mentality. We need to take our time. We need to be much more structured and methodical than we might be at an ordinary structure fire or EMS call. In fact, we need to be a lot more alert to recognize when what appears to be an ordinary structure fire or EMS call is actually a hazmat incident or terrorist event.

I was fortunate to be the chief of a very progressive fire department that has a dedicated hazmat team on duty at all times. But the department also has 18 other first-line engine or truck companies and up to 40 volunteer firefighters trained to the first responder level. Despite the best training we can give our first responders, it isn't easy to remember everything that must be done at a hazmat incident or terrorist event. That's why we develop standard operating procedures and operational checklists.

The First Responder's Field Guide to Hazmat & Terrorism Emergency Response is another tool to help firefighters and other response personnel successfully manage a hazmat incident or terrorist event. It essentially puts the curriculum of an entire 24-hour First Responder course at their fingertips in an easy-to-use field guide format. Perhaps someday this field guide will be carried on every emergency response vehicle in the country.

Douglas Sporleder, Fire Chief (retired)
Santa Clara County Fire Department
(2003)

Preface

The First Responder's Field Guide to Hazmat & Terrorism Emergency Response was conceived for two reasons. One is that no matter how much training we receive in the classroom, we're not going to remember everything at the scene of an emergency. This book gives us a "cheat sheet" to help us handle hazmat incidents and terrorist events until more highly trained and better equipped personnel arrive.

More importantly, there are still too many people killed or injured by hazardous materials because either they fail to detect the presence of these products or they underestimate the danger potential when they know hazardous materials are present. A tool like this can help save lives.

This book is the fifth edition of *The First Responder's Pocket Guide to Hazardous Materials Emergency Response*. It was renamed in 2003 to better reflect the book's contents. Every chapter was updated to provide current information and incorporate as many of the NFPA 472 and 473 first responder competencies as possible. Other improvements were made based on suggestions from responders who have used earlier editions.

The most difficult part of writing this book is that there is no "one size fits all" approach to dealing with hazmat incidents or terrorist events. Every situation is different. There are exceptions to every rule. And things are forever changing in both of these arenas, more so after 9/11 than ever before. Additionally, every first responder who uses this field guide is different. Requirements and resources vary from one state to another and from one jurisdiction to the next. But we all have an equal need to be safe at a hazmat incident or terrorist event, regardless of the communities we serve, what type of agency we work for, or whether we're paid or volunteer.

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Preface (continued)

My goal was to provide information that would be the most useful for first responders. But this book is *just a guide*. It's not intended as a tool to determine compliance with specific laws and regulations. It's not intended to replace formal hazmat training, terrorism training, department SOPs, or contingency plans that apply in your area. Nor is it designed to replace common sense and good judgment. It's up to you to accurately size up the incident and determine the appropriate response based on the hazards present and on your training, resources, and capabilities.

Take time to familiarize yourself with this field guide *before you need it in an emergency*. Use it during drills and training so that you become proficient with it. Above all, use it to protect your life and the lives of others around you.

Your comments and suggestions are welcome.

Jill Meryl Levy
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Acknowledgments

First and foremost, I want to thank my friends at the Santa Clara County Fire Department in California for their encouragement and support. It was District Chief Charlie Anderson (now retired) and Captain David Ghilarducci (now a doctor) who introduced me to the world of hazardous materials in 1994. Their passion for the subject, their dedication to the fire service, and their commitment to quality provided the inspiration that ultimately led to this book. I'll always be grateful for the training I've received from them and for the opportunities I've enjoyed because of our friendship.

I owe special thanks to my friend and mentor Captain Robert Kelly Seitz of the Santa Clara County Fire Department, a man whose tireless efforts have benefitted hazmat responders nationwide. I couldn't ask for a friend more generous with his time and knowledge. Nor could I find a friend more supportive of a volunteer firefighter in a predominantly paid fire department.

Many outstanding people from agencies throughout the country reviewed drafts of one or more editions of this book. (For simplicity, they are listed below in alphabetical order, with title and affiliation as of the last time they reviewed a draft.) This list also includes people who provided input on *The First Responder's Pocket Guide to Radiation Incidents*. Their contributions toward that book helped me rewrite Chapter 11 in this one.

The people on the following pages shared tremendous insight about how emergency responders from different disciplines manage a hazmat incident or terrorist event. They helped me identify information that needed to be updated to reflect current standards and regulations. Most important, they helped me shape this book into a powerful tool for both field and classroom use.

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This book was inspired, in part, by the outstanding training I've received through the California Specialized Training Institute (CSTI) and the Continuing Challenge Hazmat Workshop. I'm grateful to all the people I've met through those organizations and other conferences I've attended for their valuable insight.

I want to thank all of my customers who purchased earlier editions of this book and shared their comments with me. Many of the changes made through the years were shaped by their comments.

Last but not least, I'm grateful to the friends who have played pivotal roles in my career. Robert Charles Innis, Drew Bardet, and Glenn Bardet first captured my heart in junior high school. But a few years later, they and a fourth friend, Kevin McQuiston, inspired in me a passion for writing and set me on the path that led my becoming a firefighter, an author, and a paralegal. These special friends will always have a place in my heart ... especially Charlie, who is now my boyfriend.

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Introduction and Purpose

The Goal of the First Responder

The goal for first responders at any hazardous materials incident or terrorist event is to respond safely and competently within the limits of their training, resources, and capabilities.

This Book's Target Audience

This book addresses most of the NFPA 472 (2008 edition) core competencies for **operations level responders** (still called *first responder operations level* in 29 CFR 1910.120)—persons who respond to hazardous materials or WMD incidents for the purpose of protecting nearby persons, the environment, or property from the effects of the release. These persons shall be trained to respond in a defensive fashion to control the release from a safe distance and keep it from spreading.

This book covers *some* of the optional mission-specific competencies for operations level personnel who are authorized to:

- Use PPE, as provided by the authority having jurisdiction
- Perform technical decontamination
- Perform mass decontamination
- Perform product control
- Perform air monitoring and sampling
- Perform victim rescue and recovery operations
- Preserve evidence and perform sampling
- Respond to illicit laboratory incidents

Awareness level personnel (still called *first responder awareness level* in 29 CFR 1910.120) are those persons who, in the course of their normal duties, could encounter an emergency involving hazardous materials or WMDs. They are expected to recognize the presence of hazardous materials or WMDs, protect themselves, call for trained personnel, and secure the area.

Awareness level personnel must understand that a lot of the information in this book is beyond the scope of their responsibilities. Nonetheless, it covers almost everything an awareness level person needs to know to fulfill the NFPA 472 competencies.

This book also covers most of the **incident commander** competencies.

Introduction and Purpose

Above and Beyond the Target Audience

To a lesser degree, the book covers competencies at other levels listed below. To include everything would have made an already comprehensive book overwhelming. Since this book is geared for operations level responders and the incident commanders who direct their activities, any "extra" material was evaluated on the basis of how it might meet the needs of the target audience.

- EMS Personnel - Basic Life Support (BLS) *
  - Emergency Care First Responder (ECFR)
  - Emergency Medical Technician—Ambulance (EMT-A)
  - Emergency Medical Technician—Basic (EMT-B)
- EMS Personnel - Advanced Life Support (ALS) *
  - Emergency Medical Technician—Intermediate (EMT-I)
  - Emergency Medical Technician—Paramedic (EMT-P)
  - Medical Director
  - Medical Team Specialist
- Hazardous Materials Technicians

* The EMS titles were changed in the 2008 edition of NFPA 473. Previously, EMS personnel were referred to as EMS/HM Level I or Level II Responders. Level I responders performed patient care in the cold zone on individuals who no longer posed a significant risk of secondary contamination. Level II personnel could operate in the warm zone, providing care to patients who might still pose a significant risk of secondary contamination.

This field guide can be used by personnel both in the public sector and in private industry as long as you use good common sense and act within the scope of your employment. For example, actions appropriate for firefighters wearing structural firefighting clothing and SCBA may not be safe for other responders. Know your capabilities and limitations, and act accordingly.

Note: This book does not distinguish between the terms *hazardous materials* (DOT), *hazardous substances* (EPA and OSHA), *hazardous chemicals* (OSHA), *dangerous goods* (UN), or other similar terms. These terms are tied to different regulations, each of which has a different focus. This book is concerned only with the safety of first responders and the public we serve, regardless of the substances involved or how they are regulated.

Introduction and Purpose (continued)

Scope of the Information in this Field Guide

This book contains general guidelines based on nationally accepted standards and practices. It is *not* intended to replace your standard operating procedures (SOPs) or formal training. Nor will it address all possible contingencies that may be associated with a hazmat incident or terrorist event. Rather, it is designed to supplement the information in your agency's own SOPs and other resources, such as the *Emergency Response Guidebook*.

This information is intended to aid you in (1) quickly identifying the material(s) and/or container(s) involved in the incident and (2) protecting yourself and the general public during the initial response phase of the incident. As soon as possible, you should request assistance from a trained hazmat team, CHEMTREC, a shipper, product specialists, or other appropriate resources. This book is designed to be generic enough for use throughout the United States. However, you should familiarize yourself with any requirements specific to your state or local area.

29 CFR 1910.120 Versus NFPA 472 and 473

29 CFR 1910.120, also known as HAZWOPER (Hazardous Waste Operations and Emergency Response), is a federal regulation that applies to both industry and public safety organizations that respond to hazardous materials or hazardous waste emergencies. Paragraph (q) covers emergency response to hazardous substance releases. (Public sector personnel in states that do not have their own OSHA program are covered under a similar regulation—40 CFR Part 311—enacted by the EPA.) Some states have enacted their own analogous regulations that may be more restrictive than 29 CFR 1910.120.

NFPA 472 and 473 are *standards* for professional competence based on a process of voluntary consensus. A standard is the minimum acceptable level of service to be provided based on laws, regulations, and local protocols and practices. However, once a jurisdiction adopts a standard, response personnel must comply with the requirements of that standard. This book is based on NFPA 472 and 473 (rather than limited to only what's required by law) to encourage responders to perform to the higher standard of care.

Acronyms and Abbreviations

AAR	Association of American Railroads
ABC	Airway, Breathing, and Circulation
AC	Hydrogen Cyanide (military designation)
ACGIH	American Conference of Governmental Industrial Hygienists
AED	Automated External Defibrillator
AEGL	Acute Exposure Guideline Level
AFFF	Aqueous Film Forming Foam
AIHA	American Industrial Hygiene Association
ALARA	As Low As Reasonably Achievable
ammo	Ammunition
ANFO	Ammonium Nitrate and Fuel Oil
ANSI	American National Standards Institute
APR	Air Purifying Respirator
ASPCA	American Society for the Prevention of Cruelty to Animals
ATC	Alcohol-Type Concentrate
ATF	Bureau of Alcohol, Tobacco and Firearms
atm	Atmospheres
ATSDR	Agency for Toxic Substances and Disease Registry
BAL	British Anti-Lewisite
BLEVE	Boiling Liquid Expanding Vapor Explosion
BP	Blood Pressure
Bq	Becquerel
BVM	Bag-Valve Mask
CAM	Chemical Agent Monitor
CAMEO	Computer Aided Management of Emergency Operations
CANUTEC	Canadian Transportation Emergency Centre
CAS	Chemical Abstracts Service
CBRN	Chemical, Biological, Radiological, and Nuclear
CBRNE	Chemical, Biological, Radiological, Nuclear, and High-Yield Explosive
CD	Civil Defense
CDC	Centers for Disease Control and Prevention
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERT	Community Emergency Response Team
CFR	Code of Federal Regulations

CG	Phosgene
CGI	Combustible Gas Indicator
CHEMTREC	Chemical Transportation Emergency Center
Ci	Curie
CISD	Critical Incident Stress Disorder
CK	Cyanogen Chloride
CL	Chlorine
CMA	Chemical Manufacturer's Association
CN	Chloracetophenone (Tear Gas, Mace)
CO_2	Carbon Dioxide
cpm	Counts per Minute
CR	Dibenzoxazephine (Tear Gas)
CS	Chlorobenzylidenemalononitrile (Tear Gas)
CSB	Chemical Safety and Hazard Investigation Board
CSI	Criticality Safety Index
CST	Civil Support Team (National Guard)
CX	Phosgene Oxime
DEA	Drug Enforcement Administration
Decon	Decontamination
DG	Dangerous Goods
DHHS	Department of Health and Human Services
DHS	Department of Homeland Security
DM	Diphenylaminearsine Chloride (Adamsite)
DMAT	Disaster Medical Assistance Teams
DMORT	Disaster Mortuary Operational Response Teams
DNA	Deoxyribonucleic Acid
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of the Interior
DOJ	Department of Justice
DOT	Department of Transportation
DOT-E	Department of Transportation Exemption
DOT-SP	Department of Transportation Special Permit
DPETAP	Domestic Preparedness Equipment Technical Assistance Program
EARS	Emergency Animal Rescue Service
EHS	Environmental, Health, and Safety
EMA	Emergency Management Agency
EMS	Emergency Medical Services
EMS/HM	Emergency Medical Services / Hazmat
ERG	Emergency Response Guidebook
EOC	Emergency Operations Center

Acronyms and Abbreviations (continued)

EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
ERT	Emergency Response Team
EVC	Emergency Valve Control
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FOSC	Federal On-Scene Coordinator
GA	Tabun
GB	Sarin
GD	Soman
GHS	Globally Harmonized System of Classification and Labeling of Chemicals
gm	Gram
Gy	Gray
H	Mustard
Hazmat	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HD	Distilled Mustard
HEPA	High-Efficiency Particulate Air
HHS	Health and Human Services
HN	Nitrogen Mustard
HRCQ	Highway Route Controlled Quantity
HVAC	Heating, Ventilation, and Air Conditioning
IAP	Incident Action Plan
IC	Incident Commander
ICAM	Improved Chemical Agent Monitor
ICS	Incident Command System
IED	Improvised Exposive Device
IDLH	Immediately Dangerous to Life and Health
IM	Intermodal
IMS	Incident Management System
IND	Improvised Nuclear Device
JIC	Joint Information Center
L	Lewisite
LC	Lethal Concentration
LD	Lethal Dose

Acronyms and Abbreviations (continued)

LEL	Lower Explosive Limit
LEPC	Local Emergency Planning Committee
LNG	Liquefied Natural Gas
LNR	Laboratory Response Network
LOC	Level of Concern
LOX	Liquid Oxygen
LPG	Liquid Petroleum Gas
LSA	Low Specific Activity
MC	Motor Carrier
Mg/M^3	Milligrams per Cubic Meter
MHR	Maximum Heart Rate
mmHg	Millimeters of Mercury
MMRS	Metropolitan Medical Response System
MMST	Metropolitan Medical Strike Teams
MOPP	Mission-Oriented Protective Posture gear
MOT	Materials of Trade
mR/hr	Millirems per Hour
MRE	Meals Ready-to-Eat
rem	Millirems
MSDS	Material Safety Data Sheet
MSST	Maximum Safe Storage Temperature
NA	North America
NBC	Nuclear, Biological, and Chemical
NCN	Nitro-Carbo-Nitrates
NDMS	National Disaster Medical System
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NIOSH	National Institute for Occupational Safety and Health
NNRT	National Nurse Response Team
NPRT	National Pharmacy Response Team
NRC	National Response Center
NRT	National Response Team
NVRT	National Veterinary Response Team
OC	Oleoresin Capsicum (Pepper Spray)
ORM	Other Regulated Materials
OSHA	Occupational Safety and Health Administration
PAC	Protective Action Criteria
PAPR	Powered Air Purifying Respirator
PASS	Personal Alert Safety Systems

Acronyms and Abbreviations (continued)

PBI	Polybenzimidizole
PCB	Polychlorinated Biphenyl
PCP	Pest Control Product
PDA	Personal Digital Assistant
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PIO	Public Information Officer
PPE	Personal Protective Equipment
ppb	Parts per Billion
ppm	Parts per Million
PS	Chloropicrin (Mace)
psi	Pounds per Square Inch
PTSD	Posttraumatic Stress Disorder
PVC	Polyvinyl Chloride
rad	Radiation Absorbed Dose
RDD	Radiological Dispersal Device
REL	Recommended Exposure Limits
rem	Radiation Equivalent Man
RNA	Ribonucleic Acid
RQ	Reportable Quantity
SADT	Self-Accelerating Decomposition Temperature
SAR	Supplied Air Respirators
SBCCOM	U.S. Army Soldier and Biological Chemical Command
SCAPA	Subcommittee on Consequence Assessment and Protective Actions
SCBA	Self-Contained Breathing Apparatus
SCO	Surface Contaminated Objects
SDS	Safety Data Sheet
SEB	Staphylococcal Enterotoxin B
SERC	State Emergency Response Commission
SETIQ	Emergency Transport System for the Chemical Industry (Mexico)
SNS	Strategic National Stockpile
SOP	Standard Operating Procedure
START	Simple Triage and Rapid Treatment
STEL	Short-Term Exposure Limit
Sv	Sievert

Acronyms and Abbreviations (continued)

TARU	Technical Advisory Response Unit
TEEL	Temporary Emergency Exposure Limit
TERC	Tribal Emergency Response Commission
TI	Transportation Index
TIH	Toxic Inhalation Hazard
TLD	Thermoluminescent Dosimeter
TLV-C	Threshold Limit Value - Ceiling
TLV-TWA	Threshold Limit Value - Time Weighted Average
TNT	Trinitrotoluene
TRU	Transuranic Waste
TSD	Treatment Storage Disposal
UAN	United Animal Nations
UEL	Upper Explosive Limit
UN	United Nations
US&R	Urban Search and Rescue
USCG	United States Coast Guard
VEE	Venezuelan Equine Encephalitis
VHF	Viral Hemorrhagic Fever
VMI	Vendor Managed Inventory
VX	V Agent
WMD	Weapons of Mass Destruction

Disclaimer

This book is a condensed summary only. It is not a substitute for a complete hazmat or WMD course under a qualified instructor. All hazmat emergencies and terrorist events should be managed under the Incident Command System (ICS) defined by the National Incident Management System (NIMS). All local, state, federal, and jurisdictional laws, regulations, and SOPs take precedence over these guidelines.

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Quick Reference Guide

This chapter is designed to be a quick reference guide to the tasks that should be performed at a hazmat incident or terrorist event. It provides a concise overview of first responder responsibilities based on the competencies in NFPA 472 and NFPA 473.

Most of the tasks listed are cross-referenced to other pages or chapters in this book that provide additional guidance. However, there are a number of other pages not referenced in this chapter that provide important response information. Take time to familiarize yourself with this book before you need it in an emergency so that you become proficient with it.

Awareness Level Personnel

Awareness level personnel are people who, in the course of their normal duties, could encounter an emergency involving hazardous materials or WMDs. This group includes truck drivers, train crews, plant workers, and others who work in facilities where hazardous materials or WMDs are manufactured, used, stored, transported, or could otherwise be released. They are expected to recognize the presence of hazardous materials or WMDs, protect themselves, call for trained personnel, and secure the area.

Perform the Following Tasks Safely

Detect the presence of hazardous materials/WMD. *(pages 2-4 and 2-5)*

Survey (size up) the incident from a safe spot (upwind, uphill, upstream) to obtain information for emergency responders:

- Product name *(page 2-27)*, 4-digit identification number *(page 3-4)*, or hazard class. *(chapter 3)*
- Labels, placards, and other marking systems. *(chapter 3)*
- Container shapes. *(chapter 4)*

Collect hazard information from the current edition of the *Emergency Response Guidebook*. *(pages 2-27 and 14-6 to 14-11)*

- Note: Other reference materials may be more appropriate for incidents at fixed facilities. *(page 2-28)*

Initiate appropriate protective actions.

- Begin by isolating the immediate area. *(page 2-20)*
- Initiate protective actions per the local emergency response plan, your organization's SOPs, and the current edition of the *Emergency Response Guidebook*. *(pages 2-55 and 2-56)*

Initiate the notification process specified in the local emergency response plan and your organization's SOPs.

- Call for trained personnel. *(page 2-6)*
- Make appropriate notifications and call for additional resources as needed. *(pages 2-22 and 2-23 and chapter 14)*

Your responsibilities may go beyond those listed above. However, any actions you take should be within the scope of your employment and the limits of your training, resources, and capabilities. Above all, do not initiate any actions unless it is safe to do so.

Operations Level Responders

Personnel at the operations level respond to hazardous materials or WMD incidents for the purpose of protecting nearby persons, the environment, or property from the effects of the release. They shall be trained to respond in a defensive fashion to control the release from a safe distance and keep it from spreading.

Anyone tasked to respond to a hazmat or WMD incident during the emergency response phase is viewed as an operations level responder. This level includes fire, rescue, law enforcement, emergency medical services, private industry, and other allied professionals. NFPA 472 makes no distinction between career and volunteer responders; it applies to both.

NFPA 472 should also be interpreted to include personnel tasked to respond during the emergency phase of *any* incident that could reasonably be expected to involve hazardous materials or WMDs. Even when agencies have a policy that their personnel will back out and leave a hazmat incident to a hazmat team, there are many scenarios in which firefighters, law enforcement, EMS personnel, and other emergency responders can find themselves in the hot zone before they recognize that hazardous materials or WMDs are present.

Perform the Following Tasks Safely

Detect the presence of hazardous materials/WMD. *(pages 2-4 and 2-5)*

Ensure your safety.
- Make a safe approach (from upwind, uphill, upstream). *(pages 2-7 to 2-9)*
- Lay a safe foundation. *(page 2-10)*

Initiate command and control activities.
- Report on conditions. *(page 2-11)*
- Assume initial command and establish a command post in a safe location. *(page 2-12)*
- Isolate the area and deny entry. *(pages 2-20 and 2-21)*
- Initiate the notification process. *(pages 2-22 and 2-23)*

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Operations Level Responders (continued)

Analyze (size up) the incident to determine magnitude of the problem in terms of potential outcomes. *(pages 2-24 to 2-26)*

- Determine the following:
  - Materials and containers involved. *(chapters 3 and 4)*
  - Whether hazardous materials have been released.
  - Potential for criminal or terrorist activities (including secondary devices or events). *(pages 7-4 and 7-5)*
  - Surrounding conditions. *(page 2-25)*
- Collect hazard and response information from appropriate resources. *(pages 2-27 to 2-28)*
- Predict the likely behavior of a material and its container. *(pages 2-29 to 2-30 and chapters 3 to 5)*
- Estimate the potential outcome. *(pages 2-31)*
- Look at the big picture. Maintain situational awareness.

Plan an initial response. *(pages 2-32 to 2-43)*

- Develop your plan based on the capabilities and competencies of available personnel and equipment.
- Determine the following:
  - Additional resources needed.
  - Response objectives (strategy). *(page 2-32)*
  - Defensive options (tactics). *(page 2-33 and chapter 12)*
  - Whether your PPE is appropriate for implementing each defensive option. *(pages 2-47 to 2-54)*
  - Decon needed. *(pages 2-57 to 2-58 and 6-10 to 6-15)*
  - Protective actions needed. *(pages 2-55 to 2-56)*

Implement planned response to favorably change the outcome.

- Be consistent with the local emergency response plan and your organization's SOPs.
- Establish and enforce scene control procedures including:
  - Control zones. *(page 2-21)*
  - Emergency decon. *(pages 2-57 to 2-58 and 6-10 to 6-15)*
  - Communications.
- Initiate the incident command system. *(pages 2-12 to 2-19)*
- Use PPE that is appropriate for the hazards and your level of training. *(pages 2-47 to 2-54)*
- Perform defensive control functions identified in the plan of action. *(page 2-33 and chapter 12)*
- Preserve evidence if possible. *(pages 13-16 to 13-20)*

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Operations Level Responders (continued)

Evaluate the progress of actions taken to ensure response objectives are being met safely, effectively, and efficiently.

- Evaluate the status of defensive actions in accomplishing response objectives. *(page 2-61)*
- Communicate the status of planned response. *(page 2-61)*
- Adjust as necessary.

Document your activities. *(pages 2-65 to 2-66)*

The steps identified above represent the core competencies at the operations level. You may have mission-specific responsibilities that go beyond this. Regardless, any actions you take should be within the scope of your employment and the limits of your training, resources, and capabilities. Above all, do not initiate any actions unless it is safe to do so.

EMS Responders (BLS and ALS)

EMS personnel who respond to hazardous materials or WMD incidents shall be trained to meet the NFPA 472 core competencies for operations level responders. They must also be trained to meet the NFPA 473 competencies for BLS or ALS responders, as applicable.

Perform the Following Tasks Safely

Detect the presence of hazardous materials/WMD. *(pages 2-4 and 2-5)*

Ensure your safety.

- Make a safe approach (from upwind, uphill, upstream). *(pages 2-7 to 2-9)*
- Lay a safe foundation. *(page 2-10)*
- Report on conditions. *(page 2-11)*
- Isolate the area and deny entry. *(pages 2-20 and 2-21)*

Analyze (size up) the incident to determine the risks to responders and patients.

- Determine the following:
  - Whether hazardous materials have been released.
  - Hazards present. *(chapters 3 and 5)*
  - Potential for criminal or terrorist activities (including secondary devices or events). *(pages 7-4 and 7-5)*
  - Number of patients.
  - Risk of secondary contamination and need for body substance isolation procedures. *(pages 6-3 to 6-9)*
  - Need for and effectiveness of patient decon.
- Collect hazard and response information from appropriate resources to determine the nature of the problem and potential health effects of the substances involved.
- Look at the big picture. Maintain situational awareness.

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EMS Responders (BLS and ALS) (continued)

Plan to deliver BLS or ALS care to exposed patients.

- Identify the capabilities of the hospital network to accept exposed patients and perform emergency decon if required.
- Identify the medical components of the communications plan.
- Identify your role (and limitations) per the local emergency response plan and the incident management system.
- *ALS Responder:* If the incident warrants it, identify supplemental medical resources, including those from the strategic national stockpile (SNS) and the metropolitan medical response system (MMRS).

Implement a prehospital treatment plan within your scope of practice.

- Evaluate patients for signs and symptoms of exposure. *(pages 6-21 to 6-25)*
- Determine the appropriate emergency care. *(pages 6-26 to 6-29)*
- Treat the patients.
- Transport patients to medical facilities capable of performing emergency decon (if needed) and best able to treat the specific injuries. *(pages 6-9 and 6-30)*
- Provide medical support for incident response personnel. *(pages 6-33 to 6-34)*
- Request additional medical resources (personnel, equipment and supplies, antidotes, transport units, etc.) as needed.
- Preserve evidence if possible. *(pages 13-16 to 13-20)*
- Document your activities. *(pages 2-65 to 2-66)*
- *ALS Responder:* Participate in the incident debriefing and critique. *(pages 2-63 to 2-64)*

Incident Commander

The incident commander is the person responsible for all incident activities, including developing strategies and tactics, ordering resources, and releasing resources. When a unified command has been established for multiagency or multijurisdictional incidents, the lead persons for each agency collectively manage the incident.

Incident commanders are expected to meet all competencies at the awareness level, all core competencies at the operations level, and all competencies at the incident commander level outlined in NFPA 472. Incident commanders are also expected to receive any additional training necessary to meet applicable governmental regulations and the specific needs of the jurisdiction.

Perform the Following Tasks Safely

Analyze (size up) the incident to determine the magnitude of the problem and potential outcomes.

- Collect and interpret hazard and response information from appropriate resources. *(pages 2-27 to 2-28, chapter 5)*
- Estimate the potential outcome. *(page 2-29 to 2-31)*
- Assess the potential for criminal or terrorist activities (including secondary devices or events) *(pages 7-4 and 7-5)*
- Look at the big picture. Maintain situational awareness.

Plan the response operations.

- Designate a safety officer. *(pages 2-15 to 2-17)*
- Identify the response objectives (strategy) *(page 2-32)*
- Identify the potential action options (defensive, offensive, and nonintervention) available by response objective. *(pages 2-32 to 2-33)*
- Approve the level of PPE required for a given action option. *(pages 2-47 to 2-54)*
- Develop an incident action plan and site safety plan *(pages 2-32 to 2-43)* that is:
  - Consistent with the local emergency response plan and your organization's SOPs, and
  - Within the capabilities and competencies of available personnel and equipment.

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Incident Commander (continued)

Implement the planned response to favorably change the outcome.

- Implement the incident command system, including procedures for notification and utilization of nonlocal resources. Emergencies should be managed using the Incident Command System (ICS) as defined by the National Incident Management System (NIMS). *(pages 2-12 to 2-19 and page 2-44)*
- Direct resources with expected tasks assignments and on-scene activities.
- Provide management overview, technical review, and logistical support to private and governmental sector personnel.
- Provide a focal point for information transfer to media and local elected officials. *(pages 13-3 to 13-5)*
- Preserve evidence if possible. *(pages 13-16 to 13-20)*

Evaluate the progress of actions taken.

- Evaluate the planned response to ensure response objectives are being met safely, effectively, and efficiently. *(page 2-61)*
- Adjust as necessary.

Terminate the incident.

- Transfer command (control) when appropriate.
- Conduct an incident debriefing. *(page 2-63)*
- Conduct a multiagency critique. *(page 2-64)*
- Document the incident and submit the report to the designated agency. *(pages 2-65 to 2-66)*

Recognizing and Responding to a Hazmat/WMD Incident

This chapter contains general guidelines for responding to a hazmat incident or terrorist event and is based on nationally accepted standards and practices. However, there is no “one size fits all” approach to dealing with these incidents. It will be up to you to accurately size up the incident and adjust accordingly.

These are general guidelines only. All local, state, federal, and jurisdictional laws, regulations, and standard operating procedures (SOPs) take precedence over these guidelines.

2-2

How to Use This Chapter

This chapter is designed to be used in conjunction with the Quick Reference Guide in Chapter 1. The Quick Reference Guide provides a concise overview of your responsibilities. This chapter provides more detailed explanations to help you understand those responsibilities.

The Order of Things

The information in this chapter was organized *primarily* for operations level responders. Responsibilities for awareness level personnel, EMS personnel, incident commanders, and safety officers are incorporated where appropriate. Once again, there is no "one size fits all" approach to dealing with hazmat incidents or terrorist events. There are times it may be appropriate to modify the order in which you accomplish the following activities.

Be Prepared

Know Your Emergency Response Plan / SOPs

Various laws require that employers, emergency responders, and communities in general have emergency response plans. (Jurisdictions that have not developed a plan can refer to the National Response Team document NRT-1, *Hazardous Materials Emergency Planning Guide*.) Know where your plan and SOPs are located, and be familiar with the contents of each.

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Location of Emergency Response Plan & SOPs

Know the Risks in Your Community

Most hazmat incidents involve flammable or combustible liquids, corrosives, anhydrous ammonia, or chlorine. If you have SOPs for events involving these products—flexible SOPs that include likely variables—you'll be reasonably well prepared for most incidents. However, know what other hazardous materials exist in your community and where they're located.

It's highly probable that hazardous materials (including consumer goods) will be found at the following places:

- Fuel storage and dispensing facilities
- Auto repair and service shops
- Manufacturing, industrial, and research facilities
- Airports, truck terminals, rail yards, piers, docks, and other port shipping facilities
- Utilities (water treatment facilities, electrical substations, etc.)
- Retail occupancies (e.g., hardware, paint, and building supply stores; garden centers; grocery/drug stores; craft/hobby stores)
- Dry cleaners
- Farms and agricultural facilities
- Medical facilities and veterinary clinics
- Schools (chemistry/science labs and storerooms, auto shop, pool supply and maintenance areas)
- Print shops
- Warehouses
- Treatment storage disposal (TSD) facilities
- Landfills and hazardous materials/waste disposal sites
- Homes (garages, sheds, kitchens, and bathrooms)

Detect the Presence of Hazardous Materials or WMDs

It's not always immediately obvious that hazardous materials or WMDs are present at the scene of an emergency. Many hazmat/WMD incidents are initially reported as something else (e.g., fire, smoke or odor investigation, traffic accident, medical aid call).

Look for Hazmat/WMD Recognition Clues

Assume that hazardous materials are present until proven otherwise. Look for clues or warning signs such as:

- **Details** provided by the caller or dispatcher
- **Occupancies or locations** where hazardous materials are likely to be manufactured, used, stored, or transported
- **Facility preplans**
- **Containers** that are likely to hold hazardous materials
- **Markings and colors** on packages, labels, or placards
- **Placard and label** information
- **Shipping papers and material safety data sheets (MSDS)**
- **Information from responsible party and witnesses**
- **People running** from the area
- **Illnesses or injuries** consistent with a hazmat exposure
- **Dead or sick animals, birds, fish, or insects**
- **Unusual colors, sounds, odors, or clouds**
- **Visible release or chemical reaction** (spill, leak, fire, etc.)
- **Condensation lines on pressure tanks**
- **Alarms** from fixed or portable monitoring equipment
- **WMDs or signs of criminal activities**

Evaluate Clues Wisely and Cautiously

- Remember, no clue is 100% reliable. All have limitations. Look for evidence to support your observations or assumptions.
- Be alert to sensory clues, but don't rely on them alone. Sensory clues are the least dependable and potentially most dangerous method of identification. Many hazardous materials are colorless and/or odorless and can do harm before you see or smell them. Observe from a safe distance, and use binoculars if needed.
- Gather pertinent information from witnesses before committing personnel to potentially dangerous areas.
- Be cautious of touching anything from the scene (including patients and shipping papers) that may be contaminated.

Call for Trained Personnel

Anyone who discovers a hazmat incident or terrorist event should call for trained emergency responders as early as possible.

Initiate the Notification Process

Initiate the notification process specified in your local emergency response plan and your organization's SOPs. Report the incident by dialing 911 or the appropriate number in your area. Notify your on-site emergency response team (ERT) if applicable.

In Case of Emergency
Dial 911 or

____

Provide Key Information When Calling

Provide as much of the following information as possible. Updates can be provided as more details become available. Stay on the line until emergency operators have all the information they need.

- Location of the incident and whether it is indoors or outdoors
- Type of hazmat/WMD incident (fire, spill, medical, etc.)
- Material(s) involved (if known)
  (If you don't know the specific product, describe any labels, placards, markings, or container shapes that are visible.)
- Number of injured or exposed persons (if applicable)
- Approximate size of the fire or release
- Environment affected (air, land, or water)
- Information on product spread so that emergency personnel can approach from an upwind, uphill, and upstream direction
- Whether criminal or terrorist activities are suspected
- Actions currently being taken
- Your name and the phone number you are calling from

Make Additional Notifications As Appropriate

Other notifications may be required. However, at this point, your main concern is getting trained personnel on their way. (Refer to pages 2-22 to 2-23 for other notification requirements. Chapter 14 lists additional resources for information and assistance.)

Make a Safe Approach

Hazmat incidents and terrorist events differ from other emergencies in that they often present a greater potential for harm and they require responders to be trained and equipped to properly deal with the incident.

Guidelines for Making a Safe Approach

- Respond slowly and methodically. Always think safety!
- Approach from upwind, uphill, and upstream.
- Do not drive through spills or clouds.
- Maintain a safe distance, and use binoculars as needed.
- Park vehicles headed away from the scene for a quick escape.
- Avoid blocking other emergency vehicles.
- Be alert for signs of criminal or terrorist activity, including the possibility of secondary events or devices.

Recommended Distances - Outdoor Incidents

If you know the product, use the *Emergency Response Guidebook* (ERG) for recommended safe distances. Remember, however, that the ERG is geared for the initial response phase of an incident (roughly the first thirty minutes). These distances may need to be adjusted as the incident progresses.

If you don't know the product, you can use the distances on the following page, adapted from the "Public Safety" sections of the ERG. Adjust as needed based on wind, rain, topography, fire, etc. If you don't know the hazards of the material, consider its form; anything in gas form or any liquid that appears to have a high vapor pressure (is evaporating rapidly) is potentially more dangerous.

Note: The ERG generally defines a *small* spill as one involving one small package (e.g., up to a 55-gallon drum), a small cylinder, or a small leak from a large package. It defines a *large* spill as a spill from a large package or multiple spills from many small packages. However, one must also consider the chemical and physical hazards associated with the material, as well as environmental conditions that impact the overall risk. A 5-gallon spill of a highly toxic material, for example, may present a far greater risk than a 500-gallon spill of a combustible liquid.

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Make a Safe Approach (continued)

Recommended Distances - Outdoor Incidents (continued)

The distances cited below are extrapolated primarily from information in the ERG2008.

The following general guidelines are *minimum* **initial isolation distances** for spills or leaks.

Distance	Hazard Potential
75 feet (25 meters)	low to moderate
150 feet (50 meters)	significant
330 feet (100 meters)	high
1/3 mile (0.5 kilometers)	most explosives

The following *minimum* **initial downwind evacuation distances** are general guidelines geared for **large spills**. (Distances may be greater for substances highlighted in the ERG yellow or blue sections and listed the green section—Table of Initial Isolation and Protective Action Distances.)

Distance	Hazard Potential
330 feet (100 meters)	moderate
800 to 1000 feet (0.25 to 0.3 kilometers)	significant
1/3 to 1/2 mile (0.5 to 0.8 kilometers)	high

The following *minimum* **evacuation distances** are general guidelines that apply to **fires**.

- **1000 feet** (0.3 kilometers) - fires involving radioactive materials
- **1/3 to 1 mile** (0.5 to 1.6 kilometers) - fires involving tanks, rail cars, or tank trucks

The following *minimum* **evacuation distances** apply to **explosive devices**. However, greater distances may be prudent, depending on the circumstances. Be particularly cautious if there is any possibility that emergency responders may be targeted. Terrorists who gain access to our training materials may build or plant devices to harm us at what we believe to be safe distances.

- **900 feet** (0.27 kilometers) - explosive devices
- **0.5 to 1.5 miles** (0.8 to 2.4 kilometers) - vehicle bombs
  See the Vehicle Bomb Evacuation Distance Table (page 8-22)

Recommended Distances - Indoor Incidents

It is more difficult to provide recommended distances for indoor incidents because there are so many variables. The building itself can make it difficult to even see the release and determine the scope of the incident.

You may be able to use the recommended distances listed on the previous page as a starting point. Another guideline that may work, depending on the product and quantity involved, is to keep at least one room or floor between you and the hazardous material. Remember that you still want to be "upwind" and "uphill" from the product, but these terms take on new significance inside a building. It may be unsafe to be on floors above or below the release, depending on the vapor density of the material and pathways between floors (routes a liquid, vapor, or gas may travel). (See pages 5-39 and 5-40 for information on vapor density.) Anticipate that the product may spread via air handling systems, floor drains, etc., and adjust accordingly.

Particularly in buildings that cannot be easily evacuated (e.g., hospitals, nursing facilities, and jails), you may need to control the spread of the product as another way to maintain a safe distance and protect people who might otherwise be threatened by the release. For example, it may be appropriate to shut down air handling systems to avoid circulating gases or vapors to other areas or, conversely, to turn air handling systems to the exhaust mode to ventilate the building. However, this kind of decision requires careful evaluation of the product, the HVAC system, the facility, and the surrounding environment. Consult with facility personnel for information and assistance. Key players may include people from the following departments: Environmental, Health & Safety (EHS); Security; Facilities; Health Services; Shipping & Receiving (or Materials Management); and managers or supervisors from departments that use the hazardous materials.

The "Rule of Thumb" - Outdoors or Indoors

If you're not sure of the appropriate distance, back out and err on the side of safety. Consider, too, the old "rule of thumb." If you've backed out to the recommended distance but can see the incident beyond your outstretched thumb, you may still be too close.

Lay a Safe Foundation

What happens in the first minutes of an incident significantly affects what happens in the hours that follow. The guidelines below can help you lay the foundation for a safe response. Additional guidelines are provided throughout the book where appropriate.

Safety Concerns Immediately Upon Arrival

- Treat all materials as hazardous until proven otherwise.
- Observe *all* hazards. Most chemicals have multiple hazards associated with them. Other dangers can include traffic, tripping hazards, electrical hazards, sharp objects, or confined spaces.
- Be alert for signs of criminal or terrorist activity, including the possibility of secondary events or devices. Don't touch suspicious items. Call for a hazmat team and/or bomb squad.
- Do not underestimate the hazards at a small incident. Many chemicals are extremely hazardous in very small quantities.
- Keep in mind that wind, rain, topography, and other variables can change the risks and impact your strategy and tactics.
- Have a plan in place before taking action. Anticipate problems and plan accordingly.
- Use the buddy system, and have backup personnel (a rapid intervention crew) standing by as appropriate.
- Isolate the area and deny entry to all unauthorized personnel.
- Give a good report on conditions (description of the problem, size of the hot zone, safe approach routes, safe staging area, etc.) that your dispatcher can relay to other responding units.
- Eliminate ignition sources (e.g., open flames, pilot lights, smoking materials, heated surfaces, electrical sparks, or static electricity) if flammable vapors are suspected and *if you can do so safely*. Keep people out of potentially flammable atmospheres.
- Do not rush to aid patients without adequately assessing the risk, wearing appropriate PPE, and ensuring that some form of emergency decon is in place.
- Decon patients before providing first aid. (Limit emergency care performed during decon activities to gross management of ABCs and immobilizing the cervical spine as needed.)
- Stop any unsafe act immediately. Correct unsafe conditions before resuming activities.
- Do not touch, ingest, or inhale an unknown material.
- Do not eat, drink, or smoke in the incident area. Wash hands thoroughly before eating, drinking, or smoking.
- Prevent unnecessary contamination of clothing and equipment.
- Follow your department SOPs.

Report on Conditions

Provide a report on conditions as soon as possible. This is particularly important when additional units are responding.

Provide the Following Information

Provide the following information in your report on conditions.

- Notification of arrival on scene
- Updated address or location if appropriate
- Type of structure or area threatened
- Conditions upon arrival
- Whether criminal or terrorist activities are suspected
- Your proposed course of action
- Instructions to other responding units, including safe response routes, staging areas, and assignments upon arrival
- An estimate of resources required
- Any other pertinent information

At this point, you should assume command, identify yourself as the incident commander, and provide a name for the incident according to your department SOPs.

Make Your Message Clear

Your message must be clearly understood by the dispatcher and other responding units.

- Speak clearly and distinctly. Remain calm when giving your report so that it will be understood.
- Follow department SOPs for providing a report on conditions.
- Use plain English or "clear text" rather than codes, particularly when multiple agencies or jurisdictions are involved.
- Be brief, accurate, and to the point. Provide only pertinent information.
- Supplement the initial report as necessary to include any significant changes in the situation or planned objectives.
- Have dispatchers repeat critical information (especially life safety concerns) to ensure they've heard you correctly and are following through with tasks as needed. Likewise, repeat critical information provided to you by the dispatchers.
- Ask the dispatcher to relay critical information to other responding units.

Assume Command

National Incident Management System (NIMS) and Incident Command System (ICS)

Emergencies should be managed using the Incident Command System (ICS) as defined by the National Incident Management System (NIMS). Key features of NIMS/ICS include:

- Common terminology
- A modular and scalable organization
- Management by specific measurable objectives
- Reliance on an incident action plan (IAP)
- Establishment and transfer of command
- Chain of command (an orderly line of authority) and unity of command (a designated supervisor for every individual)
- A manageable span of control (three to seven individuals reporting to one position, with a five-to-one ratio being optimum)
- Comprehensive resource management (for personnel, teams, equipment, supplies, and facilities)
- Personnel accountability
- Integrated communications
- A unified command structure
- Information and intelligence management

Duties of the First-Arriving First Responder

As soon as possible, the first-arriving operations level responder should take the following steps.

- Formally assume command.
- Establish a command post at a safe distance upwind, uphill, and upstream from the incident. Make sure the command post is clearly marked and that access is limited to avoid confusion.
- Manage the event until relieved by a higher authority.
- Transfer command, when appropriate, by fully briefing the incoming commander face-to-face with details of the incident and by communicating the transfer of command to other personnel.

If conditions require immediate action (e.g., rescue), it may be appropriate to pass command to the next-arriving unit. If you do so, however, you must clearly communicate your intent to pass command, as well as the conditions you've found on scene and the actions you plan to implement.

Duties of the Incident Commander

These pages contain some of the duties identified in:

- 29 CFR 1910.120: Hazardous Waste Operations and Emergency Response
- NFPA 472, Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents
- NFPA 1500, Standard on Fire Department Occupational Safety and Health Program
- NFPA 1561, Standard on Emergency Services Incident Management System

The incident commander's responsibilities are more comprehensive than those listed below. Many are sprinkled throughout this book. Others are beyond the scope of this book and should be part of the incident command training provided by your employer. While the incident commander has ultimate responsibility for these activities, many require assistance from a trained hazmat team.

- Establish a stationary command post located in or tied to a vehicle, and relay its location to the communications center.
- Provide security for the command post if appropriate.
- Initiate a personnel accountability system. (See page 2-41.)
- Monitor tactical, command, and emergency radio channels.
- Identify, to the extent possible, all hazardous substances or conditions present. Address, as appropriate, site analysis, use of engineering controls, maximum exposure limits, hazardous substance handling procedures, and use of new technologies.
- Evaluate potential harm within the endangered area. Look at the big picture; maintain situational awareness.
- Do a risk-versus-gain analysis. Risking the safety of emergency responders is acceptable only when there's a potential to save other lives.
- Determine response objectives (defensive, offensive, and nonintervention), response options (methods), and a process for determining potential effectiveness of each option.
- Develop and/or approve the incident action plan (IAP) that is (1) consistent with the local emergency response plan and SOPs and (2) within the capabilities of available personnel, PPE, and control equipment. Make sure the plan is communicated to all incident personnel.

(continued next page)

Assume Command (continued)

Duties of the Incident Commander (continued)

- Limit the number of responders in potentially hazardous areas to those who are actively performing emergency operations.
- Ensure that operations in hazardous areas are performed using the buddy system in groups of two or more.
- Make sure backup personnel (rapid intervention crew) are standing by with equipment ready to provide assistance or rescue.
- Have EMS personnel standing by with medical equipment and transportation capability.
- Ensure that PPE worn is appropriate for the hazards to be encountered.
- Ensure that emergency responders exposed to potential inhalation hazards wear SCBA until it's determined through air monitoring that a decreased level of respiratory protection will not result in hazardous exposures.
- As the incident escalates, divide the incident into tactical-level management components. Assign sufficient supervisory personnel to oversee site operations and ensure safety.
- Designate a safety official who is knowledgeable in the operations being implemented at the site. (The incident commander may also act as safety officer at a minor event.)
- Identify safe operating practices to be followed.
- Maintain an effective span of control (three to seven people reporting to one position, with a five-to-one ratio being optimum).
- Assign a public information officer (PIO or IO), and determine what information is to be provided to the media.
- Coordinate with the EOC if activated.
- Ensure that evidence is properly protected, documented, and collected. (See pages 13-16 to 13-20.)
- Evaluate the effectiveness of the incident action plan (IAP) in accomplishing the objectives. Adjust as required.
- Transfer command, if appropriate, when officers of higher authority arrive or when a new operational period begins.
- Request additional resources as appropriate. (Chapter 14 lists many resources that may be required or helpful.) Provide planning, logistical, and administrative support to those resources.
- Provide for liaison and coordination with other agencies.
- Implement a unified command as appropriate.
- Implement appropriate decontamination procedures.
- Conduct an incident debriefing. (See page 2-63.)
- Document the incident. (See page 2-65 to 2-66.)

Duties of the Safety Officer(s)

The safety officer's responsibilities are included here (1) to stress how vital they are to incident management and (2) to guide the incident commander who may be trained only to the operations level. First, let's look at the requirements for a safety officer:

- There must be a safety officer at every hazmat/WMD incident.
- The incident commander may also act as safety officer at a minor event, but only if he or she can clearly meet the demands of both roles.
- If incident activities will be limited to defensive ones at the operations level, it may be enough to use an *incident safety officer* trained to the *operations* level. Otherwise, it will be necessary to assign a *hazmat safety officer* trained to the *technician* level. Either way, the safety officer must also be trained to meet the hazmat safety officer competencies in NFPA 472.
- The incident commander can assign additional assistant safety officers as needed.

The **incident safety officer** has the following responsibilities:

- Evaluate the scene to identify existing and potential hazards (including the potential for terrorism and secondary events), and communicate those hazards to all personnel.
- Assist with risk assessment.
- Assist in developing an incident action plan (IAP) consistent with SOPs and the local emergency response plan. Recommend changes to the plan as needed.
- Ensure that a personnel accountability system is being used.
- Ensure that control zones are properly established and are clearly communicated to all personnel.
- Monitor radio transmissions, and stay alert to problems that could result in missed, unclear, or incomplete communication.
- Assign (or request) an assistant safety officer if needed.
- Ensure that rest and rehabilitation are provided.
- Alter, suspend, or terminate any unsafe activities that present imminent danger. Immediately inform the incident commander of any actions taken to correct imminent hazards.

(continued next page)

Assume Command (continued)

Duties of the Safety Officer(s) (continued)

While the incident safety officer deals with the scene as a whole, the **hazmat safety officer** is responsible for the hazmat group and for operations within the hot and warm zones. (This position may also be referred to as *hazmat branch safety officer*, *hazmat group safety officer*, or *assistant safety officer-hazardous materials*.) Duties include everything on the previous page plus the items below.

Because this book is written primarily for operations level responders, this list should be considered a partial list only. It's provided to help the incident commander and incident safety officer recognize when they may need the expertise of a hazmat safety officer.

- Coordinate safety activities with the incident safety officer.
- Review and evaluate hazard and response information as it pertains to safety.
- Identify the safety precautions for potential action options, and ensure that they are implemented.
- Ensure that appropriate environmental monitoring is conducted.
- Review the selection of PPE.
- Make sure personnel have checked the integrity of their PPE before use and have donned it properly.
- Make sure that personnel are medically monitored.
- Ensure that emergency medical services are provided.
- Ensure that there is a dedicated radio channel for entry team operations and that hand signals are established as a backup.
- Conduct safety briefings.
- Ensure that each person entering the hot or warm zone:
    - Has a specific assignment and understands that assignment.
    - Is properly trained and equipped to perform the task(s).
    - Is under the supervision of an appropriate team leader.
    - Is working with a designated partner at all times.
- Ensure that a backup team (rapid intervention crew) is in place and ready for immediate entry during entry team operations.
- Make sure appropriate decon procedures are in place before entry into the hot zone and that personnel and equipment exiting the hot zone are properly decontaminated.

(continued next page)

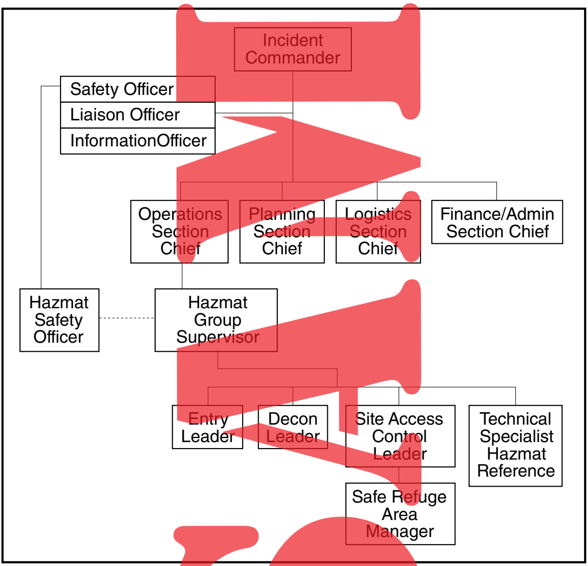
Assume Command (continued)

Duties of the Safety Officer(s) (continued)

- Identify appropriate time limits (work time and on-air time) for responders working in personal protective equipment, and ensure these time limits are being monitored.
- Monitor activities within the hot and warm zones.
- Alter, suspend, or terminate any unsafe activities that present imminent danger. Immediately inform the incident commander of any actions taken to correct imminent hazards.
- Assist with the debriefing and incident critique.
- Assist with documenting the incident.

Duties of the Hazmat Group (or Branch)

The hazmat group handles the primary tactical operations at a hazmat/WMD incident. The partial organization chart below highlights key ICS positions within the group. Brief position descriptions are provided on the next page.



Partial ICS Organization Chart Showing Key Positions Within the Hazmat Group

Assume Command (continued)

Duties of the Hazmat Group (or Branch) (continued)

The *hazardous materials group supervisor* is responsible for directing the primary tactical operations at a hazmat incident. He or she reports to the operations section chief (or *hazardous materials branch director*, if activated) and supervises the following positions:

- An *entry leader*, who directs all operations (assessment, rescue mitigation, etc.) within the hot zone.
- A *decontamination leader*, who is responsible for all decon operations (for people and equipment).
- A *site access control leader*, who establishes and/or enforces control zones and controls the movement of people and equipment through appropriate access routes.
  - The site access control leader may appoint a *safe refuge area manager* to evaluate and prioritize victims for treatment, collect information from victims, and prevent the spread of contaminants by these victims.
- A *technical specialist-hazardous materials reference*, who provides technical support for collecting hazard and response information, analyzing samples, interpreting the data, and developing an action plan based on the information.

The hazmat group supervisor also coordinates with the *hazmat safety officer*, who reports to the incident safety officer.

Incident Command Authority

When multiple agencies respond, which agency has incident command authority may vary depending on location (highway, public property, private property, etc.). However, the first agency on scene is in charge of the incident and must establish and maintain command until it's appropriate to transfer command to another agency. Refer to your department SOPs or the applicable contingency plan for your area to determine specific requirements in your state.

Assume Command (continued)

Unified Command

When multiple agencies respond, it's often best to establish a unified command post with representatives from each of the key agencies. Each agency shares in the overall management burden. However, there is one incident commander from the lead agency with greatest responsibility for managing that phase of the incident. For example, a fire department representative would likely be the incident commander during the emergency phase of a hazmat incident, then pass command to law enforcement when the emphasis moves to crime scene management and incident investigation. Most important in Unified Command is having all players in one location, sharing information and coordinating decisions to avoid unnecessary delays, confusion, duplication of effort, or conflicting plans.

Delegation of Responsibilities

This book (and particularly this chapter) outlines many of the responsibilities identified in NFPA 472, NFPA 473, and 29 CFR 1910.120. However, the functions are often carried out by personnel from many entities. The incident commander must be able to identify the appropriate entities for each function. As much as possible, this should be spelled out beforehand in an emergency response plan or standard operating procedures.

Medical Component of the Incident Command System

The medical component of the incident command system deserves a brief mention to clarify the division of responsibilities:

- The *medical group/branch* (if needed) falls under the operations section and is responsible for triage, treatment, and transport of the public.
- The *medical unit* (if needed) falls under the logistics section and is responsible for medical monitoring and treatment of emergency responders.

If the operations and/or logistics sections are not activated on a small incident, the incident commander supervises the medical components.

Isolate and Deny Entry

Establish an Initial Isolation Zone (Perimeter)

Set up an *initial isolation zone*, or perimeter, to separate people from the problem. This step is also known as *isolate and deny entry*. (Evacuation or sheltering in place may also be necessary. See pages 2-55 and 2-56 for details.) The following are some key points to ensure the effectiveness of your initial isolation zone:

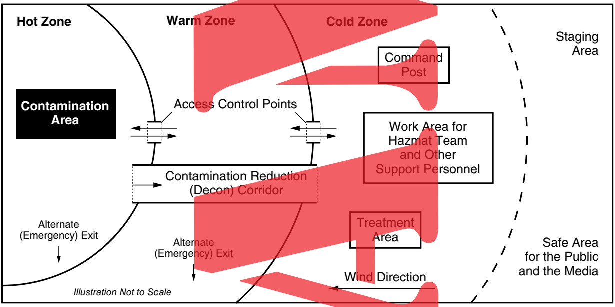
- Direct potentially contaminated people to a safe refuge area for evaluation and decon if needed.
- Direct witnesses who may have important information to remain on scene in a safe location until interviewed and released.
- Establish the initial isolation zone based on the ERG or other reference sources, department SOPs, or the recommended distances on pages 2-7 and 2-8.
- If you are unsure of the appropriate distance, assume the worst and err on the side of safety. It is generally easier to reduce a larger isolation zone than it is to expand a smaller one.
- Make the isolation zone larger on the downwind side. Anticipate wind changes and adjust as needed.
- First isolate areas that are immediately affected. Isolate other nearby locations as appropriate to protect people or to create staging areas for responders and equipment. Don't overlook the air space above the incident or nearby bodies of water that may also need to be isolated.
- Deny entry to all unauthorized personnel. Control the zone(s) and all entry points to limit access to contaminated areas.
- Continue to evaluate the effectiveness of the isolation zone throughout the incident, and adjust as needed.
- Use existing barriers (gates, fences, etc.) whenever possible. They are generally more reliable than barrier tape and traffic cones are. You still need personnel for access control, but you won't tie up as many resources.
- Use law enforcement officers and/or facility personnel as needed to help restrict access.
- Do not use flares if flammable vapors are suspected.

Limit the number of responders at the site, but don't compromise safety. Request enough resources to safely manage the incident. Use the buddy system; don't allow anyone to work alone in a potentially hazardous environment. Have a backup team (rapid intervention crew) standing by.

Assist in Setting Up Control Zones

A hazmat team will set up *control zones* based on established exposure limits (see pages 5-13 to 5-21) and the results of atmospheric monitoring. This is usually not done by first responders, although they can assist once the appropriate distances are known. The three control zones are as follows:

- **Hot (Exclusion) Zone** - The area immediately around the incident where contamination exists. It should extend far enough to prevent adverse effects from hazardous materials releases to personnel outside the zone. Entry into the hot zone requires the use of proper PPE.
- **Warm (Contamination Reduction) Zone** - The zone where decontamination activities take place. It requires the use of proper PPE once contaminated people or equipment enter the zone.
- **Cold (Support) Zone** - A clean area outside the contamination control line where command and support functions take place. Special PPE is not required in this area (though it's wise to have it handy in case of an emergency or a sudden wind shift). Note: While it is safe for the public and the media to be in the cold zone, they should be kept far enough away from command and support functions that they don't interfere.



Sample Control Zone Layout

Specific access control points are used to control movement of people in and out of the zones. However, an alternate exit route should be established for personnel working in these zones in case of a sudden wind shift or an emergency that blocks the primary escape route.

Initiate the Notification Process

The responsible party is required to make mandatory notifications to the proper authorities whenever there is a hazardous materials release with a potential adverse impact to health and safety or the environment. However, first responders must make these notifications if a responsible party can't be identified or fails to follow through. Notification should be made as early as possible, as long as it does not delay responding to the emergency.

Some regulations require notifications be made for *threatened* releases also in order to track and evaluate near-miss accidents. Refer to your department SOPs for more information.

Emergency Dispatch

Call for trained emergency response personnel (local emergency responders) if you have not already done so. Refer to page 2-6 for more information.

Mandatory Notifications for Reportable Quantities

Although reporting requirements vary from state to state, some notifications are mandatory for all incidents involving a reportable quantity of hazardous materials. Refer to shipping papers, material safety data sheets (MSDS), or other references to identify the reportable quantity; it will often be indicated by the initials "RQ." (Pages 14-37 and 14-38 provide an overview of federal reporting requirements.)

Contact	**Phone Number**
Fire Dept. Having Jurisdiction	911 or ______________
Local Emergency Planning Committee (LEPC) *	____________________
State/Tribal Emergency Response * Commission (SERC/TERC) and/or	____________________
State 'Single Point of Contact' * (state notification/warning center)	____________________
National Response Center (NRC)	(800) 424-8802
Others ____________________	____________________
____________________	____________________

* These agencies may be called by different names in different states. Fill in the correct phone numbers for your area.

Initiate the Notification Process (continued)

Additional Notifications

The agencies listed on the previous page are the minimum notifications required by law on any reportable incident, regardless of circumstances. Additional notifications are often mandatory, depending on the hazardous material involved, the population or environment threatened, or the location in which the incident occurred. Often these additional notifications will be made for you by the NRC or your local and state contacts. However, you may need to make some calls yourself (e.g., to prepare area hospitals to receive contaminated patients who have already left the scene). Refer to your department SOPs for more information.

Most of the agencies listed on page 2-22 need to be contacted for *notification* purposes. They may put you in contact with agencies that provide technical assistance or emergency response personnel. However, except for the fire departments, they generally don't provide technical assistance themselves, nor do they have emergency response teams of their own.

Chapter 14 lists various resources, as well as names and phone numbers of agencies that can assist you.

Information to Provide When Calling

Report as much of the following information as possible. Updates can be provided as more information becomes available. A follow-up written report is generally required as well.

- Identity of the material(s) involved
- Whether the substance(s) are on the EPA (Environmental Protection Agency) or CERCLA (Comprehensive Environmental Response, Compensation and Liability Act) lists of extremely hazardous substances (if known)
- Whether criminal or terrorist activities are suspected
- Nature of release and environment affected (air, land, water)
- Time, duration, and estimated quantity of the release
- Associated health risks and any medical attention required for exposed individuals
- Recommended precautions (evacuation or in-place protection)
- Actions being taken in response to the release
- Names and phone numbers of contacts for further information

Size Up the Incident

The following is an overview of things to look at when sizing up the incident. Additional information can be found on the pages and/or chapters as indicated. Keep in mind that size-up is an ongoing process that starts when the emergency is first reported and continues throughout the incident.

Know What to Look For

Awareness Level Personnel

Survey (size up) the incident from a safe location to obtain vital information for emergency responders. Look for the following:

- Product name
- Labels, placards, and other markings *(chapter 3)*
- Container shapes and markings that may indicate the presence of hazardous materials *(chapter 4)*
- Signs of criminal or terrorist activities *(chapter 7)*

Operations Level Responders

Analyze (size up) the incident from a safe location to determine the magnitude of the problem in terms of potential outcomes. Look at the big picture. (Maintain situational awareness.) Determine the following:

- Hazardous materials *(chapter 3)* or WMDs *(chapters 8 to 11)* involved, including identity, form (solid, liquid, gas), and amount
- Labels, placards, and other markings *(chapter 3)*
- Containers involved, container markings, and the extent of damage to the containers *(chapter 4)*
- Surrounding conditions *(page 2-25)*
- Signs of criminal or terrorist activities *(chapter 7)* and the possibility of secondary events or devices

Once you have analyzed the incident:

- Collect hazard and response information from appropriate resources *(pages 2-27 and 2-28)*
- Predict the likely behavior of the material and its container *(pages 2-29 and 2-30 and chapters 3 through 5)*
- Estimate the potential outcome *(page 2-31)*

Size Up the Incident (continued)

Know What to Look For (continued)

EMS Personnel

Survey (size up) the incident from a safe location. Look for items listed under the awareness level *(page 2-24)* plus these:

- Risk of injury to patients and response personnel
- Number of patients, their locations, potential injuries, and need for decon
- Environmental factors that may affect patient care (e.g., indoor versus outdoor exposures, weather conditions)
- Medical support needed for responders *(pages 6-33 to 6-34)*
- Risk of secondary contamination and precautions needed to care for patients in the warm zone if applicable *(pages 6-3 to 6-15)*

Pay Attention to Surrounding Conditions

Pay attention to the surrounding conditions that can affect both the risks involved and the way you handle the incident.

- Topography that can affect the flow of liquids, vapors, and gases
- Land use on affected and nearby properties (e.g., schools, hospitals, rail lines, and highways)
- Accessibility for incoming resources
- Weather conditions (e.g., temperature, wind, and rain)
- Rivers, creeks, or other bodies of water threatened
- Public exposure potential (e.g., number of people threatened and high-risk populations)
- Overhead and underground wires and pipelines
- Storm and sewer drains that may need to be protected
- Possible ignition sources (e.g., a lit match, smoking materials, flares, electrical sparks, pilot lights, static electricity, or friction)
- Situations requiring intrinsically safe (nonsparking) equipment
- Building information (floor drains, ventilation ducts, air returns, secondary containment systems, etc.)
- Confined spaces with atmospheric hazards (oxygen-deficient, oxygen-enriched, flammable, explosive, or toxic) and physical hazards (engulfment, falls and slips, electrical, structural, or mechanical)
- Safe refuge areas and emergency escape routes

Size Up the Incident (continued)

Pay Attention to Surrounding Conditions (continued)

Resources for obtaining current and prediction weather conditions can include:

- Weather channel on responder radios (if applicable)
- Weather channel on cable or satellite connections
- Local airport weather sources
- Local weather phone recordings
- Satellite technology on hazmat units

Determine the Incident Level

Response organizations should develop a “tiered response plan” to ensure the right resources are dispatched based on the potential risks of an incident and the capabilities and limitations of the responders. The ability to correctly assess the incident level will help get those resources mobilized early.

The following are general descriptions for a three-tiered response that can be modified based on the needs and resources in your community.

Level 1 hazmat incidents can generally be controlled by first responders. They are small incidents posing little or no threat to life, the environment, or property. No evacuation is required beyond isolating the immediate area around the container or material.

Level 2 hazmat incidents are beyond the capabilities of first responders. They require the services of a trained hazmat team and may require assistance from other regional, state, or federal resources. These incidents pose a potential threat to life, the environment, or property and may require limited protective actions in the surrounding area.

Level 3 hazmat incidents require a joint response from multiple resources, which may include local, regional, state, and federal agencies plus private industry. These incidents pose a severe threat to life, the environment, and property and may require large-scale protective actions.

Collect Hazard Information

Collecting hazard information can be an involved process, depending on the material and the circumstances of the release.

Awareness level personnel are expected to identify the product (if possible) and basic hazard information contained in the ERG. If an MSDS or other resource is provided instead, personnel should identify hazard and response information similar to that contained in the current edition of the ERG. (See pages 14-6 to 14-11 for details.) Operations level responders may need additional resources to predict the behavior of the material and its container, estimate the potential outcome, and plan an initial response.

Correctly Identify the Product

It's *essential* to get the correct name of the material.

- When in doubt, spell the name phonetically. Many chemical names sound alike, but the hazards, safety precautions, and mitigation measures can be dramatically different.
- Pay attention to prefixes (e.g., *n-, i-,* and *iso-*) and numbers in a chemical name. They can be significant.
- Identify the concentration, because concentration often has a direct bearing on the hazards. For example, a 90% solution of hydrogen peroxide is very dangerous, but a 3% solution is not.
- If possible, get a CAS (Chemical Abstracts Service) number from a container label, shipping papers, hazardous waste manifest, or MSDS. The CAS number is a unique identification number assigned to specific chemical substances.

If you can't accurately identify the material or if there are multiple products involved, treat this unknown situation as a worst-case scenario. Always err on the side of safety. Be wary whenever:

- You can't get close enough to safely see placards, labels, or other identifying information.
- Labels or placards are missing.
- You have any suspicion that labels or placards are erroneous (e.g., a material is not doing what it is "supposed to" according to reference sources or it appears the container was refilled with a different product).
- You see a "Dangerous" placard for a mixed load shipment.
- Shipping papers or MSDSs are unavailable or inaccessible.
- There are any indications of criminal or terrorist activity.

Collect Hazard Information (continued)

Use at Least Three Information Sources

Use at least three information sources for product identification and hazard assessment. Possible information sources include:

- Placards, labels, pipeline markers, etc.
- Shipping papers and material safety data sheets (MSDS)
- *Emergency Response Guidebook* (ERG)
- Reference manuals (e.g., *NIOSH Pocket Guide*)
- Technical information centers (e.g., CHEMTREC)
- Hazardous materials databases (e.g., CAMEO, CHRIS)
- Technical information specialists (e.g., chemists)
- Facility employees, vehicle driver, or other responsible party
- Witnesses and bystanders with relevant information
- Monitoring equipment, field identification kits, etc.
- Business plans, facility preplans, etc.
- Hazardous waste manifests

Never rely on a single resource. Reference sources can be incomplete, erroneous, or difficult to interpret. If you get conflicting information, check additional reference sources. When in doubt, assume the worst and err on the side of safety until you can get more information.

Reference sources vary in what they emphasize and how they present information. Likewise, technical information centers and specialists have different areas of expertise. Familiar resources, like the ERG, make the process easier, but choose additional resources with the strengths you need for the specific incident.

The same guidelines apply to monitoring equipment, each of which has strengths and weaknesses and can give false readings for a variety of reasons. Never rely on a single instrument.

Many facilities have in-house emergency response teams (ERTs). Not only are they familiar with the materials used at the facility and their associated hazards, they are also more familiar with the facility itself. They are a good resource for information on facility control systems and the availability of special materials and equipment for mitigating and/or cleaning up the release.

Refer to Chapter 5 for details on hazard assessment and Chapter 14 for resources to contact for information and assistance.

Predict the Behavior of a Material and Its Container

You should be able to predict the behavior of a material and its container based on information from the *Emergency Response Guidebook*, MSDSs, the shipper or manufacturer, CHEMTREC, or other available resources. Some of this information may require the expertise of a hazmat team. However, do your best as you wait for additional resources to arrive.

Identify the Following

Start with the basics in your initial assessment:

- Has the container been damaged?
- Has any product been released?

Consider both current and potential hazards and conditions as you assess the type, location, and extent of damage to the container or its closures. Try to identify the following:

- Chemical and physical properties: corrosivity (pH), flammable (explosive) range, flash point, form (solid, liquid, gas, vapor, dust, etc.), ignition temperature, reactivity, specific gravity, toxic products of combustion, vapor density, and water solubility.
- Types of stress on the container and its contents: thermal, mechanical, or chemical.
- Ways in which the container can breach: disintegration, runaway cracking, closures opening up, punctures, splits, or tears.
- Ways in which the containment system can release its contents: detonation, violent rupture, rapid relief, spill, or leak.
- Dispersion pattern expected upon release: hemisphere, cloud, plume, cone, stream, pool, or irregular.
- Potential duration of hazmat exposures in the endangered area: short-term (minutes or hours), medium-term (days, weeks, or months), or long-term (years or generations).
- Health and physical hazards: thermal, mechanical, poisonous, corrosive, asphyxiation, radiation, and etiologic.

When terrorist events are suspected, consider the resolve of the perpetrator and the true potential for harm posed by the material(s) or device(s). At one extreme, a bungled effort may present relatively little danger. At the other extreme lies the potential for damage beyond anyone's expectations.

Predict the Behavior of a Material and Its Container (continued)

Utilize Resources in This Book

This book contains a variety of information that can help you predict the behavior of a material and its container. It is not a substitute for formal training; the information is designed only to give you a basic understanding. However, it should provide you with valuable assistance until a trained hazmat team arrives.

Chapter 3 provides an overview of the DOT (Department of Transportation) hazard classes and some of the key points to know about each.

Chapter 4 includes illustrations of various containers and identifies the types of products they may hold. It also provides limited information on how these containers may behave in an emergency. It is important to look at both the introductory information about each general type of container (e.g., nonbulk, cargo tanks, and rail cars) and the specific information about the particular container in question.

Chapter 5 is devoted to assessing the hazards. Topics include:

- How hazardous materials and WMDs cause harm
- Toxicology and exposure values
- Properties of flammable liquids
- Other chemical and physical properties
- Atmospheric monitoring
- High-risk situations
- Illicit laboratories
- Hazmat triage

Possible terrorist events are covered in the following chapters:

- **Chapter 7** - Introduction to Terrorism
- **Chapter 8** - Explosives Incidents
- **Chapter 9** - Chemical Warfare Agents
- **Chapter 10** - Biological Warfare Agents
- **Chapter 11** - Nuclear Events (intentional or accidental)

Chapter 14 contains resources for information or assistance.

Estimate the Potential Outcome

Determine the Following

Determine the following factors to the best of your ability. Some of this information will require the expertise of a trained hazmat team. However, two good resources at the first responder level are the *Emergency Response Guidebook* and facility preplans. Another excellent resource may be your community's contingency plans, particularly if they contain plume dispersion modeling results. These plans should include estimates of the potential outcome in worst-case scenarios involving the materials manufactured, used, stored in, or transported through your community.

- Quantity of material released (and available for release).
- Speed of the release.
- Form of the material (solid, liquid, gas, vapor, dust, aerosol).
- Contaminant concentration throughout the endangered area.
- What stressed (or is stressing) the container.
- Expected behavior of the material and its container.
- Physical, health, and safety hazards of the material.
- How long the hazardous condition may exist.
- Size of the endangered area.
- Population (number and vulnerability) in the endangered area. (This may vary based on the time of day or day of the week.)
- Environment and property in the endangered area.
- Surrounding conditions. (See page 2-25.)
- Potential for secondary events.
- Possibility that criminal suspects may still be on scene.

Carefully Evaluate Any Estimate

Estimates must be carefully evaluated and periodically reevaluated. It is easy to underestimate the severity of the problem or to make a simple miscalculation. Sometimes estimates become distorted for reasons not in the best interest of public safety. For example, a company may not reveal the true scope of the problem in order to avoid bad publicity. Or there may be political or financial pressures to downplay the seriousness of an incident.

Remember that life safety is always your first priority. Do not hesitate to question anything that does not feel right to you. Make sure that estimates are based on information you can trust.

Plan Your Initial Response

Before implementing any activity, identify all hazards present, the resources available to deal with the problem, and what exposures can be saved through your efforts. Look at the big picture. (Maintain situational awareness.) Your incident action plan (or site safety plan) is built on that information and becomes a framework for how emergency personnel are going to operate. It also helps the incident commander establish objectives to measure results. Keep in mind that if you fail to plan, you may be planning to fail.

Note: Pages 13-8 and 13-9 contain guidelines to help you ensure that incident action plans (IAPs) contain the required elements.

Response Objectives (Strategy)

By definition, operations level responders are limited to *defensive* actions for the purpose of protecting life, the environment, and property. However, they can have additional competencies that are specific to their response mission, expected tasks, equipment, and training as determined by the authority having jurisdiction. You must decide which objective, or strategy, is most appropriate based on the incident and the resources available to handle it.

Sometimes the best course of action is to do nothing beyond isolate and deny entry. **No action** (nonintervention) may be appropriate in situations where it is unsafe to do anything, the incident poses no risk to life, or there is a lack of adequate resources to safely and effectively deal with the problem.

Defensive actions are conducted to restrict, slow, or redirect the spread of a hazardous material and to keep it as close to the source as is safe and practical. (More information on defensive actions is provided on the following page and in Chapter 12.)

Offensive actions are those conducted to stop the release. They are usually done by hazardous materials technicians. However, offensive actions may, on occasion, be performed by a first responder. For example, fighting a hazardous materials fire is an offensive operation, though it may or may not be the best course of action, depending on the material involved. Remember, do not undertake any offensive actions unless you have been properly trained, you have the right PPE, and it is safe to do so. Follow your department SOPs.

Plan Your Initial Response (continued)

Response Options (Tactics)

If action is needed (as opposed to nonintervention), determine which option (tactic) is most appropriate. Defensive options fit into two categories: containment (keeping a material in its container) and confinement (keeping a material, once released, in a defined area or location). NFPA 472 lists the following options for operations level responders. More information about each of these methods can be found in Chapter 12.

- Absorption and adsorption
- Diking, damming, diversion, and retention
- Dilution
- Remote valve shutoff
- Vapor dispersion
- Vapor suppression (blanketing)

Chapter 12 also describes offensive control options that incident commanders must be aware of, including:

- Covering
- Firefighting
- Neutralization
- Overpacking
- Patching and plugging
- Pressure isolation and reduction (e.g., flaring and venting)
- Solidification
- Transfer

Determine the potential effectiveness *of each option you're considering* by assessing the following:

- The purpose for your actions
- Potential deaths and injuries (risk versus gain)
- Potential environmental and property damage (risk versus gain)
- Whether the option is within the scope of your training
- Whether your PPE provides adequate protection
- Proper procedures and safety precautions
- Resources required (personnel and equipment)

Note: This book is not designed to provide instructions on how to perform these options. It provides only general guidelines. You must follow your training and your department SOPs.

Plan Your Initial Response (continued)

No-Go Situations

NFPA 472 cites the following as conditions under which personnel would not be allowed into the hot zone. This is not necessarily a complete list, but it provides a good platform for planning your response. If you *can't* change one of the conditions below, stay out of the hot zone. If you *can* change conditions to make operations safer, it gives you more options.

- Decon procedures are not established or not in place
- Advanced first aid and transportation are not available
- Flammable or explosive atmosphere is present
- Oxygen-enriched atmosphere is present (23.5% or greater)
- Runaway reaction is occurring
- Appropriate PPE is not available
- There's no effective action to be taken
- Risk outweighs benefits
- Personnel are not properly trained
- Insufficient personnel are available to perform tasks

Respected instructor Michael Callan teaches the concept of ***Safe, Unsafe, or Dangerous***—another tool that you can use to help determine an appropriate response:

- *Safe:* No harmful effects from the chemicals currently exists.
- *Unsafe:* Harmful effects are possible with prolonged exposures. Potential injuries are not life-threatening, because concentration and/or exposure time are limited.
- *Dangerous:* An immediate threat to life and health exits. Deadly, catastrophic events are possible.

The greatest danger exists where there is a potential for an uncontrolled release of energy (explosives, overpressurized tanks, runaway polymerization, etc.). However, topping the list of dangerous situations is the unknown atmosphere, because you can't reliably protect yourself if you don't know the hazards.

Oxygen-enriched and flammable atmospheres are generally more dangerous than toxic atmospheres are, because explosion and fire, if they happen, are an immediate threat; PPE provides only limited protection. In a toxic or oxygen-deficient atmosphere, if you have the proper PPE, there's no immediate threat; air supply normally dictates how long responders can remain in the hot zone.

Plan Your Initial Response (continued)

Specific Equipment and Procedures

- Determine if the available PPE is appropriate.
- Determine if there is a rescue involved and what resources are required to safely accomplish it. (See page 2-36.)
- Determine whether lockout-tagout and/or confined space entry procedures are needed. Request resources as appropriate.
- Identify whether there are multiple patients, whether triage is needed, and how triage will be accomplished.
- Identify decon procedures for patients and responders. Establish a plan to contain contaminated patients. If contaminated patients have already left the scene, alert area hospitals.
- Determine the level of medical care needed.
- Establish a plan to provide medical support (including medical monitoring) for responders.
- Identify potential problems or risks before taking action.
- Establish emergency procedures in case anything goes wrong. Make sure everyone knows where to go and what to do if problems arise. Have appropriate equipment standing by.
- Identify whether criminal or terrorist activities are suspected. If so, identify the potential for secondary events, weapons, and booby traps. Establish security procedures to ensure that only authorized personnel are allowed access to the scene.
- Identify procedures to preserve evidence. This is vital when criminal or terrorist activities are suspected, but can also aid in cost recovery with accidental releases. (Evidence preservation guidelines are included on pages 13-16 to 13-20.)
- Include a communications plan in your incident action plan:
  - Make sure all personnel have reliable radios and are on appropriate channels.
  - Use intrinsically safe radios in potentially flammable atmospheres.
  - Have a backup plan (e.g., hand signals or air horn blasts) in case of an emergency or equipment failure.
  - Request priority cell phones from your local phone companies if radio frequencies become overloaded.
- Determine if atmospheric monitoring is needed and what resources are required to safely accomplish it.
- Determine if protective actions (evacuation or in-place protection) are necessary. If so, determine how to best implement the appropriate protective action and provide instructions to the public. (Sample protective action messages are included on pages 13-13 to 13-15.)

Plan Your Initial Response (continued)

Rescue Considerations

General Questions

Anytime a rescue is involved, it adds a lot of stress to the situation. This page is not intended to answer the question of whether or not you should attempt a rescue, but rather to address some of the key points that must be considered. You must adequately size up the situation and determine if attempting a rescue is in the best interest of all parties. Do a risk-versus-gain analysis. How can you do the most good for the most number of people? Remember to follow your department SOPs.

- Can the patients self-extricate? Can you "rescue" them without entering the hot zone?
- Can you confirm that downed patients are still alive?
- What are the patients' chances of survival? Is a successful rescue possible, or will this be a body recovery operation?
- How many people need to be rescued?
- How long will it take to effect a rescue?
- What is the degree of risk posed by the material? Consider health, flammability, and reactivity hazards; the form of the product (solid, liquid, or gas); size and location of the release; and any variables that might increase the risk.
- What other hazards are present? Consider *all* aspects of scene safety.
- Is this a confined space? If so, are you properly trained and equipped for confined space operations?
- Could this be a terrorist event with secondary devices designed to injure responders?
- Do you have appropriate PPE?
- Can you perform a rescue without getting directly in the product? If not, can you limit your exposure to areas of your body that are adequately covered by protective clothing?
- Do you have enough first responders with proper training to effect a safe and successful rescue?
- Are you using a buddy system?
- Do you have a backup team (rapid intervention crew) in place?
- How soon can a trained and equipped hazmat team be on scene and ready to perform the rescue?
- Do you have some form of emergency decon in place? Emergency decon must be set up prior to performing any rescue for your protection as well as for the patients' protection.

Rescue Considerations (continued)

Risks Based on Hazard Class

NFPA's *Hazardous Materials/Weapons of Mass Destruction Response Handbook* identifies risks to rescuers based on hazard class. Many of those risks are summarized below. However, this list is not meant to be all-inclusive. Most risks exist with each hazard class to a greater or lesser degree. (Hazard classes are described in Chapter 3.)

- *Class 1 - Explosives*. Burn injuries and mechanical injuries from the shock, blast overpressure, fragmentation, shrapnel, or structural damage are common. Other possibilities include chemical contamination, exposure to bloodborne pathogens from injured victims, and asphyxiation from depleted oxygen.
- *Class 2 - Gases*. Risks vary with the type of gas (toxic, flammable, etc.). Displaced oxygen can create an asphyxiation risk, especially with cryogenic liquids. Cryogenic materials can cause frostbite. Sudden failure of a pressurized container can cause mechanical injury.
- *Class 3 - Flammable and Combustible Liquids*. The risks include burns if the material ignites and mechanical injury if the container forcefully ruptures.
- *Class 4 - Flammable Solids, Spontaneously Combustible Materials, and Dangerous When Wet Materials*. Burn injuries can result from fire or from the heat generated in a chemical reaction. Water-reactive materials may produce toxic gases, flammable gases, and/or corrosive solutions.
- *Class 5 - Oxidizers and Organic Peroxides*. Burn injuries are a concern, because these materials support combustion. The unstable and explosive nature of organic peroxides presents risks similar to those of Class 1 materials.
- *Class 6 - Poisonous and Infectious Substances*. Toxicity is the primary hazard with poisonous substances. Some of these materials are flammable, so burn injuries are possible. Infectious agents cause diseases, some of which can be fatal.
- *Class 7 - Radioactive Materials*. Radiation sickness and burns are possible. (See Chapter 11 for details.) Radiological substances may have other chemical hazards too.
- *Class 8 - Corrosives*. The greatest risk is chemical burns. Inhalation of vapors can also cause respiratory damage.
- *Class 9 - Miscellaneous Dangerous Goods*. The risks vary.

Plan Your Initial Response (continued)

Rescue Considerations (continued)

The ERG - Implied Rescue Considerations

While the ERG doesn't expressly state whether you can safely attempt a rescue, the health hazards identified in the guide pages reflect the degree of risk you might face in trying to rescue someone. If a guide says "may be fatal if inhaled or absorbed through the skin" or "inhalation or contact (skin, eyes) with vapors, dusts, or substance may cause severe injury, burns or death," any openings in your PPE put you at greater risk of injury. This doesn't mean you *can't* do a rescue if the odds are in your favor. However, it does mean the risks are higher.

The SBCCOM Report - Guidelines for WMD Incidents

What about WMD incidents? The U.S. Army SBCCOM Domestic Preparedness Chemical Team published a report in 1999 to address whether firefighters can safely effect a rescue after a terrorist attack with a chemical warfare agent. The report was revised in 2003 based on input from the fire service and on newly published chemical, biological, radiological, and nuclear (CBRN) PPE standards.

SBCCOM recommends that firefighters wear CBRN-certified chemical protective clothing if available. However, firefighters may not know what they're dealing with right away and may not have CBRN-certified PPE at their disposal. Then what? Ultimately, it's up to each jurisdiction and/or the on-scene incident commander to decide if it's worth the risk to attempt search and rescue operations. The SBCCOM report is merely a tool to help make an informed decision.

Assuming they follow the operational restrictions in the SBCCOM report (summarized on the following page), properly trained and equipped firefighters should be able to accomplish a quick and effective rescue without significant risks. However, firefighters in standard turnouts and SCBA are subject to greater risk of chemical effects than they would be if using CBRN-certified equipment. It's expected that half of the firefighters may experience threshold effects for chemical exposure.

(continued next page)

Rescue Considerations (continued)

The following basic operational considerations and conditions summarize the contents of the 2003 SBCCOM report:

- The presence of ***living*** victims inside the potential hazard area provides a basic indicator (in the absence of atmospheric monitoring) for firefighters to assess the level of nerve agent contamination. If at least 2 percent (1 in 50) of the victims are still alive 10 minutes after the incident, rescuers can assist those victims with little or no risk (threshold symptoms at worst) while wearing standard turnout gear with SCBA. Live victims indicate that the nerve agent concentration is relatively low compared to concentrations achievable.
- Rescuers will likely enter the hazard area after the vapor concentration has peaked (assumed approximately 10 minutes after release of agent).
- Firefighters using standard turnout gear and SCBA to perform rescue of ***known live victims*** can operate in a nerve agent vapor environment for up to 30 minutes with minimal health effects. (It is estimated that 50% of firefighters *may* experience increased sweating and muscle weakness 1 to 18 hours after exposure.)
- Firefighters using standard turnout gear and SCBA to enter a nerve agent environment ***without known live victims*** should limit their potential exposure to 3 minutes.
- Firefighters searching an enclosed area for victims should immediately exit the area and undergo decontamination if they encounter evidence of chemical contamination and cannot identify any living victims.
- Predicted health effects are based on the assumptions that:
  - Firefighters will avoid contact with any unidentified liquids.
  - Firefighters and rescued victims will undergo emergency decon immediately upon exiting the potentially hazardous area.
- If firefighters encounter oily liquid contamination (puddles/drops) and victims report signs of mustard agent (i.e., garlic odor), firefighters and victims should immediately exit the area and undergo decontamination.
- Emergency medical services are immediately available on scene.

(continued next page)

Plan Your Initial Response (continued)

Rescue Considerations (continued)

Below are some other key points from the 2003 SBCCOM report:

- The report is based on testing firefighter protective ensembles against chemical agent *vapor* only. It does not address *aerosol* or *liquid* hazards. However, turnouts generally provide better protection against aerosols than they do against vapors.
- Improperly fitted SCBA may result in inhalation and eye exposure. The first indication of eye exposure is miosis; the pupils constrict, making it more difficult to see in low light levels. Responders experiencing miosis should exit the area immediately.
- Signs and symptoms of mustard (HD) exposure can be delayed by several hours. Therefore, it's not possible to gauge relative mustard concentrations by observing victim responses the way it is with nerve agents. In the absence of immediately recognizable signs and symptoms, responders must consider other clues, such as victim reports of a garlic-like odor, presence of an oily liquid or spray, and presence of a spray device.
- If possible, victims should be removed from a building through doors or windows that lead directly to the outside.
- Positive pressure fans used to ventilate the structure can significantly reduce chemical agent vapor concentration. However, ventilation doesn't destroy the vapors; it merely moves them into other areas that must be evacuated before ventilating.
- Responders and victims exiting the scene must immediately undergo water-based decon (high volume, low pressure).
- Information in the SBCCOM report can't be used to justify the use of turnout gear and SCBA for any purpose other than lifesaving rescue operations.
- In light of the new CBRN standards, the 2003 SBCCOM report eliminates "quick fix" options, such as taping openings with duct tape or wearing a Tyvek suit under turnouts.

Personnel Accountability

Any response to a hazmat incident or terrorist event should include a personnel accountability system so that the incident commander knows where all personnel are at all times and can rapidly account for everyone in the event of an emergency.

- Initiate an accountability system at the beginning of operations, and maintain the system throughout. Update the system as personnel, assignments, and locations change.
- Ensure that all personnel comply with requirements of the accountability system.
  - Have all personnel check in at the command post or staging location, as appropriate.
  - Have supervisors maintain an ongoing awareness of the location and condition of personnel under their supervision.
  - Likewise, have all personnel remain under the supervision of those to whom they've been assigned until they are reassigned or released from the incident. There should be no freelancing.
  - When personnel are ready to leave the scene, have them check out through their supervisors or the command post, as appropriate.
- If mission duration must be limited due to air supply, the potential for heat exhaustion, or other reasons, assign a timekeeper to monitor the operation and provide time updates to personnel.
- Include a notification system to alert personnel to emergencies on site. This may include portable radios, loud speakers, and air horns.

Plan Your Initial Response (continued)

Rest and Rehabilitation

The incident commander should make suitable provisions for the rest and rehabilitation of response personnel. This is particularly important for those working in PPE, but it applies to everyone on scene.

- Request resources early. It almost always takes longer for resources to arrive than you anticipate. As soon as it becomes apparent that the incident will be extended, start thinking about backup personnel, water, food, lighting, etc.
- Ensure that personnel operating in chemical protective clothing are medically monitored pre- and post-entry into a hot zone. (See pages 6-33 to 6-34 for more information.)
- Make sure that advanced first aid personnel are standing by with treatment and transport capability.
- Provide fluids.
- Provide food if the incident will be extended.
- Remind personnel to wash their hands before eating, drinking, or smoking.
- Provide a rest area away from the noise and commotion and sheltered from extreme climactic conditions. Make sure the area is equipped with chairs, benches, or other comfortable places to relax.
- Make sure the rest area is equipped with clean toilets or that clean toilets are available nearby.
- Make sure personnel are given adequate time for rest and rehabilitation. Rest time should at least equal suit time. Longer times may be necessary.
- Make sure that all personnel entering and leaving the rehab area are tracked through the personnel accountability system.

All personnel must also be responsible for communicating rest and rehab needs to their supervisors. It's not enough to rely solely on safe practices and medical monitoring. Everyone must work together to ensure the well-being of personnel on scene.

Plan Your Initial Response (continued)

Key Points About Planning

- Look at the big picture. Maintain situational awareness.
- Base your plan on solid product identification and hazard assessment, as well as on SOPs, not on guesswork.
- Do a risk-versus-gain analysis. What favorable impact will intervention make? What are the possible risks of intervention?
- Plan a response that stays within the limits of your training, resources, and equipment.
- Use the safest and simplest method to get the job done.
- Be expedient, but remember that the quickest method is not necessarily the safest or the best.
- Use nonsparking or intrinsically safe equipment in the presence of flammable vapors.
- Include proper safety precautions and a contingency plan for unexpected emergencies in your incident action plan (IAP).
- Review the incident action plan for all personnel during a safety briefing prior to undertaking any operations.
- Document your incident action plan.
- Designate a scribe to record decisions, activities, and problems as they occur. It is difficult to take care of your responsibilities and document activities at the same time. Notes taken during the incident will be invaluable during the debriefing, as well as when you try to document the entire incident later.

Compliance with 29 CFR 1910.120

As a final checklist, make sure your incident action plan contains the following minimum components required by 29 CFR 1910.120. All should be built in to your pre-event contingency plans, but some may have to be modified to fit individual incidents.

- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority, training, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- PPE and emergency equipment

Implement the Planned Response

Once you have a plan, you can implement your response.

Establish and Enforce Scene Control

- Establish and communicate control zones. (See page 2-21.)
- Assign personnel for access control.
- Implement protective actions as needed. (See page 2-55.)

Conduct a Safety Briefing for All Personnel

Conduct a safety briefing. Make sure all personnel understand the objective and their responsibilities. Review the following:

- Preliminary evaluation of the incident
- Hazards/risks and appropriate safety measures:
  - The material and its container
  - Other site hazards (traffic, electrical, confined spaces, etc.)
  - Potential for cross contamination from treating patients
  - Potential for criminal or terrorist activities (secondary events, armed resistance, weapons, booby traps, etc.)
- Site description (safe distances, control zones, security, etc.)
- On-site organization (incident command structure)
- Incident objectives, including task(s) to be performed and time needed to perform them
- Appropriate PPE
- Monitoring requirements
- Communications procedures
- Signs and symptoms of exposure
- Decon procedures (emergency, gross, technical)
- Emergency medical care
- Emergency procedures (including alerting, evacuation routes, and areas of refuge)
- Guidelines for preserving evidence
- Any other pertinent information

Assign Roles in the Incident Command System

Assign roles and responsibilities per the incident command system. Operations level responders may be used for a variety of support functions (e.g., Logistics, Planning, Liaison, Medical, or Public Information Officer). Request additional resources as needed. (See pages 2-12 to 2-19 for more information.)

Implement the Planned Response (continued)

Use Proper Safety Precautions and PPE

- Use the buddy system. Do not allow anyone to go into a hazardous area alone.
- Ensure that a backup team (a rapid intervention crew) is standing by with appropriate equipment ready to provide assistance or rescue.
- Follow all appropriate safety precautions.
- Identify the physical capabilities and limitations of personnel working in PPE.
- Take precautions to protect personnel from heat stress or cold exposure.
- Visually inspect PPE before use to make sure it is undamaged and in proper working order.
- Use the appropriate PPE for the hazards present. However, do not use equipment for which you have not been properly trained or authorized.
- Use all PPE properly.

Use Time, Distance, and Shielding to Your Advantage

The same principles of time, distance, and shielding that protect responders from radioactive materials apply to any incident.

Time

- Spend as little time as possible in the hazard area.
- If you must enter a hazardous area, establish clear objectives ahead of time. Be sure those objectives are communicated to all personnel.
- If terrorist activities are suspected, delay entering the hazard area until it has been evaluated by law enforcement officials.
- Preplan your activities carefully so they can be completed as quickly and safely as possible.
- Test your equipment (e.g., radios, monitors, and rescue tools) before entering the hazard area to ensure everything will function properly.
- If appropriate, rotate crews to limit the time each individual spends in the hazard area.

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Implement the Planned Response (continued)

Use Time, Distance, and Shielding (continued)

- Assign someone to keep track of all responders who enter the hazard area, the time they enter, and the time they exit.
- Give responders periodic updates on how long they have been in the hazard area or how much time remains before they need to exit (especially if entry times must be limited because of air supply, heat stress, or other safety factors).
- Limit patient care in the hazard area to maintaining an open airway, controlling profuse bleeding, and immobilizing the cervical spine as needed. Delay further care until you get to an area of relative safety. When patients and responders are still in danger, it's best to use a load-and-go approach.
- If responders or victims have become contaminated, ensure they are thoroughly decontaminated as soon as possible.

Distance

- Maintain a safe distance.
- When you are not sure of the appropriate distance, err on the side of safety.
- Stay upwind, uphill, and upslope.
- If explosive devices are suspected, avoid operating radios within 330 feet (100 meters) of the device.

Shielding

- Wear proper PPE.
- Use barriers (e.g., slopes or buildings) as shielding when appropriate. Remember, however, that barriers provide limited protection. It is better, for example, to be upwind of a hazardous material than to be downwind, crouched behind a building.
- Inside a building, close doors when doing so will provide shielding against hazardous materials. Do not close doors, however, with explosives incidents. Confining an explosive device will increase the damage if the device does detonate.

Perform Defensive Control Actions As Needed

Perform defensive control actions (page 2-33) if safe to do so. Remember to act within the scope of your training, resources, and equipment. Follow your department SOPs.

Wear Appropriate PPE (Personal Protective Equipment)

Safety First

Protective clothing increases the likelihood of heat stress and heat exhaustion for the wearer, while decreasing dexterity, mobility, visibility, and communications capability. Working in PPE can be emotionally taxing too. In general, the higher the level of PPE, the greater the stress potential. Having a cold or other illness or using medications compounds the risks. Therefore, it's important that personnel using PPE be in good physical condition.

Basic Guidelines for All Personnel

- Don't use PPE you're not authorized to use. (Authorization includes, but is not limited to, medical surveillance, fit testing, and training as required for the specific PPE.)
- Know how to use your PPE and what to do if problems arise.
- Inspect your PPE before use to ensure that it's functioning properly and is not damaged.
- Think of PPE as your last line of defense. If possible, stay out of the hot zone and avoid contact with the material.
- Wear PPE appropriate for the hazards.
- Don't use PPE as an excuse to undertake unsafe activities.
- Understand your assignment.
- Prepare your tools and practice tasks in the cold zone before donning full PPE, if appropriate. This allows you to work out potential problems under less stressful conditions and may reduce the time it takes to perform the actual task.
- Establish hand signals to help with communications.
- Hydrate before and after operations requiring the use of PPE.

Equally important, but beyond the scope of this book, you must be competent in donning and doffing your PPE and must know how to clean, maintain, test, inspect, and store your PPE according to the manufacturer's recommendations and your department SOPs.

Additional Guidelines for the Incident Commander

- Have backup personnel (a rapid intervention crew) in the same level of PPE standing by to assist in an emergency.
- Provide medical monitoring for personnel working in PPE.
- Provide for rest and rehab, including fluid replacement.

Wear Appropriate PPE (continued)

Respiratory Protection

Self-Contained Breathing Apparatus (SCBA) and Supplied-Air Respirators (SAR) (In-Line Systems)

Hazmat emergencies normally require using positive pressure, self-contained breathing apparatus (SCBA) or positive pressure supplied-air respirators (SAR) with escape SCBA. This highest level of respiratory protection must be worn under any of the following conditions:

- During firefighting operations (SCBA only, not SAR)
- In oxygen-deficient atmospheres (less than 19.5% oxygen)
- When the contaminant is unknown
- When the contaminant concentration is unknown, exceeds the IDLH, or exceeds the capacity of air purifying respirators (APR)
- When there are no air purifying respirators (APR) approved for the contaminants present

SCBA provides the best level of respiratory protection without restricting the distance responders travel or the paths they take. However, SCBA is bulky and heavy, may impair movement in confined spaces, and has a limited air supply, the duration of which can be shortened by heavy exertion or a wearer not in top physical condition.

Supplied-air respirators (SAR) are lighter and less bulky and allow longer work periods. However, the air hoses limit the distance responders can travel and require them to enter and leave the site at the same point. Plus the air hoses can easily become tangled, damaged, or contaminated.

As of the 2007 edition of *NFPA 1981, Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, all emergency services SCBA must have NIOSH CBRN certification to ensure protection from chemical, biological, or radiological warfare agents. Certified SCBA will bear a "CBRN Agent Approved" label. See NIOSH's web site for more information.

Wear Appropriate PPE (continued)

Respiratory Protection (continued)

Air Purifying Respirators (APR)

Full-face air purifying respirators (APR) can be used with some hazardous materials if the criteria listed below are met. However, most emergency responders feel there are too many opportunities for error with APR. When in doubt, use SCBA.

- The identity of the contaminant(s) must be known, and the APR must be approved for the specific contaminant. Some APR work only for a specific contaminant. Others may be used for multiple contaminants. However, APR will provide little or no protection if they are not designed for the contaminants present.
- The concentration of the contaminant must be known and must not exceed the IDLH or the maximum capacity of the APR.
- Responders must have a reliable way to determine when APR cartridges have become saturated before being exposed to dangerous concentrations of the contaminant. The contaminant must have adequate warning properties. However, 29 CFR 1910.134 (the federal respiratory protection regulation) also requires that APR be equipped with a NIOSH-certified end-of-service-life indicator (ESLI) or that canisters and cartridges are changed according to a schedule based on objective data.
- The oxygen concentration in the atmosphere must be at least 19.5%, because APR does not supply air as SCBA does.
- The work area must be continuously monitored so that responders are aware of oxygen and contaminant concentrations.
- Responders must be fit-tested for the particular APR and must be properly trained in the use of APR.
- The department must have a respiratory protection program that includes training, maintenance, fit-testing, etc. (See your department's respiratory protection program for more details.)

As of the 2007 edition of *NFPA 1994: Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents*, APR must have NIOSH CBRN certification for use at terrorism incidents involving vapor or liquid chemical hazards where the concentrations are below the IDLH. (CBRN certification is not currently required for biological or radiological particulate hazards where the concentration is below the IDLH.) Certified APR will bear a "CBRN Agent Approved" label. See NIOSH's web site for more information.

Wear Appropriate PPE (continued)

Respiratory Protection (continued)

Powered Air Purifying Respirators (PAPR)

Powered air purifying respirators (PAPR) have a fan or blower that pumps air through the filter into a mask or a hood, creating a positive pressure that provides the user greater protection from contaminants than is possible with nonpowered APR. The powered air flow also makes it easier for responders to breathe, thereby reducing the stress of working in personal protective equipment.

The criteria for using PAPR is the same as for nonpowered APR, with three exceptions. The hooded units can be worn by responders with facial hair because they do not require a tight seal between the face and face piece. The hooded units do not require responders to be fit-tested. And regardless of whether one is wearing the mask type or hooded type, the PAPR requires a fully charged battery to work properly.

Particulate Respirators

Particulate respirators, such as the N-95 HEPA filtering face mask used by medical personnel, are designed to protect against particles and infectious agents, such as hepatitis and HIV. They do not protect against chemical exposures and may not provide sufficient protection against some of the biological warfare agents.

Wear Appropriate PPE (continued)

Types and Levels of Protective Clothing

Structural Firefighting Clothing

Structural firefighting clothing is sometimes referred to as Level D protective clothing, but it is not designed to provide chemical protection. Structural firefighting clothing should be used only when:

- The primary risk is flammability,
- Contact with extremely hazardous materials is not likely, and
- The atmosphere does not contain significant levels of chemicals that are toxic or harmful through skin contact.

High-Temperature Clothing

High-temperature clothing (proximity suits and fire-entry suits) are designed for use in aircraft firefighting and other situations where the heat exceeds the capabilities of structural firefighting clothing. This clothing carries an increased risk of heat stress and is more difficult to work in than structural firefighting clothing is.

Chemical Protective Clothing

NFPA categorizes chemical protective clothing as either vapor-protective or liquid/splash-protective. However, responders often refer to the four levels established by the EPA:

A - Highest respiratory, skin, eye protection (vapor protection)
Requires SCBA (or SAR) and fully encapsulated suit
B - Highest respiratory, lesser skin protection (splash protection)
Requires SCBA (or SAR) and chemical-resistant clothing
C - Lesser respiratory, modest skin protection (support function)
Requires APR and chemical-resistant clothing
D - Ordinary work uniform (for nuisance contamination only)
With eye, head, hand, and foot protection as needed

Level A, B, and C ensembles generally include inner and outer chemical-resistant gloves, chemical-resistant boots/shoes, hard hat, and two-way radios. They may also include a cooling unit, disposable boot covers, coveralls, and long cotton underwear. Additionally, chemical protective clothing must be compatible with the substances involved.

Wear Appropriate PPE (continued)

Types and Levels of Protective Clothing (continued)

Specialty Clothing

The military's answer to protecting personnel from chemical and biological warfare agents is **MOPP (Mission-Oriented Protective Posture) gear**, which provides dermal protection by absorbing the agents into a charcoal-based material. MOPP gear is not currently certified to NFPA protective clothing standards. Nor is there much data on how well it will protect against common toxic industrial materials that responders are far more likely to encounter. For those reasons and because few civilian agencies have MOPP gear, this book won't address it further. However, this is not meant to discourage agencies from purchasing or using MOPP gear if appropriate.

It's also beyond the scope of this book to go into detail on **blast protective clothing**, such as the garments worn by bomb squads. However, responders must evaluate the potential for multiple threats (e.g., an explosive device designed to disperse toxic chemicals). If PPE won't protect against both threats, it may change the way responders deal with the incident.

Personal Alert Safety Systems (PASS)

Although both NFPA 472 and 29 CFR 1910.120 fall short of saying that personal alert safety systems (PASS) are required for hazmat responses, *NFPA 1500, Standard on Fire Department Occupational Safety and Health Program* requires fire service members to use PASS devices in all emergency situations that could jeopardize their safety due to IDLH (or potential IDLH) atmospheres.

Standards for Protective Clothing

To ensure your safety and minimize liability, use protective equipment that meets NFPA and OSHA standards. NFPA has three performance-based standards on chemical protective clothing:

- *NFPA 1991, Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*
- *NFPA 1992, Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*
- *NFPA 1994, Standard on Protective Ensembles for CBRN Terrorism Incidents*

In general, an NFPA 1991-compliant ensemble is equivalent to EPA Level A protection; an NFPA 1992-compliant ensemble, Level B. However, there isn't a direct correlation, because the EPA levels don't include testing to determine the protection provided.

The NFPA performance standards cover chemical resistance, permeation, penetration, flexibility, abrasion, temperature resistance, shelf life, and sizing criteria. However, properly using and caring for the equipment is equally important to guard against inherent vulnerabilities in chemical protective clothing:

- *Penetration* is the movement of hazardous materials through a suit's closures (zippers, seams, flaps, etc.) or cracks and tears in the fabric. Protect against penetration by properly storing and inspecting protective clothing.
- *Permeation* is the movement of hazardous materials through the fabric. All fabrics absorb chemicals eventually. Protect against permeation by using garments with breakthrough times that exceed the expected mission duration.
- *Degradation* (deterioration) increases the potential for a hazardous material to penetrate or permeate protective clothing. Minimize *chemical* degradation by avoiding unnecessary contact with hazardous materials, choosing garments that are compatible with the chemicals involved, and properly decontaminating protective clothing. Minimize *physical* degradation by not rubbing against rough surfaces.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program, addresses protective clothing and equipment for fire suppression operations beyond the incipient stage.

Wear Appropriate PPE (continued)

Determining the Appropriate Level of Protection

Determine the appropriate PPE based on the factors below. When in doubt, assume the worst. If the chemical has multiple hazards, select the PPE that will best protect you from the greatest hazard and try to reduce your risks through other means (e.g., ventilation). (For more information on PPE for chemical and biological warfare agents, see pages 9-7 to 9-8 and 10-9 to 10-11, respectively.)

- Hazards or suspected hazards (e.g., toxic or flammable)
- Form of the material (solid, liquid, or gas)
- Exposure limits (e.g., IDLH)
- Potential routes of exposure and the performance of protective clothing in providing a barrier to the identified hazards
- Concentration of contaminants
- Work assignment and potential for contact or exposure
- Durability of protective clothing in relation to work assignment
- Potential for heat stress to personnel in protective clothing
- Instructions from the protective clothing manufacturer
- Chemical compatibility charts
- Advice from a hazmat team or safety officer

Use the following as an additional guide:

- Level A should be worn when there is a known or suspected potential for exposure to substances that present a severe skin hazard or are capable of being absorbed through intact skin.
- Level B should be worn when SCBA or SAR is required but it's highly unlikely that personnel will be exposed to substances that present a severe skin hazard or are capable of being absorbed through intact skin.
- Level C can be worn in place of Level B if all the criteria for using APR has been met.
- Level D should be worn only when the atmosphere contains no known hazard, the atmosphere contains at least 19.5% oxygen, and it's highly unlikely that personnel will have any exposure to or contact with hazardous levels of any chemicals.
- Thermal protection should be used if flammability is a concern.

Per NFPA and 29 CFR 1910.120, Level B is the minimum level recommended for initial site entries until the hazards have been identified. However, Level A may be more appropriate when the occupancy or circumstances suggest a higher risk potential.

Implement Protective Actions

Protective Action Options

Evacuation is the process of removing people from areas at risk to areas of safety or refuge. It is generally the preferred protective action, but it may not be practical in densely populated areas or for incidents involving large, fast-moving airborne releases. Evacuations may be voluntary or mandatory, although state laws may vary regarding forcing people from their homes.

In-place protection involves keeping people inside buildings and directing them to close doors, windows, ventilation systems, and other openings to make the structure as airtight as possible. In-place protection is sometimes the only practical option. (In some areas, it is known as **shelter-in-place** or **protection-in-place**.)

Key Points

- Choosing the right option requires evaluating the chemical, the population threatened, responder resources and capabilities, site and duration of release, time factors, current and predicted weather, and your ability to communicate with the public. (See pages 13-13 to 13-15 for protective action messages.)
- In-place protection may be needed as an alternative or as an interim measure for people who can't be evacuated right away.
- In-place protection is generally not appropriate for incidents involving flammable atmospheres or explosives.
- It's vital to maintain a method of communicating with people you've chosen to protect in place. Doing so enables you to evacuate them more efficiently if the situation deteriorates.
- Evacuation may cause more harm than good if a toxic gas or vapor has been released. Evacuation is best when there is time to accomplish it safely, the benefits outweigh the risks, or in-place protection might not adequately protect people.
- Evacuees should be sent far enough away that they won't have to be moved twice. If possible, they should be kept in one place to facilitate decon and medical treatment if needed. (See the following page regarding protective action distances.)
- Potentially contaminated areas may need to be evacuated by trained responders with personal protective equipment.
- Vehicles are not as good as buildings for in-place protection, but they can offer limited protection for a short period if the windows are closed and the ventilation system is shut off.

Implement Protective Actions (continued)

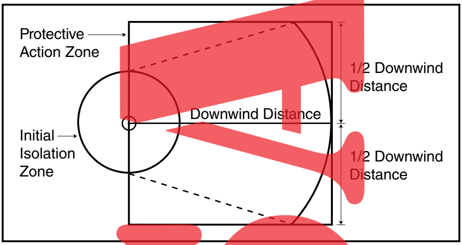
Protective Action Distances

The *Emergency Response Guidebook* (ERG) is a good resource for determining protective action distances.

For most materials, appropriate distances can be found in the orange-bordered guide pages. Under the heading of "Public Safety" will be a statement that says, "Isolate spill or leak area immediately for at least ... in all directions." This is the starting point for any spill or leak. Further down the page are evacuation distances for a large spill or a fire.

If a material is highlighted in the yellow- or blue-bordered pages, it is considered either a toxic inhalation hazard (TIH) or a material that produces toxic gas upon contact with water. Protective action distances for these materials are located in the green-bordered pages. To find the appropriate distances, you must first determine if you have a small spill or large spill. (The ERG defines a small spill as one that involves one small container or a small leak from a large container. It defines a large spill as one that involves a spill from a large container or multiple spills from many small containers.) Then use the chart to identify the initial isolation distance and an appropriate downwind protection distance based on whether it is day or night. *Important:* If the material is on fire or threatened by fire, refer first to the orange-bordered pages. The fragmentation hazard from fire or explosion may be more important than the toxicity hazard during the initial response phase.

The following illustration shows the shapes of recommended initial isolation and protective action zones provided in the ERG.



Shapes of Recommended Zones

Perform Decon as Appropriate

Decon (decontamination) is done as needed to both persons and equipment to prevent the spread of contamination and to reduce the effects of exposure to contaminated individuals. Decon should be done anytime contamination is suspected. The following pages address general decon considerations, locating the decon station, and decon of equipment and response vehicles. For information on patient decon, refer to pages 6-10 to 6-15.

General Decon Concepts

- When decon is not done or not done properly, it can result in serious health effects or death. It can also result in secondary contamination to others, including people who were not at the incident. It's crucial to evaluate the effectiveness of decon operations and adjust as needed.
- If responders are well protected, only their outer garments and the equipment they used in the hot zone will be contaminated. However, their protective clothing must be properly decontaminated before the clothing or SCBA face mask are removed.
- Decon procedures are guidelines only and should be tailored based on the materials involved, the degree of hazard, and the probability of exposure.
- Personnel used for decon must be appropriately trained.
- Emergency decon must be in place before attempting rescue.
- Patients who can walk should be directed to walk to the decon area once responders are ready so that responders need not go into the hot zone unnecessarily.
- The PPE recommended for decon is usually one level below the PPE worn by persons entering the hot zone. However, sometimes the same level of PPE is needed. If so, decon may need to be performed by specially trained and equipped personnel.
- Water used for decon is considered hazardous waste until proven otherwise. It must be contained and checked for contamination. If contaminated, it should be properly treated or disposed of. An exception is made only for water used during *emergency* decon, but you should still try to avoid spreading the contamination to the extent that doing so does not compromise the safety of patients or response personnel.
- Guidelines for protecting and decontaminating monitoring instruments may be included in the manufacturer's instructions. Many types of equipment are very difficult to decon and may have to be discarded as hazardous waste if contaminated.

Perform Decon as Appropriate (continued)

Locating the Decon Station

Set up your decon station in a location that will allow you to work safely and effectively, with minimal impact on the environment.

- Set up the decon area in the warm zone, upwind and uphill of the contamination if possible.
- Choose a location that is large enough to safely contain all activities and where you can best control runoff.
- Avoid environmentally sensitive areas if it's possible. If it's not, use dikes and plastic tarps to contain contaminants or direct the runoff around storm drains and other sensitive areas.
- Make sure there's an adequate water supply.
- Set up in an area that is easily accessible by patients and emergency responders in the hot zone. If greater distances are needed, consider using pickup trucks or other vehicles to transport people to the decon area.
- Set up multiple stations if needed (e.g., for men and women, for ambulatory and nonambulatory patients, for children and adults, for patients and responders, or even for canine partners). More stations require more resources, but it can help you decon a lot of people quickly.
- Choose an area where patients can be shielded from onlookers, including distant photographers with powerful zoom lenses.
- Use existing resources (e.g., emergency showers and eye wash stations or shower facilities at schools and fitness centers) whenever possible. Many emergency showers and eye wash stations drain to a secondary containment system, which reduces the risk of runoff.
- Consider selecting an area with lighting and electricity so you won't have to depend on generators.
- If gases or radioactive materials are involved, use existing barriers (e.g., buildings and topography) for additional protection.
- Establish an alternate decon area in case of an emergency or sudden wind shift. The alternate decon station may be as simple as an extra hose line.
- In bad weather, consider setting up decon inside a building or large truck. Remember, however, that these facilities will also have to be decontaminated afterwards and that you still need to be concerned about containing runoff water used for decon.

Perform Decon as Appropriate (continued)

Equipment Decon

As much as possible, stay out of contaminated areas and protect sensitive equipment (e.g., by covering monitors with clear plastic bags) so that decon won't be necessary. However, be prepared to decon equipment just in case.

Equipment can often be decontaminated with copious amounts of plain water. Often, however, one or more of the following solutions will be more effective at removing contaminants. (Again, these solutions are for **equipment** decon, *not for patient decon*.)

- Soap and water
- A 5% sodium hypochlorite (bleach) solution
- A 10% calcium hypochlorite (HTH) solution
- A 5% trisodium phosphate (TSP) solution
- A 5%-10% sodium bicarbonate (baking soda) solution
- A 5%-10% sodium carbonate solution

Other options often exist in a healthcare setting, for example, sterilization with formalin (formaldehyde), ethylene oxide, or steam. Acetone, ether, ammonia, ammonium hydroxide, ethylene glycol, and ultraviolet light are among other possible options. There is no one-size-fits-all approach to decontamination.

It's beyond the scope of this book to give specific recommendations. Follow department SOPs, check MSDSs and other available references, and seek advice from qualified experts. Make sure the decon solution you use is effective against the hazardous material in question, that it won't harm your PPE or other equipment, and that it won't react adversely with the contaminant. Realize that other factors (e.g., concentration of the decon solution, contact time, and diligence of those performing decon) also influence how effective decon efforts are. Because it is often difficult to ensure that some items have been thoroughly decontaminated (especially protective clothing), it may be more appropriate to dispose of contaminated equipment rather than risk injury from residual chemicals.

Patient Decon

Patient decon is covered in Chapter 6, "Medical Management of Hazmat Exposures." Refer to pages 6-10 to 6-15.

Perform Decon as Appropriate (continued)

Response Vehicle Decon

You can generally avoid contaminating response vehicles by parking upwind and uphill a safe distance away from the release, by not driving through spills, by thoroughly decontaminating equipment before putting it back, and by decontaminating patients before transporting them. However, the following are some recommendations for decontaminating vehicles should it become necessary.

- Wear appropriate PPE.
- Establish a decon area where runoff can be contained, and set up appropriate containment and/or water recovery systems.
- Thoroughly wash and rinse response vehicles with detergent or an appropriate decon solution. Concentrate on areas that can trap contaminants (e.g., wheel wells, radiators, engines, and chassis). If contamination was minimal, it may be sufficient to do initial decon on site, followed by more thorough decon at a car wash where the runoff is contained in a holding tank.
- Empty exterior compartments that were opened, and decon equipment from those compartments before putting it back. Equipment that is difficult to thoroughly decon (e.g., wooden and leather items) may need to be disposed of and replaced.
- Assess the effectiveness of decon by monitoring with appropriate devices (e.g., detection equipment and pH paper) and/or taking wipe samples for laboratory analysis.
- Replace air filters.
- Have qualified personnel inspect response vehicles for possible mechanical or electrical damage, especially to air intakes, filters, cooling systems, and air-operated systems.

"Gross Decon" Versus "Technical Decon"

NFPA 472 identifies *gross decon* as that which is done to significantly reduce contamination. It includes emergency decon, mass decon, and the initial decon performed on entry team members. *Technical decon* is the planned and systemic process of reducing contamination to a level that is as low as reasonably achievable. The term is used most often when referring to responders and their equipment, but can include more thorough patient decon. This book stresses the technical decon methods commonly used by first responders. However, a brief description of other methods is provided on pages 12-20 to 12-22.

Evaluate Your Progress

Evaluate your progress throughout the incident to make sure your efforts are successful and that everyone is operating safely.

Evaluate the Status of Defensive Actions

Evaluate the following questions:

- Has the situation stabilized or intensified?
- Are personnel operating safely and effectively?
- Is PPE functioning properly and providing adequate protection?
- Are control zones still appropriate, or do they need to be adjusted? Are you effectively enforcing control zones and denying access to unauthorized persons?
- How effective is your decon operation?
- How effective are control, containment, or confinement efforts?
- Have conditions (e.g., weather, lighting, and personnel fatigue) changed to the point where they affect your activities?
- Are the material and its container behaving as expected?
- Is it necessary to reevaluate the problem and modify your plan?
- Would it be prudent to pull back from the incident?

If there is nothing you can do to mitigate the incident and it looks like conditions may deteriorate, if the problem has intensified, or if the scene has become unsafe, pull back and reassess the situation. Never be afraid to appear foolish for retreating. Your first priority is to protect yourself and other people around you.

Update Other Response Personnel

Provide feedback to other personnel as appropriate. Situational awareness is vital at all levels for the best possible outcome.

- Communicate the status of the planned response to the incident commander and other personnel. Provide updated instructions as appropriate.
- Immediately notify the incident commander and other personnel of any critical conditions. Use multiple forms of communication as needed to ensure the message is heard by all. Loud background noises, building construction, and other factors can make it difficult to hear radios, air horn blasts, or other warnings. Request confirmation that others heard and understood your message. Make sure all personnel are accounted for.

Facilitate Cleanup and Disposal

Cleanup and disposal requirements will vary depending on the circumstances of the incident. This book provides just a brief overview of the topic. Refer to your department SOPs for more specific information.

Compliance with Hazardous Waste Disposal Laws

Anything from the incident that must be disposed of, whether it be the spilled material itself or anything contaminated by the material, should be considered hazardous waste unless proven otherwise. Hazardous waste must be disposed of in accordance with all applicable federal, state, and local laws. It is not acceptable to flush hazardous waste down the storm drain. Disposal generally must be done by a licensed waste hauler.

Funding and Disposal Responsibility

Whenever possible, the **responsible party** should fund and oversee the cleanup of hazardous materials emergencies, although he or she will need to coordinate with local and state health or environmental agencies. Someone should monitor operations to ensure that the responsible party follows through and that cleanup is being conducted safely and appropriately.

Local agencies may have cleanup funding responsibility if the responsible party cannot be identified, fails to take responsibility, or does an inadequate job of cleanup.

In some areas, the **State** may provide funding if funding is not available through a responsible party or local agencies and the incident poses a threat to life or the environment. It may be necessary to obtain preauthorization on expenditures.

Federal funds are not given directly to response agencies. However, depending on the type of hazardous material, the areas contaminated or threatened, and whether other funding is available, federal response actions may be authorized by a federal on-scene coordinator (FOSC) from the U.S. Coast Guard or the U.S. Environmental Protection Agency.

Terminate the Incident

The incident commander must properly terminate the incident to ensure the safety of response personnel, to facilitate a transition from the emergency phase to the restoration and recovery phases, and to identify lessons learned that may benefit emergency responders at future incidents.

Terminating the incident generally involves a debriefing, a post-incident analysis, and a critique. Each should allow for two-way communication so that all personnel feel free to ask questions and share their observations. The debriefing, post-incident analysis, and critique should be documented according to your SOPs.

Depending on the circumstances, terminating the incident may also involve transferring command and control to another agency.

Debriefing

Ideally, a debriefing should be conducted as soon as the emergency phase of the operation is complete, but before any responders leave the scene. However, responders often leave at different times. Therefore, it may be necessary to hold multiple debriefings to ensure that all responders are given the important information listed below. An effective debriefing should:

- Inform responders about any hazardous materials they may have been exposed to, signs and symptoms of exposure, and what to do if signs and symptoms appear.
- Identify injuries sustained, treatment given, and follow-up medical care needed.
- Identify any unsafe conditions on site that may impact investigation, cleanup, or recovery operations.
- Review the planned objectives, when the objectives were accomplished, and the extent to which they were successful.
- Summarize the activities performed (including who responded, what they did, how and when they did it, and how effective their operations were).
- Identify damaged equipment, as well as any equipment that will require decontamination or disposal.
- Assign information-gathering responsibilities for a post-incident analysis and critique.
- Assess the need for a critical incident stress debriefing.

Terminate the Incident (continued)

Post-Incident Analysis

The post-incident analysis is a reconstruction of the incident, focusing on key topics such as command and control, tactical operations, resources, support services, plans and procedures, and training. It is conducted to accomplish the following:

- Establish a clear picture of events
- Ensure that the incident is properly documented
- Determine who is financially responsible
- Lay the groundwork for any formal investigations, legal proceedings, or future training that may be necessary

Critique

The main purpose of a critique is to develop recommendations for improving the emergency response system. It should be conducted in a positive manner, with emphasis on identifying what works and what doesn't (e.g., roles, responsibilities, systems, and procedures), not on finding fault with individual performance. However, it should also constructively address any violations of the site safety plan, generally accepted safe operating practices, SOPs, laws, standards, etc. How did the violations affect the outcome? What changes might be needed in managing future incidents? Are changes needed in the emergency response plan or SOPs?

Transfer of Command/Control to Other Agencies

Many of the same principles used to transfer command *within* an organization also apply to transferring command and control to other agencies, such as when the emergency phase is replaced by cleanup and remediation activities. The following are some basic guidelines to supplement your SOPs:

- Transfer command only to an individual who is on scene
- Fully brief the incoming command/control person on the details of the incident, including:
  - Response objectives and priorities
  - Resources committed
  - Unmet needs
  - Safety issues
- Communicate the transfer of command to all other key parties

Document the Incident

Failure to document properly is one of the most common causes for an OSHA citation. Proper documentation is important for identifying the hazmat or terrorism problem, cost recovery, exposure records, training, evidence in court cases, follow-up investigations, etc. There are often very stringent requirements, particularly where negligence or criminal or terrorist activities are suspected.

Documentation should be done throughout the incident. Someone should be logging activities as they happen so that they are easily remembered when constructing official reports later. (Voice recorders, PDAs, and other devices can be handy for this purpose.) Documentation showing compliance with all applicable requirements (training, medical surveillance, planning, etc.) *before* an incident occurs is also vital for minimizing liability.

Be sure your documentation is clear, accurate, and specific. Documentation that is sloppy in any way (including grammar, punctuation, and spelling) can hurt your credibility and have negative consequences for you, your agency, and other parties.

Basic Components of Good Documentation

Listed below are the basic components of good documentation. However, the required documentation will vary depending on what agency you work for, what your role is, and state and local requirements. Refer to your department SOPs for specific information. See also page 13-19 for details on evidence documentation.

- Your incident action plan (IAP) or site safety plan
- Date, time, and location
- Names of all responders, their roles in the incident, PPE used, potential exposures (type, level, length), and decon provided
- Contact information for personnel outside your own agency
- Nature of the incident, cause, and conditions on scene
- Material identification and hazard assessment
- Factors that affected the incident (weather, topography, etc.)
- Actions taken, resources used, costs incurred, etc.
- Deaths and injuries
- Problems or other extraordinary circumstances encountered
- Statements and observations from witnesses
- Diagrams, photos, video, etc.
- Evidence and sample collection logs

Document the Incident (continued)

EMS Records

EMS records will generally require the following information.

- Detailed information on the material and its health effects
- Pertinent information on each patient treated or transported
- Routes, extent, and duration of exposure
- Actions taken to limit exposure and contamination
- Decontamination performed
- Medical care rendered

Records pertinent to medical support of response personnel should include the following additional information.

- Number and names of personnel screened
- Adverse reactions noted
- Personnel transported for further treatment
- Completed incident and exposure records
- Recommended medical, physical, and psychological needs for immediate rehabilitation
- Recommended medical surveillance follow-up

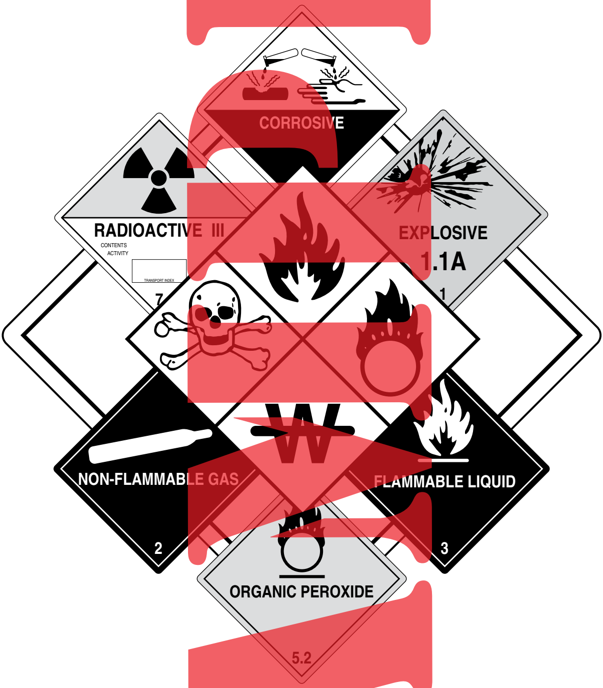
All of this information should be made available to the incident commander through the normal chain of command.

Employee Exposure Records

OSHA requires employers to keep exposure records for 30 years. Although employees have a right to obtain copies of these documents, it is strongly recommended that you maintain your own exposure records with information on date, time, location, incident number, material(s) involved, duration and amount of the exposure, decon and medical aid provided, etc.

It is important to document all exposures, whether or not you are experiencing any symptoms immediately afterwards. It is also important to obtain appropriate follow-up medical attention once signs or symptoms are first noticed. Follow your department SOPs regarding injury/exposure reporting and follow-up medical treatment.

Labels, Placards and Other Marking Systems



This chapter provides information on how to recognize hazmat incidents through UN/DOT labels and placards, the NFPA 704 system, HMIS® labels, GHS (Globally Harmonized System) pictograms, and various other marking systems. This chapter also contains important safety information about each of the UN/DOT hazard classes.

3-2

UN/DOT Placards and Labels

The UN/DOT Hazard Classes

The Department of Transportation (DOT) divides hazardous materials into different classes based on their primary hazards. Each class is described in more detail throughout this chapter.

Class #	Description
1	Explosives (and Blasting Agents)
2	Gases
3	Flammable and Combustible Liquids
4	Flammable Solids, Spontaneously Combustible Materials, and Dangerous When Wet Materials
5	Oxidizers and Organic Peroxides
6	Poisonous and Infectious Substances
7	Radioactive Materials
8	Corrosive Materials
9	Miscellaneous Hazardous Materials
-	ORM-D (Other Regulated Materials)

Information on UN/DOT Placards and Labels

UN/DOT *placards* are intended to be used on motor vehicles, freight containers, and rail cars transporting hazardous materials, though they may sometimes be found at fixed facilities as well. *Labels* are used on individual packages.

The UN/DOT placards and labels are designed with four identifying features so that even under adverse conditions when the entire placard or label is not visible, it should still be possible to determine the hazard class. You should be able to recognize the hazard classes by any of the following:

- Color of the placard or label
- Pictograph (symbol)
- Hazard class or division number found at the bottom of the placard or label
- Text (primary hazard, product name, or 4-digit UN/NA identification number) in the center of the placard or label
  (Note: Not all placards and labels will contain this text in the center. See pages 3-21 and 3-39 for more information.)

UN/DOT Placards and Labels (continued)

Subsidiary Hazard Placards

Secondary placards are required for some of the more dangerous chemicals. In general, these include products that have a subsidiary hazard of being a poison inhalation hazard or being dangerous when wet. It also includes fissile or low specific activity uranium hexafluoride (placarded as radioactive and corrosive). The following example is for ethylene oxide, which is primarily a poison gas, but is also highly flammable.

Primary and Subsidiary Hazard Placards for Ethylene Oxide

Title 49 also permits the use of subsidiary hazard placards even when not required. However, many chemicals with multiple hazards don't require subsidiary placards or labels. Never assume that a chemical has only one hazard.

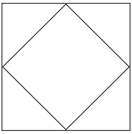
The 4-Digit UN/NA Identification Number

Most of the materials listed in the *Emergency Response Guidebook* have a 4-digit identification number that must be used for bulk transport. It may be shown on the placard (below left) or on an adjacent orange panel displayed on the ends and sides of a cargo tank, vehicle, or rail car (below center). Sometimes you'll see it displayed on a plain white square-on-point display configuration having the same outside dimensions as a placard (below right).

If the 4-digit number on labels or documents is preceded by *UN* (for United Nations), the product is recognized for international transportation. If preceded by *NA*, it's not recognized for international transportation, except in North America.

UN/DOT Placards and Labels (continued)

Placards with Square White Backgrounds



Square white backgrounds are used behind placards on vehicles containing a *highway route controlled quantity* (HRCQ) radioactive material and on rail shipments of certain flammable gases in DOT 113 tank cars, explosives, and poisons.

A square white background behind a placard should be a red flag that you need to be extra careful. Take extra precautions to prevent a container breach. Consider expanding your initial isolation zone and protective action distances if the material has breached the container. You're dealing with some bad stuff.

Variations in the Placards and Labels

Responders may encounter placards and labels that vary slightly from those depicted in this book or the *Emergency Response Guidebook*. There may be several reasons for the variations:

- Placards and labels are sometimes redesigned and given a "face lift."
- Sometimes placards and labels are phased out or replaced by others. Often there's a transition period during which the older placards can still be used if the right conditions are met.
- Placarding and labeling requirements vary slightly in other countries. (See examples on pages 3-21 and 3-39.) The correct placards should be applied when a shipment comes into the United States, but sometimes these details get missed.
- People applying the placards and labels may not be keeping up with the regulatory changes.

Seeing older placards and labels should not be cause for concern. Placards and labels are only a starting point. Identifying the specific materials involved is vital to doing an accurate hazard assessment and developing an appropriate plan of action.

UN/DOT Placards and Labels (continued)

Limitations of the UN/DOT Placards and Labels

The following pages contain an overview of the UN/DOT hazard classes, with key points to know about each. They also contain examples of the applicable placards and/or labels. (There are subtle differences between placards and labels, but the differences are not significant in terms of recognizing hazard classes.) The following are some of the limitations you should be aware of.

- Placards and labels reflect only the *primary* hazard of a chemical. Subsidiary hazard placards and labels (see page 3-4) are required for only a few hazardous materials.
- Some materials are not classified as dangerous by the DOT and thus do not require a placard, but they may still be hazardous enough to cause problems if an accident occurs.
- Many commodities are not required to be placarded at quantities less than 1001 pounds (454 kg). (See next page.) While 1001 pounds is not a lot of product—two 55-gallon drums filled with water weighs slightly less than 1000 pounds—it is still enough to do considerable damage.
- Although *most* people try to be diligent in applying labels and placards, mistakes do happen. Emergency responders should maintain a healthy dose of skepticism until the package or vehicle contents are confirmed through another source.
- Some private agricultural vehicles and military vehicles are exempt from placarding requirements.
- While it's required that placards remain on a container until it is *cleaned and purged*, some people remove placards upon *emptying* the container. Remaining residue may still present a significant danger in the event of a fire or release.
- Unless a placard or label contains the 4-digit UN/NA identification number, it does not identify the specific chemical. It tells you only the hazard class. Product name is used only in a very few cases (e.g., gasoline).
- "Dangerous" placards used for mixed loads do not provide any information about the products being transported.
- Placards and labels can be difficult to see from a distance or under adverse conditions (e.g., in poor lighting or when obscured by smoke).
- Placards are used on both sides and both ends of a cargo tank or rail car. Placards are not required on top and bottom, which may be a problem if the container overturns in an accident.

Table 1 and Table 2 Commodities

Hazardous materials have been divided into two categories with respect to placarding requirements: Table 1 and Table 2. The following is for general information only and must not be used to determine compliance with 49 CFR, Part 172.

Placarding Tables

Table 1 commodities must be placarded at any quantity.

Explosives (Class 1.1, 1.2, and 1.3)
Poison Gas (Class 2.3)
Dangerous When Wet Materials (Class 4.3)
Organic Peroxides (Class 5.2 - Type B)
Poisons (Class 6.1 - materials poisonous by inhalation)
Radioactives (Radioactive Yellow III)

Table 2 commodities on a transport vehicle or freight container generally need to be placarded only at 1001 pounds (454 kg) or more. (ORM-Ds and Class 6.2 materials do not require placards.)

Explosives (Class 1.4, 1.5, and 1.6)
Flammable and Nonflammable Gases (Class 2.1 and 2.2)
Flammable and Combustible Liquids (Class 3)
(except combustible liquids in nonbulk packaging)
Flammable Solids (Class 4.1)
Spontaneously Combustible Materials (Class 4.2)
Oxidizers (Class 5.1)
Organic Peroxides (Class 5.2 - other than Type B)
Poisons (Class 6.1 - except materials poisonous by inhalation)
Corrosives (Class 8)
Miscellaneous (Class 9)

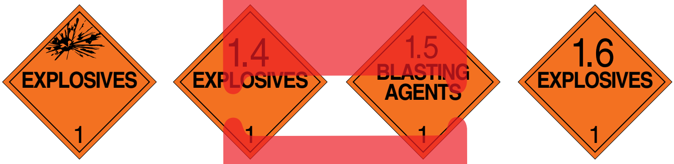
Dangerous Placards - Mixed Load

When a rail car, trailer, or container has 1001 pounds (454 kg) or more of a mixed load of Table 2 commodities in nonbulk packages, the Dangerous placard may be used in place of specific hazard class placards. However, if 2205 pounds (1000 kg) or more of one category of hazardous material is loaded at one facility, the Dangerous placard must be supplemented with the specific hazard class placard for that material.

Class 1 - Explosives (and Blasting Agents)

An explosive is any substance or article (including a device) that is designed to function by explosion or that, by chemical reaction within itself, is able to function in a similar manner. Explosives range from being very sensitive to shock, heat, or friction, to being relatively insensitive, needing an initiating device to function. They are divided into six divisions based degree of hazard.

Div.	Degree of Hazard	Examples
1.1	Mass explosion hazard	Black powder, dynamite, TNT
1.2	Projection hazard	Detonating cord, aerial flares
1.3	Fire/minor blast hazard	Propellant explosives, rocket motors
1.4	Minor explosion hazard	Practice ammo, common fireworks
1.5	Very insensitive	Blasting agents, ANFO
1.6	Extremely insensitive	Articles not otherwise specified



- One reason explosives are so dangerous is that they contain both an oxidizer and a fuel component in their structures. Two sides of the fire triangle are already complete.
- Many emergency responders have been killed by explosives because they underestimated the hazard potential.
- There is little difference between the six divisions from the first responder's perspective. While the degree of risk varies, all Class 1 materials can be just as deadly if they explode.
- Responders must never fight a fire involving explosives. The NFPA *Fire Protection Handbook* suggests evacuating to a distance of at least 2000 feet (600 meters). The ERG shows distances up to 1 mile (1600 meters).
- It *may or may not* be safe to fight a fire that *threatens* explosives (e.g., vehicle tire fire, cab fire). Follow department SOPs.
- Some explosive devices (e.g., electric blasting caps) can be set off by radio transmissions. Do not operate radios within 330 feet (100 meters) unless you are sure it's safe to do so.
- Improvised explosive devices (IEDs) are very dangerous because they can be easily concealed and triggered in many ways.

Class 2 - Gases

Class 2 materials all exist as gases in their natural states, but their hazards can vary greatly.

Div. Description

2.1 Flammable gas (e.g., propane, acetylene, methyl chloride)

2.2 Nonflammable, nonpoisonous compressed gas (including compressed gas, liquefied gas, pressurized cryogenic gas, compressed gas in solution, asphyxiant gas, and oxidizing gas) (e.g., anhydrous ammonia, carbon dioxide, nitrogen)

2.3 Gas poisonous by inhalation (identified as *inhalation hazard* in the U.S. or *poison gas* internationally) (e.g., arsine, chlorine, phosgene, methyl bromide)

- Division 2.1 gases have (1) a lower explosive limit (LEL) of 13% or less *or* (2) a flammable range of at least 12%, regardless of the LEL. Beware of “nonflammable” gases (e.g., anhydrous ammonia) that will burn in the right concentration.
- Overpressurization (from fire or nonfire conditions) can cause pressure vessels to fail catastrophically. Consider an immediate withdrawal.
- Large pressure vessels can fail in 10 to 20 minutes or days after the container was stressed. BLEVEs (boiling liquid expanding vapor explosions) can throw debris up to a mile. If enough water is not available to cool the vapor space and any part of a pressure vessel exposed to flame impingement within the first 10 minutes, consider an immediate withdrawal.
- A rising sound from a venting relief device and discoloration of the tank due to fire are indications of impending BLEVE. Withdraw immediately.
- Most compressed gas cylinders have a pressure relief device to prevent rupture when exposed to fire. (Relief devices are prohibited on cylinders containing highly toxic materials.)
- When gases are released quickly from a cylinder, the cylinder can become very cold. Beware of the frostbite hazard.
- A liquid released from a pressure vessel will expand significantly as it returns to its gaseous state. The gas can travel a considerable distance and greatly increase the scope of the incident.

(continued next page)

Class 2 - Gases (continued)

- Division 2.3 (poisonous) gases are further identified by poison inhalation zone (PIH), sometimes referred to as toxic inhalation zone (TIH). Hazard Zone A is the worst.

Zone	LC_{50} greater than	LC_{50} less than or equal to
A	—	200 ppm
B	200 ppm	1000 ppm
C	1000 ppm	3000 ppm
D	3000 ppm	5000 ppm

Cryogenic Liquids

Class 2 also includes cryogenic liquids (gases that have been liquefied by cooling to a temperature of -130˚F/-90˚C or less).

There is no label or placard specifically for cryogenic liquids. They generally have the same labels or placards used for gases. However, many containers used for bulk transportation of cryogenic liquids are not placarded; they are stenciled with the words “Refrigerated Liquid” and the name of the product instead.

Cryogenic liquids present several hazards:

- They are extremely cold; contact can cause frostbite.
- Cryogenic liquids have very high expansion ratios. Liquid nitrogen, for example, has an expansion ratio of 696 to 1. A large release of a cryogenic liquid could displace oxygen in the atmosphere and create an asphyxiation hazard, particularly in enclosed spaces or low-lying areas.
- The high expansion ratio also means that any flammability or toxicity risk is greatly increased because there is so much more volume of product present in a release.
- Some cryogenic liquids form extremely shock-sensitive mixtures when in contact with combustible materials (e.g., liquid oxygen on asphalt).
- Cylinders or tanks containing cryogenic liquids may fail catastrophically (BLEVE) when exposed to flame, radiant heat, or other high temperatures. They should be handled much like pressure vessels in an emergency.
- If the tank has been damaged and the insulation compromised, there is an added danger of the product warming much faster as either it or the inner tank is exposed to ambient air, water, a fire, or heat from any other source.

Class 3 - Flammable and Combustible Liquids

Flammable Liquids

Flammable and combustible liquids are distinguished by flash point. Flammable liquids (e.g., gasoline, acetone, toluene, and methyl alcohol) are generally defined by the DOT as those with flash points not more than 140˚F (60˚C), whereas combustible liquids (see next page) have flash points above 140˚F (60˚C). Simply put, flammable liquids can ignite easily at ambient temperatures, whereas combustible liquids must be heated first.

Caution: Always check the properties of flammable and combustible liquids rather than take placards at face value. The DOT allows some Class 3 flammable liquids with flash points at or above 100˚F (37.8˚C) to be reclassified as combustible liquids for transportation. Conversely, some combustible liquids that are intentionally heated and transported at or above their flash points may be placarded as flammable liquids.

- The vapors of flammable liquids are heavier than air and will not dissipate rapidly. Try to eliminate ignition sources *if you can do so safely*. Firefighters may need to suppress vapors with foam.
- Closed containers exposed to direct flame impingement are likely to fail unless cooling water is applied quickly. The liquid space is protected as long as there is sufficient liquid to absorb the heat. Direct initial fire streams toward the more vulnerable vapor space whenever there is flame impingement.
- Gasoline, one of the most common products involved in hazmat incidents, is generally transported in aluminum cargo tanks that will melt when exposed to fire and can fail rapidly, thereby creating a major containment problem.
- Using water on some flammable liquid fires (e.g., gasoline) can dramatically spread the fire if the product and water are not confined. Sometimes it's better to let the product burn and protect exposures instead.

(continued next page)

Class 3 - Flammable and Combustible Liquids (continued)

Flammable Liquids (continued)

- The effectiveness of foam or water in suppressing flammable liquid vapors depends on the specific gravity of the product. (See pages 5-44 and 5-45 for information on specific gravity.)
- An oxygen-enriched atmosphere (>23.5%) or the presence of oxidizers will greatly intensify fires involving flammable liquids.
- *Warning:* The word *inflammable* means *flammable*. It *does not* mean nonflammable.

Combustible Liquids

A combustible liquid (e.g., fuel oil, mineral oil, and peanut oil) is one that does not meet the definition of any other hazard class and has a flash point above 140˚F (60˚C) and below 200˚F (93.3˚C).

A placard with the 4-digit identification number and a white triangle below it (above left) identifies the product as a combustible liquid rather than a flammable one.

- Combustible liquids are not easily ignited at ambient temperatures; they must be heated first.
- Combustible liquids are easier to ignite in hot environments (e.g., if spilled on hot asphalt on a hot day) than they are normally.
- Oxygen-enriched atmospheres (>23.5% oxygen) can cause combustible liquids to ignite more easily and burn more intensely. Combustible liquids will behave similarly to flammable liquids under these conditions.
- Oxidizers mixed with combustible liquids can produce explosive combinations (e.g., ammonium nitrate and fuel oil).
- Many of the guidelines for dealing with flammable liquids are also appropriate for combustible liquids.

See pages 5-23 to 5-47 for more information on chemical and physical properties of flammable liquids, combustible liquids, and other materials.

Class 4 - Flammable Solids, Spontaneously Combustible Materials, and Dangerous When Wet Materials

This class includes any solid material, other than an explosive, that is liable to cause fires through friction or through retained heat from manufacturing or processing. It also includes solids and liquids that can be ignited readily on exposure to water or air or that are highly reactive to water or air.

Div.	Description
4.1	Flammable solids (desensitized explosives, self-reactive materials, and readily combustible solids) (e.g., magnesium [pellets, turnings or ribbons], nitrocellulose, matches)
4.2	Spontaneously combustible materials (pyrophoric and self-heating materials) (e.g., aluminum alkyls, charcoal briquettes, magnesium alkyls, phosphorus)
4.3	Dangerous when wet materials (e.g., magnesium powder, calcium carbide, sodium, potassium)

- Flammable solids burn vigorously and persistently once ignited. Metal shavings, dusts, or powders can be very dangerous under the right conditions, because there is so much surface area available to burn. Combustion can be so rapid and produce sufficient pressure that it results in a dust explosion.
- Small fires involving combustible metals require the use of special Class D extinguishing agents.
- The use of water, carbon dioxide, or halon can greatly accelerate a fire involving many Class 4 materials. It may be more appropriate to let large fires burn and protect exposures instead. Follow your department SOPs.
- Burning metals produce hazardous gases that may be toxic, corrosive, or asphyxiating.
- Many of the water-reactive materials will produce flammable and/or toxic gases when mixed with water. Some also produce very caustic (corrosive) solutions.

Class 5 - Oxidizers and Organic Peroxides

Div.	Description
5.1	Oxidizers (e.g., ammonium nitrate, bromine trifluoride, calcium hypochlorite)
5.2	Organic peroxides (e.g., dibenzoyl peroxide, methyl ethyl ketone peroxide, peroxyacetic acid).

- Oxidizers may cause or enhance combustion of flammable or combustible materials by yielding oxygen or other oxidizing agents. The reactions can be violent and explosive.
- Firefighting clothing contaminated with an oxidizer will burn vigorously and may need to be discarded.
- Organic peroxides are flammable and unstable; they are more dangerous than ordinary oxidizers are. The new placards and labels (above right) highlight the fire danger. (Older placards and labels may be used until January 1, 2011 [rail, vessel, or aircraft] and January 1, 2013 [highway].)
- Organic peroxides are similar to explosives; they contain a fuel and an oxidizer in the same formula. Do not attempt to fight a fire. Withdraw to a safe distance—at least 2000 feet (600 meters).
- Some organic peroxides can form extremely unstable, shock-sensitive crystals on the outside of the container if exposed to air. Request assistance from a hazmat team or bomb squad.
- Oxidizers and organic peroxides can react violently to friction, temperature, or contamination.
- Organic peroxides may be prone to runaway polymerization and catastrophic container failure (signified by a “P” next to the guide number in the yellow and blue sections of the ERG).
- If an organic peroxide reaches its self-accelerating decomposition temperature (SADT), it will decompose in a dangerous reaction that can’t be stopped. Organic peroxides should be kept below their maximum safe storage temperature (MSST), which provides a margin of safety to prevent getting to the SADT.
- Organic peroxides are divided into 7 types (A through G) based on whether they detonate or deflagrate and how they behave when heated under confinement. Type A is the most hazardous.

Class 6 - Poisonous and Infectious Substances

While all chemicals may be toxic to some degree, toxicity is the primary threat with these materials. (Refer to Chapter 5 for more information on toxicology.) Class 6 has two divisions:

Div.	Description
6.1	Poisonous materials (signified by *Poison, Inhalation Hazard, or PG III*) (e.g., aniline, arsenic, hydrocyanic acid, carbon tetrachloride, tear gas)
6.2	Infectious substances (labels only, not placards) (e.g., anthrax, botulism, rabies, tetanus)

- Structural firefighting clothing and SCBA may *not* provide sufficient protection. Avoid contact with poisonous or infectious substances. Request assistance from a hazmat team.
- Other good sources for information include your local poison control center, CHEMTREC, or the CDC.
- It is sometimes best to allow fires involving these materials to burn. Fire can destroy the toxic properties of some products, thus decreasing the danger. Allowing the fire to burn also minimizes spread of the product from runoff.
- Pesticide container labels must include a signal word: *Danger* (high toxicity), *Warning* (moderate toxicity), or *Caution* (relatively low toxicity). The word *Poison* and a skull and crossbones icon must be added if the product fits into the high toxicity category based on oral, inhalation, or dermal toxicity (as distinct from skin and eye irritation).
- Pesticide container labels must also contain a flammability statement: *Extremely Flammable, Flammable, Combustible,* or *Contents Under Pressure*.
- Division 6.1 materials are assigned to packing groups (PG I, II, or III). Packing Group I (PG I) is the most hazardous. Within Packing Group I are two hazard zones (A and B). Zone A materials are the most dangerous.

Class 7 - Radioactive Materials

Radioactive materials (e.g., cobalt, uranium hexafluoride, and "yellow cake") are covered in depth in Chapter 11.

- The Radioactive I, II, and III labels (first three above) reflect the radiation level as measured both at the surface of the package and 1 meter (3 feet) away. (See page 11-20.) Radioactive I is the least hazardous, while Radioactive III is the most hazardous.
- Fissile labels are used for fissile materials (also called *special nuclear materials*) that can be used to create an atomic bomb.
- The radioactive *placard* (far right) is required only when transporting Radioactive III materials.
- Radiation cannot be seen or smelled. It can be detected only with special instruments.
- Protection from radiation requires a combination of time, distance, and shielding. (See pages 11-11 to 11-15.)
- Structural firefighting clothing and SCBA will protect against alpha and low-energy beta particles, but it won't protect against penetrating radiation. (See page 11-15.)
- An initial control zone should be set where radiation levels are at or below 2 mR/hr above background level. If you can't confirm radiation levels, use minimum distances in ERG Guide 163:
  - Isolate 75 feet (25 meters) for a spill or leak.
  - Evacuate downwind 330 feet (100 meters) for large spills.
  - Evacuate 1000 feet (300 meters) for a major fire.
- Whether you can safely extinguish a fire or should allow it to burn will depend on the degree of risk. Do as little overhaul as possible once the fire is out. Contact your state or local radiological officer or health department for assistance.
- Radiation exposures should be kept as low as reasonably achievable (ALARA). The U.S. EPA recommends the following radiation dose limits for emergency services:
  - 5 rem whenever possible
  - 10 rem to protect valuable property (if a lower dose is not practicable)
  - 25 rem to save a life or protect large populations (if a lower dose is not practicable)

  These limits are based on hour-long exposures. You can exceed these limits for shorter exposures. (See page 11-10.)

Class 8 - Corrosive Materials

Corrosives (e.g., sulfuric acid, nitric acid, and sodium hydroxide) are materials that degrade metals and cause destruction to living tissue on contact. Corrosives can be solids or liquids. They are divided into two categories: acids and bases. Bases can also be referred to as caustics or alkalis.

- The *strength* of a corrosive is measured by pH. The pH scale goes from 0 to 14, with 7 being neutral. Materials with a pH from 0 to 6 are acidic. The closer to 0, the stronger the acid. Materials with a pH from 8 to 14 are basic. The closer to 14, the stronger the base.
- Corrosives are also measured in terms of *concentration*, which is independent of strength (pH). Concentration refers to the percentage of an acid or base in water. A concentrated acid or base is more hazardous than a less concentrated one.
- Protection from corrosives generally requires the use of chemical protective clothing and SCBA. Vapors can permeate the fabric of a work uniform or structural firefighting clothing and cause severe irritation or damage, especially to mucus membranes and moist skin.
- Smoke from burning corrosives is also very dangerous. It may be more appropriate to let these materials burn and protect exposures instead. Follow your department SOPs.
- Foam or fog streams may be used to disperse or redirect vapors in a release. However, keep the water away from the container and the spill, because adding water to a concentrated corrosive can cause a very violent reaction.
- Acids and bases are not compatible with each other. Although acids and bases can sometimes be used to neutralize each other by a trained hazmat team or chemical expert, mixing strong acids and bases can lead to a fire or explosion and severe injury or death. Do not try to mix acids and bases. Let the experts determine if neutralization is appropriate.
- Acids are not compatible with most metals. Contact with metal may produce highly flammable hydrogen gas.
- Some acids are incompatible with other acids.
- Some acids are flammable. Some are strong oxidizers.
- *See also pages 5-46 and 5-47 for information on corrosivity.*

Class 9 - Miscellaneous Hazardous Materials

Miscellaneous hazardous materials (also known as miscellaneous dangerous goods) are those that present a hazard during transportation but *do not meet the definition of any other hazard class*. This class includes:

- Materials that have an anesthetic, noxious, or other similar property that could cause extreme annoyance or discomfort to a flight crew member so as to prevent the correct performance of assigned duties.
- Any materials that meet the definition in 49 CFR for an elevated temperature material, a hazardous substance, a hazardous waste, or a marine pollutant.

Examples of Class 9 materials include adipic acid, PCBs, and molten sulfur.

- Materials that have anesthetic or noxious properties can cause a lot of public concern even when the hazards are minimal.
- Because this class includes a variety of materials, it will be necessary to obtain shipping papers in order to identify these products and the hazards associated with them.

ORM-D Materials

ORM-D material means a material such as a consumer commodity that, although otherwise subject to the regulations in 49 CFR, presents a limited hazard during transportation due to form, quantity, and packaging. (ORM stands for Other Regulated Materials.) There is no UN/DOT class number associated with ORM-D materials.

Packages containing ORM-D materials should have one of the labels shown below. (There is no *placard* for ORM-D materials.) The ORM-D-AIR label is for an ORM-D material prepared for air shipment. All other ORM-D materials should have the label on the left.

CONSUMER COMMODITY
ORM-D

CONSUMER COMMODITY
ORM-D-AIR

Do not underestimate the hazards associated with products packaged as consumer commodities. For example, a truck carrying a large shipment of cigarette lighters may contain the same flammable product as a cargo tank carrying liquefied petroleum gas (LPG). The quantity and packaging reduce the degree of risk and the potential for an accident, but the hazardous properties of the chemical itself have not changed.

Materials of Trade (MOTs)

Materials of Trade (MOTs) are hazardous materials (other than hazardous waste) that are carried on a motor vehicle for one of the following reasons:

- To protect the health and safety of the motor vehicle operator or passengers. Examples include SCBAs, fire extinguishers, and insect repellent.
- To support the operation and maintenance of a motor vehicle (including its auxiliary equipment). Examples include gasoline and spare batteries.
- To directly support a principal business of a private motor carrier (including vehicles operated by a rail carrier) for purposes other than transportation by motor vehicle. Examples of such businesses include landscaping, pest control, painting, plumbing, or welding services. The MOTs these businesses use can include a wide variety of hazardous materials (e.g., acetylene, propane, oxygen, nitrogen, paint, paint thinner, pesticides, muriatic acid, and asbestos).

It's beyond the scope of this book to cover the regulations, which can be found in 49 CFR 173.6. However, the following are some key points for emergency responders:

- Although MOT quantities are limited, any of these materials can be harmful in the event of a fire or release.
- Vehicles are not required to be placarded.
- Vehicle operators are not required to carry shipping papers or emergency response information (although they must be informed of the presence of the hazardous material and whether the package contains a reportable quantity).
- Vehicle operators are not required to have formal training to transport MOTs (although workplace safety regulations may require that they be trained in the safe use of the materials).

Canadian and Mexican Placards and Labels

The placards and labels used in Canada and Mexico are based on UN recommendations, so they are similar to those used in the United States. Some of the major differences are highlighted below, but this is by no means a complete list.

- Most Canadian transport placards do not contain signal words. Thus it's important to look at the class or division number at the bottom of the placard to distinguish between similar placards.
- Mexican placards and labels may be written in Spanish.
- Canadian labels and markings may be written in both English and French.
- Subsidiary placards and labels may not have the hazard class or division number at the bottom.

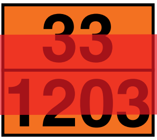
Examples of Canadian Transport Placards

Examples of Mexican Placards and Labels in Spanish

A Subsidiary Placard with No Hazard Class or Division Number

Intermodal
Hazard Identification Codes

Some intermodal containers display a double orange panel. The bottom panel contains the product's 4-digit UN/NA identification number. The top panel contains a two- or three-digit hazard identification code (or hazard identification number).



A thorough listing of the hazard identification codes can be found in the *Emergency Response Guidebook* (ERG). However, in general, the numbers indicate the following hazards:

2 - Emission of gas due to pressure or chemical reaction
3 - Flammability of liquids (vapors) and gases or self-heating liquid
4 - Flammability of solids or self-heating solid
5 - Oxidizing (fire-intensifying) effect
6 - Toxicity or risk of infection
7 - Radioactivity
8 - Corrosivity
9 - Miscellaneous dangerous substance (if 90 or 99)
Risk of spontaneous violent reaction (if used as the second or third digit in any other combination)

The way the numbers are combined is also significant:

- If a digit is followed by zero (e.g., 30), the initial digit is sufficient to convey the hazard.
- Doubling of a digit indicates greater intensity. The example above (33) signifies a *highly* flammable liquid.
- Digit combinations reflect the hazards in order of importance. For example, 38 indicates a flammable liquid that is also corrosive, whereas 83 indicates a corrosive liquid that is also flammable.
- If the letter "X" precedes the hazard identification code (e.g., X80), the material will react dangerously with water.

NFPA 704 Marking System

The NFPA 704 standard addresses the health, flammability, instability, and related hazards presented by short-term, acute exposure to materials under conditions of fire, spill, or similar emergencies. The marking system was designed for use at fixed facilities, but the markings are sometimes found on individual containers too.

NFPA Credit & Disclaimer

The NFPA has graciously permitted inclusion of its 704 system in this book for the benefit of first responders. The text of the paragraph below and symbol at the bottom of the page are NFPA's. However, the information on the following five pages, while based on NFPA's material, has been edited to fit the format of this field guide. For NFPA's exact language, refer to the current edition of *NFPA 704, Identification of the Hazards of Materials for Emergency Response*.

What the 704 System Looks Like

The NFPA 704 system uses a diamond-shaped symbol that is divided into four sections as shown below. The numbers and symbols are explained on the following pages.

Color	What It Signifies
Blue	Health Hazards
Red	Flammability Hazards
Yellow	Instability Hazards
White	Special Information

NFPA 704 Marking System (continued)

What the Numbers Mean (General Explanation)

The top three sections of the NFPA 704 symbol use numbers from 0 to 4 to identify the degree of hazard presented. The number 0 represents no special hazard, while the number 4 indicates a severe hazard. If there is no number indicated, assume the worst (4) until proven otherwise. The numbers have the following general meanings for firefighters:

4 — Fire is too dangerous to approach with standard firefighting equipment and procedures. Withdraw to a safe distance and obtain expert advice on how to handle the fire. When in doubt, allow the fire to burn.

3 — Fire can be fought using methods intended for extremely hazardous situations, such as remote-control monitors or personal protective equipment that prevents all bodily contact.

2 — Fire can be fought with standard procedures. However, hazards are present that can be handled safely only with certain special equipment or procedures.

1 — Nuisance hazards are present that require some care, but standard firefighting procedures can be used.

0 — No special hazards are present; therefore, no special measures are needed.

The bottom section contains information about special hazards. NFPA recognizes three symbols for this section: the letter W with a bar through it (~~W~~) to indicate a water-reactive material, the letters OX to indicate an oxidizer, and the letters SA to indicate a simple asphyxiant. However, some users will put other information in this section, such as a radioactive symbol to warn of radioactive materials.

According to NFPA, the ~~W~~ symbol doesn't mean "do not use water," since some forms of water, such as fog or spray, may be appropriate in some situations. Rather, the ~~W~~ symbol means that the material is unusually reactive with water and that water may cause additional hazards. If you use it, do so cautiously and in copious amounts.

NFPA 704 Marking System (continued)

What the Numbers Mean (Specific Explanations)

Health Hazards

When numbers are assigned in this category, it is based only on the inherent physical and toxic properties of the material, unless the combustion or decomposition products present a significantly greater degree of risk. Assigned numbers reflect the health hazards associated with an acute short-term exposure under emergency conditions. They do not reflect hazards associated with chronic or repeated long-term exposure to low concentrations.

4 – *Severe hazard*. These materials can be lethal under emergency conditions. A few whiffs of the vapor or skin contact with the vapor or liquid can be fatal. Normal structural firefighting clothing and SCBA will not provide adequate protection against inhalation or skin contact.

3 – *Serious hazard*. These materials can cause serious or permanent injury under emergency conditions. Responders require SCBA and full protective clothing that ensures no skin surfaces are exposed.

2 – *Moderate hazard*. These materials can cause temporary incapacitation or residual injury under emergency conditions. Responders require SCBA with full face and eye protection.

1 – *Slight hazard*. These materials can cause significant irritation under emergency conditions. SCBA is recommended.

0 – *Minimal hazard*. These materials present no health hazard beyond that of ordinary combustibles.

NFPA 704 Marking System (continued)

What the Numbers Mean (continued)

Flammability Hazards

Numbers in this category are based on susceptibility to burning.

4 – *Flammable gases, flammable cryogenic materials, very volatile flammable liquids, Class IA liquids, pyrophoric materials*. Fire should be fought by shutting off the flow and cooling exposed tanks or containers. Withdrawal may be necessary.

3 – *Ignites at ambient temperatures (Class IB liquids)*. Water may be ineffective because of the low flash point.

2 – *Ignites when moderately heated (Class II and IIIA liquids)*. Water spray may be used to cool the material below its flash point and extinguish the fire.

1 – *Must be preheated to burn (Class IIIB liquids)*. Water fog should be applied gently to the surface of the liquid. Water that gets below the surface and turns to steam may cause frothing.

0 – *Will not burn*.

Some people find it helpful to know how flash point relates to the numbers above. Flash point is the primary criterion for assigning the flammability rating, but other factors, such as flammable range, autoignition temperature, and susceptibility to container failure due to fire exposure, could be of equal importance. The following information is provided for your reference, but it is *not* a complete description.

4 – Any liquid or gaseous material that is liquid while under pressure and has a flash point below 73˚F (22.8˚C) and a boiling point below 100˚F (37.8˚C).

3 – Liquids with a flash point below 73˚F (22.8˚C) and a boiling point at or above 100˚F (37.8˚C). Liquids with a flash point at or above 73˚F (22.8˚C) and below 100˚F (37.8˚C).

2 – Liquids with a flash point above 100˚F (37.8˚C), but not exceeding 200˚F (93.3˚C).

1 – Liquids, solids, and semisolids with a flash point above 200˚F (93.3˚C).

0 – Materials that will not burn.

What the Numbers Mean (continued)

Instability Hazards (Chemical Reactivity)

Numbers are assigned in this category based on the susceptibility of materials to release energy either by themselves or in combination with other materials. Conditions of shock, pressure, and fire exposure were the primary factors considered.

4 – *Capable of detonation or explosive decomposition at normal temperatures and pressures*. This includes materials that are sensitive to localized thermal or mechanical shock. If they are involved in a massive fire, vacate the area.

3 – *Capable of detonation, explosive decomposition, or explosive reaction, but either require a strong initiating device or must be heated under confinement before initiation*. This includes materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures or that may react explosively with water without requiring heat or confinement. Firefighting should be conducted from behind explosion-resistant locations.

2 – *Violent chemical change possible at elevated temperature and pressure*. This includes materials that react violently with water or that may form potentially explosive mixtures with water. Fight fires using portable monitors if possible. If necessary to use hand lines, fight fires with straight hose streams from a distance. Use caution.

1 – *Normally stable, but becomes unstable if heated*. These materials may react vigorously but not violently with water. They may change or decompose on exposure to air, light, or moisture. Use normal precautions when approaching a fire involving these materials.

0 – *Normally stable*. No special precautions are required.

NFPA 704 Marking System (continued)

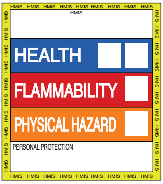
Limitations of the NFPA 704 Marking System

- The NFPA 704 markings do not provide information regarding chemical identity or quantities present.
- Hazards are identified generically by health, flammability, and instability. The system does not, for example, specify particular type of health hazard (oral, dermal, or inhalation).
- Where multiple chemicals are present, the ratings may or may not reflect the hazards associated with *specific* chemicals. Ratings may be assigned based on one of three methods:
  - The *Composite Method* summarizes the maximum (worst) ratings for all of the materials in the building or area.
  - The *Individual Method*, used when there are only a few chemicals present or only a few that are of concern to emergency responders, allows for individual signs with the chemical's name displayed below each sign.
  - The *Composite-Individual Combined Method* uses a single sign to summarize the ratings for buildings or areas with multiple chemicals, supplemented by individual signs (as described above) for rooms or areas within the building containing fewer chemicals.
- These ratings may not reflect the hazards that result if multiple chemicals become mixed in an accident.
- While 704 markings applied to the outside of a building warn of potential hazards, they don't necessarily identify what is burning. Doing a good size-up will keep you safe without unnecessarily sacrificing a building to a fire that doesn't involve or threaten hazardous materials.
- If done properly, the ratings will also take into consideration the effects of local conditions, such as whether a material is stored in a ventilated area or unventilated area. However, emergency responders may not be able to count on that.
- There is no guarantee that the markings have been applied properly. Use at least three reference sources to confirm product identity and associated hazards. Reference sources may include, but are not limited to, the *NFPA Fire Protection Guide to Hazardous Materials*, material safety data sheets, chemical reference books, technical information centers, computer databases, facility employees, business plans, and facility preplans.

Hazardous Materials Identification System (HMIS®)

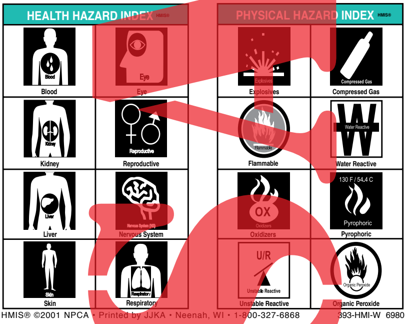
The Hazardous Materials Identification System (HMIS®) developed by the National Paint & Coatings Association (NPCA) is similar to the NFPA 704 system in its use of colors and numbers (0 to 4) to quickly communicate the relative hazards. However, HMIS® labels have a different purpose. They're designed to help employers comply with OSHA's Hazard Communication Standard, not to provide critical information to emergency responders. As such, the ratings are different; they're not interchangeable with the NFPA 704 system. (HMIS® is a registered mark of the NPCA.)

The HMIS® label has three color bars: blue for health, red for flammability, and orange for physical hazards. Previous versions used yellow for reactivity, but the physical hazards category encompasses more (water reactive, organic peroxides, explosives, compressed gases, pyrophorics, oxidizers, and unstable reactives).



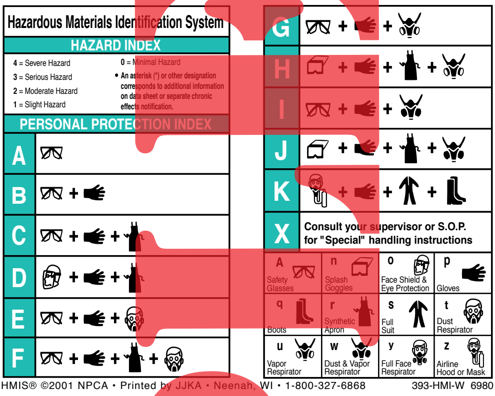
It's beyond the scope of this field guide to describe HMIS® labels in detail. However, the following are some other key features:

- The blue bar has two boxes: one for a numerical rating and one for an asterisk (*) if chronic health effects can result from repeated exposure.
- Icon stickers are used around the label to emphasize the target organs affected and the physical hazards (see below).
- Required PPE is indicated by a letter designation and icon stickers (see next page).



Icons for Target Organs and Physical Hazards

HMIS® (continued)



Letter Designations and Icons for Required PPE

Note: The letter designations for PPE are for normal workplace conditions and have nothing to do with the EPA Level A through D PPE designations used in emergency response.

Caution: HMIS® ratings are based on a 0-4 rating scale, with 0 representing minimal hazards or risk, and 4 representing significant hazards or risks. Although HMIS® ratings are not required on MSDSs under 29 CFR 1910.1200, the preparer may choose to provide them. HMIS® ratings are to be used with a fully implemented HMIS® program. HMIS® materials may be purchased exclusively from J. J. Keller. The ratings for the HMIS® labels are as follows:

Health Hazards Ratings

* – *Chronic Hazard.* Chronic (long-term) health effects may result from repeated overexposure.
0 – *Minimal Hazard*. No significant risk to health.
1 – *Slight Hazard*. Irritation or minor reversible injury possible.
2 – *Moderate Hazard*. Temporary or minor injury may occur.
3 – *Serious Hazard*. Major injury likely unless prompt action is taken and medical treatment is given.
4 – *Severe Hazard*. Life-threatening, major, or permanent damage may result from single or repeated overexposures.

(continued next page)

HMIS® (continued)

Flammability Ratings

0 – *Minimal Hazard*. Materials that will not burn.

1 – *Slight Hazard*. Materials that must be preheated before ignition will occur. Includes liquids, solids, and semi solids having a flash point above 200˚F. (Class IIIB)

2 – *Moderate Hazard*. Materials that must be moderately heated or exposed to high ambient temperatures before ignition will occur. Includes liquids having a flash point at or above 100˚F but below 200˚F. (Classes II & IIIA)

3 – *Serious Hazard*. Materials capable of ignition under almost all normal temperature conditions. Includes flammable liquids with flash points below 73˚F and boiling points above 100˚F, as well as liquids with flash points between 73˚F and 100˚F. (Classes IB & IC)

4 – *Severe Hazard*. Flammable gases or very volatile flammable liquids with flash points below 73˚F and boiling points below 100˚F. Materials may ignite spontaneously with air. (Class IA)

Physical Hazard Ratings

0 – *Minimal Hazard*. Materials that are normally stable, even under fire conditions, and will *not* react with water, polymerize, decompose, condense, or self-react. Non-explosives.

1 – *Slight Hazard*. Materials that are normally stable but can become unstable (self-react) at high temperatures and pressures. Materials may react non-violently with water or undergo hazardous polymerization in the absence of inhibitors.

2 – *Moderate Hazard*. Materials that are unstable and may undergo violent chemical changes at normal temperature and pressure with low risk for explosion. Materials may react violently with water or form peroxides upon exposure to air.

3 – *Serious Hazard*. Materials that may form explosive mixtures with water and are capable of detonation or explosive reaction in the presence of a strong initiating source. Materials may polymerize, decompose, self-react, or undergo other chemical change at normal temperature and pressure with moderate risk of explosion.

4 – *Severe Hazard*. Materials that are readily capable of explosive water reaction, detonation or explosive decomposition, polymerization, or self-reaction at normal temperature and pressure.

Military Markings

The military has its own marking system to identify detonation, fire, and special hazards.

The Markings

Materials are divided into four categories based on the relative detonation and fire hazards. The markings are shown below. (Note: The numbering scheme is opposite that of the NFPA 704 and HMIS® systems, where 4 represents the greatest hazard.)

Division	Hazard	DOT Equivalent
1	Mass detonation	Class 1.1
2	Explosion with fragments	Class 1.2
3	Mass fire hazard	Class 1.3
4	Moderate fire hazard	Class 1.4

Three additional symbols are used to indicate the following:

- Chemical hazard
  Red = toxic agents (e.g., sarin, mustard gas)
  Yellow = harassing agents (e.g., tear gas, smoke producers)
  White = white phosphorous
- Apply no water
- Wear protective mask or breathing apparatus

Other Key Points About Military Ordnance

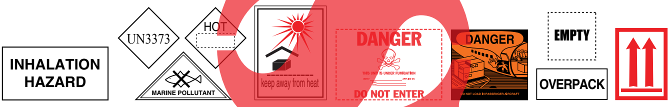
- Nearly all military ordnance are designed to cause significant damage to life and/or property. Use extreme caution.
- Military drivers may be under orders not to identify their cargoes. But if a military driver rapidly abandons the vehicle, it's a good clue that you should withdraw immediately. Use caution around *any* military vehicle involved in an accident or fire.
- Military shipments are sometimes transported in unmarked vehicles for security.

Other Marking Systems

It's beyond the scope of this book to cover all of the marking systems you might encounter. The following are some of the more common ones. If you are not familiar with a particular marking, seek assistance from a trained hazmat team, facility personnel, industry experts, CHEMTREC, or other resources.

Other Packaging and Transportation Markings

- "Inhalation Hazard" is used for materials that are hazardous by inhalation (e.g., anhydrous ammonia).
- The UN3373 label is for Category B infectious substances.
- "Marine Pollutant" is used on bulk packages of marine pollutants, except when the package contains other DOT placards (e.g., poison or flammable liquid) as appropriate.
- "HOT" signifies materials that are placed into transportation at elevated temperatures. (Exception: Bulk containers transporting molten aluminum or molten sulfur are stenciled with the word "molten" and the name of the product instead.)
- "Keep Away From Heat" can warn of self-reactive materials (Division 4.1) or organic peroxides (Division 5.2).
- The fumigant marking is used on transport vehicles or freight containers with lading that has been fumigated or is undergoing fumigation.
- "Cargo Aircraft Only" indicates a package intended for air transport, but restricted to cargo aircraft because the contents are prohibited on passenger aircraft or exceed the amount permitted on passenger aircraft.
- The "Empty" label is used for radioactive materials packaging that has been emptied of it contents as much as practical.
- "Overpack" signifies hazardous materials in an inner package.
- Package orientation markings can indicate liquid hazardous materials.
- "DOT-SP" or "DOT-E" (not shown) signifies a package authorized by special permit or exemption, respectively.
- Most nonbulk packages and some bulk containers are marked with the proper shipping name. Nonbulk packages may also contain the product's technical name.
- *See Chapter 4 for other container markings.*



Other Marking Systems (continued)

Agricultural Chemicals and Pesticide Labels

Labels on nonbulk packages containing agricultural chemicals and pesticides display a lot of information that can be used for identification and hazard assessment. This information may include, but is not limited to:

- Name of pesticide
- Pesticide classification (e.g., insecticide, rodenticide, organophosphate, carbamate, organochlorine)
- Signal words:
  - *Danger* (high toxicity) – with the word *Poison* and a skull and crossbones illustration if the product fits into the high toxicity category based on oral, inhalation, or dermal toxicity (as distinct from skin and eye irritation)
  - *Warning* (moderate toxicity)
  - *Caution* (relatively low toxicity)
- Flammability statement: *Extremely Flammable, Flammable, Combustible,* or *Contents Under Pressure*
- First aid statement or note to physician
- Precautionary statement (e.g., Keep Out of Reach of Children)
- Hazard statement (e.g., Environmental Hazard)
- Ingredients:
  - Active ingredients by name and percentage by weight
  - Inert ingredients in total percentage by weight (unless EPA requires a particular ingredient to be listed by name)
  - Information about arsenic content (if applicable)
- Environmental information
- EPA registration number (United States) or pest control product (PCP) number (Canada) – can be used to identify the product
- EPA establishment number

Packing Group Designations

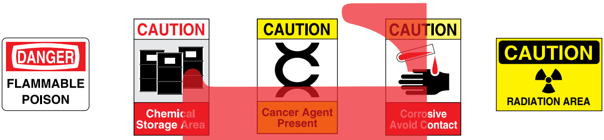
A packing group designation on shipping papers and labels, when applicable, also provides an indication of the degree of danger presented by the material:

Packing Group (PG)	Degree of Danger
I	Great
II	Medium
III	Minor

Other Marking Systems (continued)

Facility Signage (Required by OSHA)

Pay attention to signs posted in work areas of a facility. The following are just a few examples that warn of hazardous materials.



Pipeline Markers

Pipelines carrying hazardous materials must be identified. The pipeline marker must contain a signal word (e.g., *Warning*), product identity (or class), name of the pipeline company, and a 24-hour emergency telephone number. Look for pipeline markers where they intersect with a street or railroad track. However, know that markers are not always exact indicators of pipeline locations, and pipelines don't always follow a straight line between markers. Consider markers an approximate guide only until you get confirmation from the pipeline company.

Pipe Marking Systems

Many facilities in the U.S. and Canada follow the optional ANSI Standard A13.1-1996 for pipe identification.

Label Color	**Significance** *(per the 2007 ANSI standard)*
Yellow / Black	Flammable fluids
Orange / Black	Toxic and corrosive fluids
Brown / White	Combustible fluids
Green / White	Water (potable, cooling, boiler feed)
Blue / White	Compressed air
Red / White	Fire suppression materials

Caution: Under the old standard, yellow was used for all high-hazard materials, green was used for low-hazard liquids, and blue was used for low-hazard gases. And under the new standard, there are four user-defined label color combinations not listed above.

Caution: Other countries may use other colors (e.g., red labels for flammable materials, not fire suppression materials).

Globally Harmonized System (GHS)

GHS stands for the *Globally Harmonized System of Classification and Labelling of Chemicals*. It was developed as an international effort to standardize the way we classify chemicals and communicate health and safety information on labels and safety data sheets (SDS)—the equivalent of an MSDS.

The GHS is a voluntary system that can be adopted in whole or in part. However, to the extent that countries adopt the GHS into regulatory requirements, it will be binding on the regulated community.

It's beyond the scope of this book to cover the GHS in depth. However, the following pages highlight key points you should be aware of. (A brief overview of safety data sheets and how they differ from MSDSs is provided on page 14-14.)

Hazard Classes

There are three major hazard groups within the GHS:

- Health hazards
- Physical hazards
- Environmental hazards

Health hazards are divided into the classes listed below. Many of these classes are further divided into different categories based on set criteria, but the details are beyond the scope of this book.

- Acute toxicity
- Skin irritation/corrosion
- Serious eye damage/irritation
- Respiratory or skin sensitization
- Mutations in germ cells
- Cancer
- Reproductive toxicity
- Target organ systemic toxicity - single exposure
- Target organ systemic toxicity - repeated exposure
- Aspiration hazard
- Chemical mixtures

(continued next page)

Globally Harmonized System (GHS) (continued)

Hazard Classes (continued)

Physical hazards are divided into the classes below. Many of these classes are further divided into different categories based on set criteria, but the details are beyond the scope of this book.

- Flammable liquids
- Flammable solids
- Flammable gases
- Flammable aerosols
- Pyrophoric liquids
- Pyrophoric solids
- Self-heating substances
- Substances that, in contact with water, emit flammable gases
- Oxidizing liquids
- Oxidizing solids
- Oxidizing gases
- Organic peroxides
- Self-reactive substances
- Gases under pressure
- Explosive substances (liquid or solid) and explosive articles
- Corrosive to metals

Environmental hazards consist of chemicals that are hazardous to aquatic life. This class, too, is further divided into categories.

Signal Words and Precautionary Statements

The GHS uses two signal words to communicate hazard level. *Danger* represents a more severe hazard. *Warning* represents a lesser hazard. (The word *Caution* is not used in the GHS.)

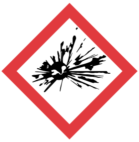
The GHS contains a "menu" of suggested standardized statements for use on labels. These statements fall under the major headings below. (The details are beyond the scope of this book.)

- General
- Prevention
- Response
- Storage
- Disposal

Globally Harmonized System (GHS) (continued)

GHS Pictograms

Under the GHS, each hazard class has specific red and black pictograms for use on labels and safety data sheets (SDS).

GHS Pictograms and Hazard Classes		
 Oxidizers	 Flammables Self-Reactives Pyrophorics Self-Heating Emits Flammable Gas Organic Peroxides	 Explosives Self-Reactives Organic Peroxides
 Acute Toxicity (severe)	 Corrosives	 Gases Under Pressure
 Carcinogen Respiratory Sensitizer Reproductive Toxicity Target Organ Toxicity Mutagenicity Aspiration Toxicity	 Environmental Toxcity	 Irritant Dermal Sensitizer Acute Toxicity (harmful) Narcotic Effects Respiratory Tract Irritation

GHS Labels

The GHS does not specify label format, but it does specify three standardized label elements: symbols (the pictograms above), signal words (*Danger* or *Warning*), and hazard statements (standard phrases assigned to a hazard class and category that describe the nature of the hazard).

Globally Harmonized System (GHS) (continued)

GHS Transport (Placard) Pictograms

This chart shows the GHS transport (placard) pictograms.

GHS Transport Pictograms		
 Flammable Liquid Flammable Gas Flammable Aerosol	 Flammable Solid Self-Reactive Substances	 Pyrophoric (spontaneously combustible) Self-Heating Substances
 Substances Which, in Contact with Water, Emit Flammable Gases (dangerous when wet)	 Oxidizing Gases Oxidizing Liquids Oxidizing Solids	 Explosives Divisions 1.1, 1.2, 1.3
 Explosive Division 1.4	 Explosive Division 1.5	 Explosive Division 1.6
 Compressed Gases	 Acute Toxicity (Poison): Oral, Dermal, Inhalation	 Corrosive
 Marine Pollutant	 Organic Peroxides	

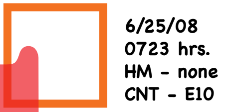
Urban Search & Rescue (US&R) Marking System

When hazmat or WMD incidents involve urban search and rescue operations, rescuers may use US&R marking systems. The following are from FEMA's September 2003 *National Urban Search and Rescue (US&R) Response System Field Operations Guide*.

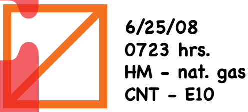
Structure/Hazards Evaluation Marking (FEMA)

Once the structure is assessed, make a large (2' x 2') square box with orange spray paint outside any accessible entrance. Use a carpenter crayon or lumber chalk to indicate the date, time, hazardous materials conditions, and team or company identifier.

Structure is accessible and safe for search and rescue operations. Damage is minor with little danger of further collapse.

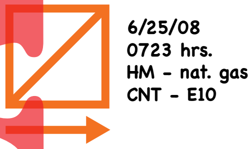


Structure is significantly damaged. Some areas are relatively safe, but other areas may need shoring, bracing, or removal of falling and collapse hazards.



Structure is not safe for search and rescue operations and may be subject to sudden additional collapse. Remote search operations may proceed at significant risk. If rescue operations are undertaken, safe haven areas and rapid evacuation routes should be created.

Arrow located next to a marking box indicates the direction to the safe entrance to the structure, should the marking box need to be made remote from the indicated entrance.



Once a hazard (e.g., natural gas) has been mitigated, draw a line through the HM notation and update the markings with the time and team/company identifier.

Urban Search & Rescue (US&R) Marking System (continued)

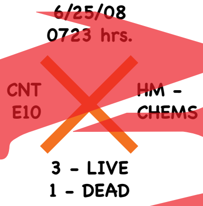
Search Assessment Marking (FEMA)

Use orange spray paint to denote the status of search and rescue operations. Draw a single slash (2' x 2') as you enter to indicate search operations in progress. Complete the “X” as you exit the structure, floor, room, or area.

When You Enter When You Exit

Use a carpenter crayon or lumber chalk to indicate additional information:

- Write the date and time you exited on top.
- Put your team or company identifier on the left.
- Note hazards on the right.
- Indicate the number of live and dead victims still inside the structure beneath the “X.” A “0” indicates no victims.



Be familiar with any variations your agency might use. Some agencies leave the victim area blank if no victims are located. Others use an “X” instead of “0.” Some note the number of victims *removed* from the structure in addition to any still inside. (Examples are provided on the following page.)

The location of victims inside a building must also be marked with spray paint, surveyor’s tape, flags, or other markers. And all markings must be updated when victims are removed. This prevents a duplication of efforts and helps keep responders safe.

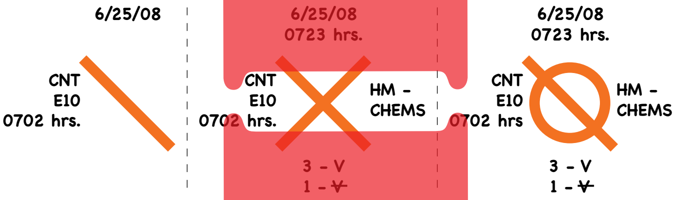
Urban Search & Rescue (US&R) Marking System (continued)

Other Markings (not FEMA)

The markings on this page are *not* part of FEMA's September 2003 *Field Operations Guide*, but other agencies have adopted them to communicate additional information. They're similar to the FEMA markings, with the following exceptions:

- Indicate entry time below the search team identifier.
- Use "V" to denote *live* victims, "~~V~~" to denote *dead* victims, and "X" to denote *no* victims.
- If you're unable to complete the search, draw a circle instead of completing the orange "X."

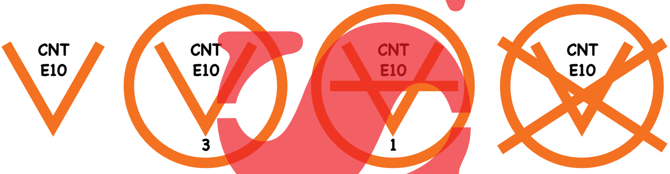
When You Enter | When You Exit Complete Search | When You Exit Incomplete Search



Use the markings below to identify victim locations:

- Draw a "V" indicate the location of *potential* victims.
- If victims are confirmed *alive*, draw a circle around the "V." Write the number of live victims below.
- If victims are confirmed *dead*, draw a circle around the "V" and a line through it. Write the number of dead victims below.
- If you find both live and dead victims, use both symbols.
- Use an "X" to indicate that *all* victims have been removed.
- If a victim's location is not immediately near where the markings are painted, use orange arrows to point toward the victim.

Potential Victim | Confirmed Alive | Confirmed Dead | All Victims Removed



Container Recognition

All first responders should have a basic understanding of some of the containers used to store or transport hazardous materials, their likely contents, and how different containers will behave in an emergency.

This chapter addresses container recognition, general safety considerations, and the hazards associated with specific containers. However, it is beyond the scope of this book to provide instructions for handling specific emergencies involving these containers. Refer to your department SOPs, the *Emergency Response Guidebook*, or other appropriate resources for more information.

Containers and Packages

Sometimes the shape of a container or package can give you a clue as to its contents. You should also be familiar with how different containers will behave in an emergency.

What This Chapter Covers

This chapter groups containers and packages as indicated below. Each part starts with general considerations that apply to all the containers in that group. It is important to review both this general information and the specific details that apply to the particular container in question.

- Nonbulk Packaging
- Bulk Packaging (other than those listed below)
- Intermodal Tanks
- Cargo Tanks
- Rail Cars
- Facility Containers
- Other Large "Vessels" (aircraft, ships/barges, and pipelines)

General Safety Considerations

- Container shape should be used for initial assessment only. Always confirm the container contents through labels, placards, shipping papers, material safety data sheets, facility preplans, and/or information from a responsible party.
- Small containers can be just as dangerous as large ones. The only difference is the size of the incident.
- Empty containers can be just as hazardous as full ones until they have been cleaned and purged. For example, a container with a residue of flammable liquid can still have vapors within the flammable range. There can also be a significant amount of vapor pressure within the container.
- Placards are not required when transporting less than 1001 pounds (454 kg) of a Table 2 commodity. (See page 3-7.)
- People do not always put chemicals in the proper containers. This is particularly a problem in private homes. It can also be a problem in other occupancies where people are not aware of storage regulations or choose to ignore them. Be especially careful with unlabeled containers and abandoned drums.
- Any container can be used to smuggle contraband (e.g., drugs or weapons). Be wary.

Containers and Packages (continued)

Container Failure

A container failure can significantly affect emergency response personnel and the surrounding community (life, environment, and property). The following is some important information to keep in mind about container failure.

- A container exposed to direct flame impingement is subject to failure. Severity of the failure varies depending on the type of container and the material inside.
- Most metal containers can BLEVE when heated if the internal pressure exceeds the capacity of the container or the safety relief device. (A BLEVE is a boiling liquid expanding vapor explosion.) Pressure vessels are particularly susceptible to BLEVE.
- Aluminum tanks will melt when exposed to fire. However, when they fail, they can do so rapidly, creating an immediate containment problem.
- Plastic containers melt when heated. Since plastic is made from hydrocarbons, it should be considered a fuel that will add to the fire load. Plastic will also release toxic vapors when burning.
- Overpressurized drums can fail catastrophically if disturbed even slightly. Be alert to signs of impending container failure (e.g., drums that have lost their original shape, drums with bulging ends, or drums exposed to high temperatures).
- Rusty drums are likely to fail if moved, since the metal might be severely weakened beneath the rust.
- Containers with crystals on the outside can be extremely sensitive to shock and friction. They should be treated as if they are potentially explosive. Call for assistance from a trained hazmat team and/or bomb squad.

As a general rule, you should not attempt to handle an incident involving containers that show signs of impending failure. Call for assistance from a trained hazmat team. There are times it may be safe to take offensive actions, such as cooling a container that is exposed to heat. However, the first priority is to ensure the safety of response personnel and nearby citizens. Consider an immediate withdrawal.

Nonbulk Packaging

The majority of hazmat incidents involve nonbulk packaging. But small containers can be just as dangerous as larger ones in an emergency. The only difference is the size of the incident.

What Is Nonbulk Packaging?

For the sake of simplicity, nonbulk packaging may be described as relatively small packages or containers. To be more specific, nonbulk packaging has maximum capacities as follows: liquids (119 gallons or 450 liters), solids (882 pounds or 400 kg), and gases (water capacity of 1000 pounds or 454 kg).

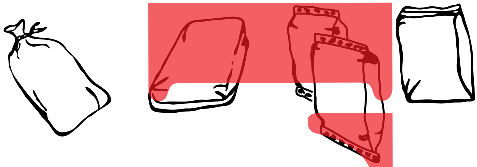
General Comments About Nonbulk Packaging

The next few pages provide a brief overview of various types of nonbulk packaging and some key points about each. The following are general comments that apply regardless of the type of container.

- People do not always put hazardous materials in the proper containers. This is true particularly in private homes where hazardous materials storage is not regulated. However, it can be a problem in any type of occupancy.
- Abandoned drums or other containers might contain anything. Be wary.
- Containers that show signs of impending failure can be very dangerous. Request assistance from a trained hazmat team.
- Container type or shape should be used for initial assessment only. Always confirm container contents through labels, placards, shipping papers, material safety data sheets, and/or information from a responsible party.
- Most nonbulk packages used for transportation of hazardous materials will contain a specification marking that CHEMTREC might be able to use to track the manufacturer and get more information when all else fails. However, this can be a long, difficult process and should be a last resort. Look for “DOT” or “UN” followed by some combination of numbers and letters.
- Containers used for pesticides and agricultural chemicals have several other important markings, including an EPA registration number that may be used to identify the product and signal words that indicate relative degree of toxicity: *danger* (high), *warning* (moderate), or *caution* (low). (See page 3-34.)

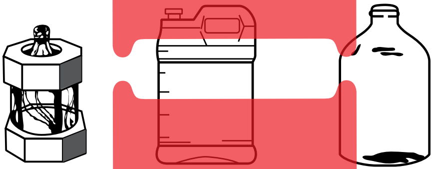
Nonbulk Packaging (continued)

Bags



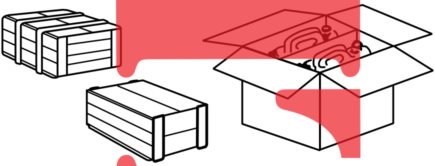
- Bags are used for solid materials such as fertilizers, pesticides, and caustic powders.
- They are made of cloth, burlap, kraft paper, plastic, or some combination of these materials.
- Often multiple bags are stored on pallets, which will contribute to the fuel load in a fire.
- *(See also the general comments on page 4-5.)*

Bottles



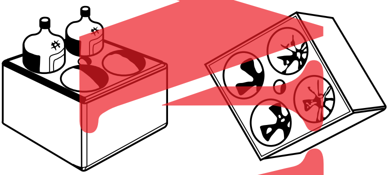
- Bottles are used for liquids and solids, including laboratory reagents, corrosive liquids, and antifreeze.
- Glass bottles do not often contain flammable liquids due to the risk of breakage, but flammable liquids are allowed in limited quantities in special circumstances.
- Brown bottles are commonly used for light-sensitive and reactive materials, such as organic peroxides.
- Bottles are usually made of glass or plastic, but they can also be made of metal or ceramic. They are usually placed inside boxes or other containers for transport.
- *(See also the general comments on page 4-5.)*

Boxes



- Almost any kind of hazardous material can be found inside boxes, since they are commonly used as outer packaging for other nonbulk packages. Boxes are used primarily for liquids and solids, but they can also contain small compressed gas cans or cylinders.
- Boxes can be made of a variety of materials, including fiberboard, wood, metal, plywood, or plastic.
- Fiberboard boxes can contain up to 65 pounds (29.5 kg) of material, whereas wooden boxes may hold up to 550 pounds (249 kg).
- Absorbent or vermiculite might be used to protect inner packaging and help absorb the contents in the event of breakage.
- *(See also the general comments on page 4-5.)*

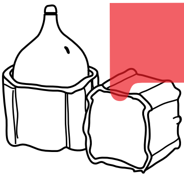
Multicell Packaging

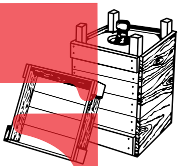


- Multicell packaging is used for liquid products like specialty chemicals, corrosives, and solvents.
- It consists of a form-fitting, expanded polystyrene box encasing one or more bottles.
- *(See also the general comments on page 4-5.)*

Nonbulk Packaging (continued)

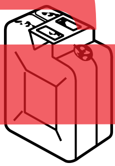
Carboys





- Carboys are used for liquids such as acids, bases, and water.
- They consist of glass or plastic “bottles” encased in outer packaging usually made from polystyrene or wood.
- *(See also the general comments on page 4-5.)*

Jerricans



- Jerricans are used for liquids such as antifreeze and other specialty products.
- They are made of metal or plastic.
- *(See also the general comments on page 4-5.)*

Nonbulk Packaging (continued)

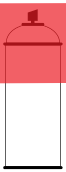
Cylinders (General Comments)

There are three types of cylinders: aerosol containers, uninsulated cylinders, and cryogenic (insulated) cylinders. The following are general comments that apply to all of them. Specific information on each is included on the next two pages.

- Cylinders are used for pressurized, liquefied, and dissolved gases.
- Service pressures range from a few psi (pounds per square inch) to several thousand psi.
- Most compressed gas cylinders are equipped with a pressure relief device to prevent rupture when exposed to fire. However, relief devices are not required on some of the smaller cylinders.
- Pressure relief devices are prohibited on cylinders containing highly toxic materials. Although this increases the risk of catastrophic failure in the event of a fire, it is considered a lesser threat than the potential for accidental discharge due to moderate increases in temperature or damage to the cylinder.
- Direct flame impingement can cause cylinders to fail catastrophically. Consider making an immediate withdrawal.
- If a cylinder is knocked over and the valve is damaged, the pressure of the gas escaping can propel the cylinder a considerable distance, much like a little rocket or missile. It can do a lot of damage to anything in its path. The larger the cylinder, the greater the danger.
- A liquid released from a pressure or cryogenic cylinder will expand significantly as it returns to its gaseous state. Flammable or toxic gases can travel a considerable distance from the source and greatly increase the scope of the incident.

Nonbulk Packaging (continued)

Aerosol Containers

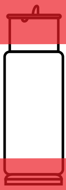


- Aerosol containers are used for hazardous materials such as cleaners, lubricants, paint, toiletries, and pesticides.
- They contain a propellant, which is often a flammable gas such as propane or butane.
- These small cylinders are made of metal, glass, or plastic and are often transported in boxes.
- *(See also the general comments on pages 4-5 and 4-9.)*

Uninsulated Cylinders

- Uninsulated cylinders are used for pressurized and liquefied gases, such as acetylene, LPG, chlorine, and oxygen.
- They are typically made of steel, but they can also be made of aluminum or fiberglass/aluminum composites.
- Sometimes a leak from a compressed gas cylinder can be slowed by rotating the container to where the leak is in the vapor space rather than in the liquid space. However, this should be done by first responders only if the chemical presents minimal risks and proper protective equipment is used. Otherwise, it should be left for a specially trained and equipped hazmat team.
- *(See also the general comments on pages 4-5 and 4-9.)*

Cryogenic (Insulated) Cylinders / Dewar Flasks



- Insulated cylinders are used for cryogenic liquids, such as liquid argon, helium, nitrogen, and oxygen (LOX).
- They consist of an insulated cylinder contained within an outer protective metal jacket. A Dewar flask (also known as a vacuum flask or thermos) uses a vacuum for thermal insulation. However, some cylinders combine a vacuum with other insulating materials.
- Cryogenic liquids are extremely cold (-130˚F/-90˚C or lower). Contact with cryogenic liquids can cause severe frostbite.
- These products have very high expansion ratios. A release can displace oxygen in the atmosphere and create an asphyxiation hazard, particularly in enclosed spaces or low-lying areas. In addition, hazardous gases can travel a considerable distance from the source and greatly increase the scope of the incident.
- These cylinders are subject to catastrophic failure if exposed to flame, radiant heat, or other high temperatures. If cylinders are exposed to flame, try to remove the source of the fire first. If it becomes necessary to use water to extinguish the fire, be careful not to spray water on the safety relief device. The escaping product will be cold enough to freeze the water and prevent the safety relief device from operating.
- If the cylinder has been damaged and the insulation compromised, there is an added danger of the product warming much faster as either it or the inner cylinder is exposed to ambient air, water (from rain or firefighting efforts), a fire, or heat from any other source. Dealing with a cryogenic cylinder under these conditions is generally beyond the scope of the first responder. Contact the manufacturer, a facility representative, industry experts, or a trained hazmat team for assistance.
- Some cryogenic liquids form extremely shock-sensitive mixtures when in contact with combustible materials (e.g., liquid oxygen on asphalt).
- *(See also the general comments on pages 4-5 and 4-9.)*

Nonbulk Packaging (continued)

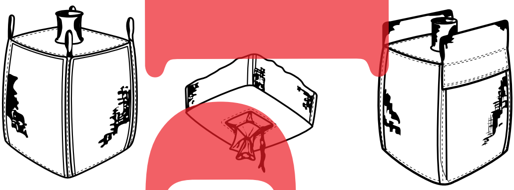
Drums

- Drums are used for a variety of liquids and solids, including lubricating grease, caustic powders, corrosive liquids, flammable solvents, and poisons. Content will depend on drum construction and chemical compatibility.
- Drums can be made of metal, plastic, fiberboard, or other suitable materials. They may contain plastic liners.
- The typical capacity is 55 gallons (208 liters), although some drums are smaller. Overpack drums used to hold damaged or leaking nonbulk packaging generally have a capacity of 85 gallons (322 liters).
- Some drums have removable heads. Others have closed heads and are loaded and unloaded through "bung holes."
- Some drums are equipped with safety relief devices.
- Overpressurized drums may fail catastrophically if disturbed even slightly. Be alert to signs of impending container failure (e.g., drums that have lost their original shape, drums with bulging ends, or drums exposed to high temperatures).
- Rusty drums may fail if disturbed.
- Plastic drums melt when exposed to fire. Since plastic is made from hydrocarbons, it should be considered a fuel that will add to the fire load. It will also release toxic vapors when burning.
- Sometimes a leak can be controlled by either uprighting a drum or rotating it to where the hole or crack is at the top. However, this should be done by first responders only if the chemical presents minimal risks and proper protective equipment is used. Otherwise, it should be left for a hazmat team.
- *(See also the general comments on page 4-5.)*

Bulk Packaging

The larger bulk packaging pictured on the following pages may be found on various transport vehicles or at fixed facilities. The first four are sometimes referred to as *intermediate* bulk containers, as distinguished from the larger bulk containers (e.g., cargo tanks, rail cars, and facility tanks).

Bulk Bags



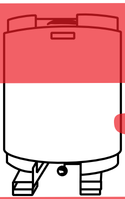
- Bulk bags are used for solid materials such as fertilizers, pesticides, and water treatment chemicals.
- They are constructed of flexible materials and may be plain, coated, or lined. They may be protected by a metal frame.
- Capacities range from 500 to 5000 pounds (227 to 2268 kg).
- They can be transported in both open and closed transport vehicles.

Portable Bins

- Portable bins are used for solid materials such as ammonium nitrate fertilizer and calcium carbide.
- They are approximately 4 feet (1.2 meters) square and 6 feet (1.8 meters) high and can contain up to 7700 pounds (3493 kg) of product.
- They are usually placed on flatbed trucks and trailers in agricultural areas.
- These bins are sometimes referred to as "totes."

Bulk Packaging (continued)

Nonpressure Portable Tanks



- These tanks are used for liquids such as water treatment chemicals, liquid fertilizers, and flammable solvents.
- They are approximately 6 feet (1.8 meters) high and have capacities of approximately 300 to 400 gallons (1136 to 1514 liters).
- They can contain internal pressures up to 100 psi.
- These tanks are sometimes referred to as "totes."

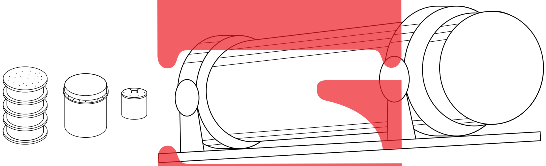
Ton Containers (One Tons)

Source: Union Pacific Railroad

- Ton containers are used for liquefied gases such as chlorine, sulfur dioxide, and phosgene.
- Because of the severe health hazards associated with these gases, first responders should not attempt to handle a leak from a ton container. Request assistance from a trained hazmat team. CHEMTREC is another good resource for assistance; it maintains a network of emergency response teams that deal with chemicals such as those transported in ton containers.
- Ton containers are cylindrical tanks approximately 8 feet (2.4 meters) long and 3 feet (1 meter) in diameter. The valves are located at one end under a protective cap.
- They are transported on both rail cars and trucks. They are also commonly found at water treatment facilities.
- Ton containers may also be referred to as "one tons," "one ton containers," "MC-110s," or "high-pressure drums."

Bulk Packaging (continued)

Radioactive Protective Overpacks and Casks



Small Packages and a Cask (Not to Scale)

- Radioactive materials are transported in a variety of packages, from small nonbulk containers to large casks. You should recognize radioactive packaging more by labels or placards than by container shape, because the containers can vary greatly and can be packed inside other boxes or crates.
- *Excepted packages* are used for materials with extremely low levels of radioactivity (e.g., smoke detectors). These packages range from cardboard boxes to sturdy wooden or steel crates.
- *Industrial packages* are used for materials with low levels of radioactivity (e.g., uranium or thorium ores and concentrates). Packages can be constructed of steel, wood, or fiberboard.
- *Strong-tight packages* are used for materials with low levels of radioactivity (e.g., natural uranium and contaminated rubble). Packages can be constructed of steel, wood, or fiberboard.
- *Type A packages* are used to transport small quantities of radioactive materials with somewhat higher concentrations of radioactivity (e.g., radiopharmaceuticals and low-level waste). They typically have three layers, the outer one constructed of fiberboard, wood, or metal. Type A packages are designed to protect and retain their contents under normal transport conditions and in minor accidents.
- *Type B packages*, used for materials with the highest level of radioactivity, range from steel drums to large, heavily shielded steel casks. Type B packages typically transport spent fuel, high-level radioactive waste, or high concentrations of some isotopes. Type B packages are designed to protect and retain their contents in minor and severe accidents conditions.
- *Type C packages* (authorized for international shipments but not for domestic use) are used for air transportation of materials with high levels of radioactivity. They're designed to withstand severe air transport accidents.
- Type B and C packages are the only ones that contain potentially life-endangering amounts of radioactive materials.

Intermodal Tanks

Intermodal tank containers are growing in popularity throughout the United States and abroad. They are named "intermodal" because they can be used interchangeably in two or more modes of transport (e.g., rail, highway, and water).

Each tank is contained within either a box-type or beam-type frame for easy handling and stacking during transportation. Most are about 20 feet (6.1 meters) in length, 8 or 8.5 feet (2.4 or 2.6 meters) wide, and 8 to 9.5 feet (2.4 to 2.9 meters) tall. Intermodal tanks generally carry up to 6340 gallons (24,000 liters) of bulk liquid. However, a release from a tank transporting a compressed or liquefied gas will fill a much greater volume due to the high expansion ratio.

General Incident Guidelines

In general, first responders should not attempt offensive control options for a hazmat incident involving intermodal tanks.

- View all incidents from a safe distance.
- Use binoculars to look for placards, tank markings, and other clues that indicate the presence of hazardous materials.
- Obtain the shipping papers if possible. A responsible party may bring you the shipping papers in an emergency, but you should know where they're normally located.
  - Highway incidents: The *bill of lading* is kept in the cab within easy reach of the driver, either in a pouch on the door or lying on the driver's seat.
  - Rail incidents: The *waybill* and/or *consist* is kept with the conductor or engineer, either on the engine or the caboose (if there is one).
  - Shipboard incidents: The *dangerous cargo manifest* is kept in a designated holder on or near a ship's bridge or in a readily accessible location on a barge (with a copy furnished to the person in charge of the towing vessel).
- Request assistance from the shipper, CHEMTREC, or a trained hazmat team. Provide an accurate, detailed description of placards, container shape and markings, condition of the tank, and circumstances of the incident.

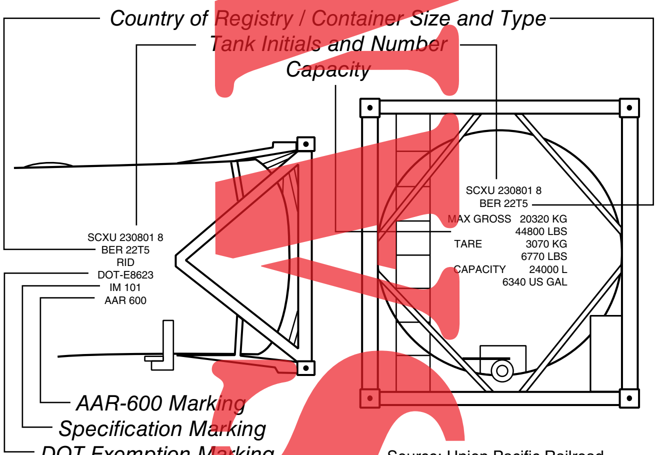
Intermodal Tanks (continued)

Intermodal Container Markings

The illustration below shows examples of the information that might be stenciled on intermodal tanks. It is beyond the scope of this field guide to go into detail as to what these markings mean. At the first responder level, it is more important that you know what to look for so that you can relay that information to the carrier or shipper, CHEMTREC, a trained hazmat team, or other resource. Don't hesitate to ask them for help if you need someone to walk you through how to find these markings.

- *Tank initials (reporting marks) and number* are stenciled on both sides and on both ends. The initials indicate who owns the tank; the number identifies the specific tank. By cross-referencing this information with shipping papers or computer databases, you (or the shipper or CHEMTREC) can determine the tank's contents.
- The *specification marking* can be found on both sides near the reporting marks. They indicate the standards to which the tank was built. This mark may begin with "IM" or "Spec," followed by a number. It can be used to determine the type of product being transported.

(continued next page)



Source: Union Pacific Railroad

Intermodal Tanks (continued)

Intermodal Container Markings (continued)

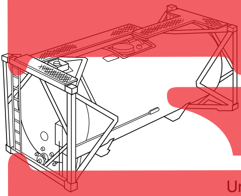
- A *DOT exemption marking* will be included if the material is being shipped under an exemption authorized by the DOT. It will be indicated by "DOT-E" marked on the container. (This will soon be replaced by "DOT-SP" to signify that the material is shipped by special permit.)
- An *AAR-600* marking may be included if the tank conforms to requirements specified by the Association of American Railroads (AAR). "AAR-600" means that the tank can be used for rail transportation of regulated materials, whereas "AAR-600NR" means that it cannot. (You may also see an RID marking if the container meets international standards for rail transport or an ADR marking if it meets international standards for both rail and highway transportation.)
- A two- or three-letter code identifies the tank's country of registry. This code is followed by four numbers that signify the container size and type.
- The *capacity stencil* should indicate in pounds the weight of the empty container, the maximum cargo weight the container is designed to carry, and the sum of both (container weight and maximum cargo weight). (Despite current regulations, it's possible to encounter older tanks stenciled with only two of the three required weights, as illustrated on the previous page.) The markings might also include the capacity in gallons or liters.
- A *dataplate* attached to the tank or frame provides additional technical, approval, and operational data. However, it might not be safe to get close enough to see the dataplate.
- *UN/DOT placards* are used to identify intermodal containers transporting hazardous materials.
- Some intermodal containers display a double orange panel, as shown on page 3-22. The bottom panel contains the product's 4-digit UN/NA identification number. The top panel contains a two-or three-digit *hazard identification code* (or hazard identification number).

The transport vehicles also contain identification numbers that can be used, with the aid of the shipper or CHEMTREC, to determine the products involved.

- Highway incidents: Look for the *vehicle identification number* or *license plate number* of the transport unit.
- Rail incidents: Note the *rail car number*.

Intermodal Tanks (continued)

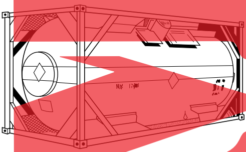
Nonpressure Intermodal Tanks



Source:
Union Pacific Railroad and NFPA

- Nonpressure intermodal tanks are used for liquid and solid materials, including flammables, corrosives, solvents, pesticides, and other toxics. They can also be used for alcohols, whiskey, and other food grade commodities.
- The maximum allowable working pressure for products transported in nonpressure intermodal tanks is 25.4 to 100 psi (IM 101) and 14.5 to 25.4 psi (IM 102).
- These tanks might be equipped with pressure/vacuum relief devices and/or rupture disks, depending on the product.
- *(See also the general comments on pages 4-16 to 4-18.)*

Pressure Intermodal Tanks

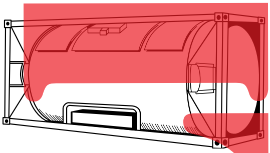


Source:
Union Pacific Railroad
and NFPA

- Pressure intermodal tanks (IMO Type 5 or DOT Spec 51) are generally used for gases liquefied under pressure, like LPG, chlorine, and anhydrous ammonia. They can also carry liquids like motor fuel antiknock compound or aluminum alkyls.
- They are designed for internal pressures of 100 psi to 500 psi.
- They present a serious BLEVE hazard if exposed to direct flame impingement. If an adequate water supply is not available to cool the tank within the first 10 minutes, consider making an immediate withdrawal to a distance of 1 mile.
- A rising sound from a venting relief device and discoloration of the tank due to fire are indications of an impending BLEVE.
- A liquid released from a pressure tank will expand significantly as it returns to its gaseous state. Gases can travel far from the source and greatly increase the scope of the incident.
- *(See also the general comments on pages 4-16 to 4-18.)*

Intermodal Tanks (continued)

Cryogenic Intermodal Tank Containers

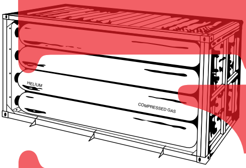


Source:
Union Pacific Railroad

- Cryogenic tanks (IMO Type 7) carry refrigerated liquefied gases, such as liquid argon, nitrogen, oxygen (LOX), and helium.
- These tanks should be handled much like pressure tanks for the purpose of emergency response.
- Cryogenic tanks are subject to catastrophic failure (BLEVE) if exposed to flame, radiant heat, or other high temperatures. If the tank is exposed to flame, try to remove the source of the fire first. If it becomes necessary to use water to extinguish the fire, be careful not to spray water on the safety relief device. The escaping product will be cold enough to freeze the water and prevent the relief device from operating.
- If the outer tank has been damaged and the insulation compromised, there is an added danger of the product warming much faster as it or the inner tank is exposed to ambient air, water, a fire, or heat from any other source. These conditions are generally beyond the scope of the first responder. Contact the shipper, CHEMTREC, and/or a hazmat team for assistance.
- Cryogenic liquids are time-sensitive and cannot be stored in these tanks for too long before they warm up and expand.
- The tanks can experience some normal venting as ambient temperatures cause the material to warm up and expand. Vapor “burping” from the relief value is usually not indicative of a problem, although it often causes concern from citizens.
- The cryogenic liquids are extremely cold (-130˚F/-90˚C or lower). Contact can cause severe frostbite injuries.
- These products have very high expansion ratios. A large release can displace oxygen in the atmosphere and create an asphyxiation hazard, particularly in enclosed spaces or low-lying areas. The gases can travel a considerable distance and greatly increase the scope of the incident.
- Some cryogenic liquids form extremely shock-sensitive mixtures when in contact with combustible materials (e.g., liquid oxygen on asphalt).
- *(See also the general comments on pages 4-16 to 4-18.)*

Intermodal Tanks (continued)

Tube Modules



Source: Union Pacific Railroad

- Tube modules are used for pressurized gases, such as helium, nitrogen, and oxygen.
- They consist of several seamless steel cylinders permanently mounted inside an open frame. The valves are enclosed in a compartment at one end.
- Service pressures can be as high as 5000 psi.
- Direct flame impingement can cause these cylinders to fail catastrophically. Consider making an immediate withdrawal.
- *(See also the general comments on pages 4-16 to 4-18.)*

Cargo Tanks

Some cargo tanks can hold up to 12,000 gallons (45,425 liters) of liquid. However, the release of a compressed or liquefied gas will fill a much greater volume due to the high expansion ratio.

Cargo Tank Markings and Features

The illustrations and descriptions in this book are generalizations only and should not be relied upon for positive identification. For example, many MC-306 or DOT-406 cargo tanks have an elliptical appearance from the rear, but some appear circular instead. Some cargo tanks have insulation that can hide distinguishing characteristics.

- Common tank markings include company names and logos, vehicle or tank identification numbers, license plate numbers, and UN/DOT placards.
- Some cargo tanks are stenciled with the commodity name for easy identification.
- Tank color, though not always a reliable indicator, can sometimes provide an additional clue about the type of product being transported. For example:
  - High-pressure tanks generally have at least the top two thirds painted white.
  - Corrosive tank trucks sometimes have a contrasting color band of corrosive-resistant paint or rubber material on the tank in line with the manway.
- A manufacturer's specification plate near the front of the tank (on either side) provides information about the tank design and construction. If information about the product is not available, it might be possible to determine what type of material is being transported based on the tank specifications.
- Most tanks transporting hazardous materials have a manual emergency valve control (EVC) or shutoff device located near the front left fender (driver's side). Some have two shutoff devices, one on each side of the trailer. Many of these devices have a fusible link that operates automatically in a fire.
- Tanks transporting hazardous materials must have shear or crash box protection for internal safety valves and rollover protection for the dome lid and vents on top. A tank without these safety features is most likely transporting a nonhazardous and/or food grade commodity.

General Incident Guidelines

In general, first responders should not attempt offensive control options for a hazmat incident involving cargo tanks. The following are some basic guidelines to supplement your department SOPs:

- View incidents from a safe distance.
- Use binoculars to look for placards or other clues that hazardous materials might be present.
- Obtain shipping papers from the driver if possible. The *bill of lading* is kept in the cab within easy reach of the driver. If the vehicle is unattended, the driver is supposed to leave shipping papers in a pouch on the door or lying on the driver's seat.
- Request assistance from the shipper, CHEMTREC, or a trained hazmat team. Provide an accurate, detailed description of placards, container shape and markings, condition of the tank, and circumstances of the incident.
- Whenever possible, use the truck driver or trucking company for technical assistance regarding vehicle operation.

Gasoline Tanker Incidents

Gasoline is the most common commodity transported on our nation's highways. It is generally transported in atmospheric pressure cargo tanks (MC-306 or DOT-406) as described on page 4-24. All fire departments should have procedures in place for dealing with fires or spills involving gasoline tankers.

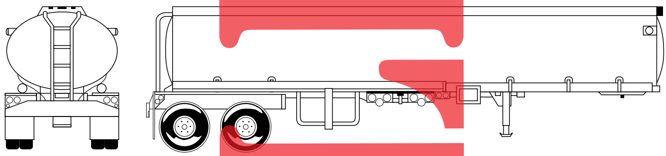
In the event of a **spill**, the priorities are to contain the product and prevent ignition *if safe to do so*:

- Eliminate ignition sources.
- Cover nearby storm drains.
- Dike the product.
- Use foam lines to suppress flammable vapors if appropriate.

Because water supplies are often limited at highway accidents, it might be necessary to let a gasoline **fire** burn and protect exposures instead. Firefighters must also weigh the risk of further spreading the fire by applying water or foam. Containing the product and any runoff water might be a higher priority than extinguishment.

Cargo Tank Trucks (continued)

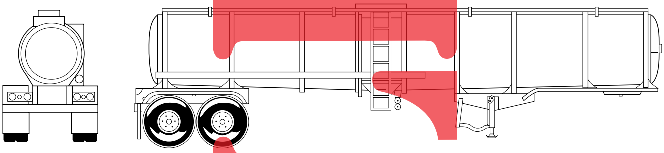
Atmospheric-Pressure (Nonpressure) Cargo Tanks (MC-306/DOT-406)



- Atmospheric-pressure cargo tanks (or nonpressure cargo tanks) are used to transport flammable liquids, such as gasoline, diesel or jet fuel, and kerosene, as well as combustible and poison liquids. However, some contain liquid food products.
- Over 90% of these tanks are constructed of aluminum, which is more susceptible to tears and punctures than comparable steel tanks are.
- Overturned aluminum tankers generally must be offloaded before being uprighted to avoid further container failure.
- Aluminum tanks will melt when exposed to flame and can fail rapidly, thereby creating a major containment problem.
- These tanks can contain up to 12,000 gallons (45,425 liters) of product. Some have multiple compartments, each with different products. Determine the number of compartments by counting the number of discharge valves.
- Up to 40 gallons (151 liters) of product can be in the bottom piping before the first delivery is made. In the event of a leak, try to determine if the product is coming from the tank or the bottom piping. It can make a difference in how the incident is handled and the resources required to mitigate it.
- Atmospheric-pressure cargo tanks are built to withstand only very low pressures—generally not more than 4 psi.
- Aluminum tanks may or may not be designed to support the weight of a full load resting on the landing gear. Never disconnect a tractor from a fully loaded aluminum shell tank without direction from the driver, tank manufacturer, or other reliable source. The landing gear may puncture the shell.
- Static electricity is a hazard with these tanks. Equipment must be bonded and grounded when transferring product.
- These tanks can also be referred to as MC-306 or DOT-406 depending on when they were constructed and the specifications to which they were built.
- *(See also the general comments on pages 4-22 and 4-23.)*

Cargo Tanks (continued)

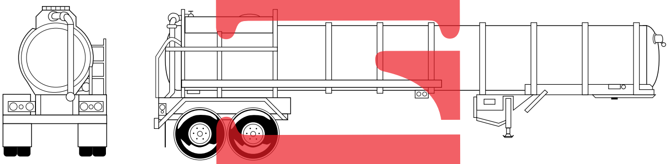
Low-Pressure Cargo Tanks (MC-307/DOT-407)



- Low-pressure cargo tanks are used to transport flammable and combustible liquids, mild corrosives, some poisons, and a wide variety of other liquids.
- Most of the tanks are constructed of stainless steel, which is harder but more brittle than comparable tanks made of mild steel or aluminum.
- Stainless steel begins to sustain damage at temperatures above 1200˚F (649˚C) and significant loss of strength at 1500˚F to 1600˚F (816˚C to 871˚C). Tanks constructed of any other type of steel will likely fail at comparable temperatures.
- Many of the tanks are insulated to protect temperature-sensitive commodities.
- Tank capacity is generally between 2000 and 7000 gallons (7570 and 26,498 liters) of product.
- Low-pressure cargo tanks are generally designed to withstand pressures of 25 to 35 psi.
- These tanks may or may not be compartmented.
- Some low-pressure cargo tanks have external stiffening rings, as illustrated above. However, many do not.
- These tanks can also be referred to as MC-307 or DOT-407 depending on when they were constructed and the specifications to which they were built.
- *(See also the general comments on pages 4-22 and 4-23.)*

Cargo Tanks (continued)

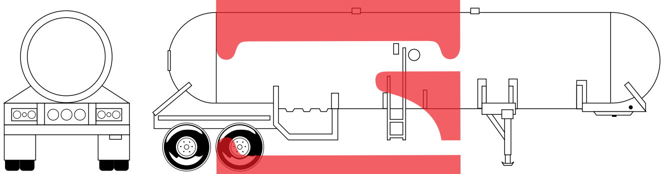
Corrosive Liquid Cargo Tanks (MC-312/DOT-412)



- Corrosive liquid cargo tanks are used to transport corrosive liquids and other heavy or high-density liquid products. They can also be used to transport water.
- Most are made of mild or stainless steel, though some are made of aluminum.
- Some corrosive liquid tanks are protected with a lining made of rubber, glass, or other materials.
- These tanks can contain up to 7000 gallons (26,498 liters) of product. They are generally built as a single compartment, but some have multiple compartments.
- Corrosive liquid cargo tanks are smaller than many other tanks because they carry heavier products.
- Corrosive liquid cargo tanks can generally be distinguished by circular cross sections and external stiffening rings that provide tank for added strength. However, some of these tanks have insulation or jackets that can conceal some of the distinguishing characteristics. (Other tanks may have external rings too, but these other tanks are larger in diameter than those used for corrosive liquids.)
- Corrosive liquid cargo tanks may have a contrasting color band of corrosive-resistant paint or rubber material that circles the tank in line with the manway.
- These tanks are generally designed to withstand minimum pressures of 5 to 25 psi.
- These tanks can also be referred to as MC-312 or DOT-412 depending on when they were constructed and the specifications to which they were built.
- *(See also the general comments on pages 4-22 and 4-23.)*

Cargo Tanks (continued)

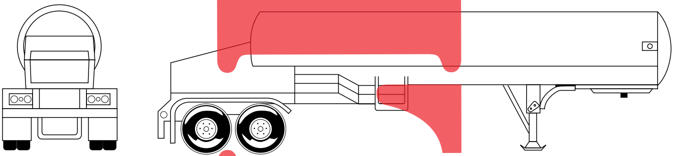
Pressure Cargo Tanks (MC-331)



- High-pressure cargo tanks are used to transport LPG, chlorine, anhydrous ammonia, and other gases that have been liquefied through compression.
- Most pressure cargo tanks are constructed of steel, which loses its tensile strength when exposed to high temperatures.
- Direct flame impingement on the vapor space of a pressure vessel can cause catastrophic failure (BLEVE). Large pressure vessels can fail within 10 to 20 minutes or even days after the container is first stressed. BLEVEs have been known to throw debris almost a mile (1.6 km). The greatest danger is generally at the ends of the tank, but there is still significant risk at the sides. If an adequate water supply is not available to cool the upper part of the tank (vapor space) and any areas of direct flame impingement within the first 10 minutes, consider making an immediate withdrawal to a distance of 1 mile (1.6 km).
- A rising sound from a venting relief device and discoloration of the tank due to fire are indications of an impending BLEVE. Withdraw immediately.
- A liquid released from a pressure cargo tank will expand significantly as it returns to its gaseous state. Hazardous gases can travel a considerable distance from the source and greatly increase the scope of the incident.
- Pressure cargo tanks have circular cross sections and rounded (spherical) heads. The upper two thirds are generally painted white or another reflective color to reflect heat from the sun.
- The tanks are required to have emergency remote shutoff devices at opposite ends of the trailer (front left and right rear).
- Tank capacity is generally between 2500 and 11,500 gallons (9464 and 43,532 liters) of liquid product.
- Pressure cargo tanks are designed to withstand pressures of 100 to 500 psi.
- These tanks can also be referred to as MC-331. The smallest ones are sometimes called *bobtails*.
- *(See also the general comments on pages 4-22 and 4-23.)*

Cargo Tanks (continued)

Cryogenic Liquid Cargo Tank (MC-338)



- Cryogenic liquid cargo tanks are used to transport gases that have been liquefied through temperature reduction. Examples include liquid oxygen (LOX), nitrogen, and argon.
- These tanks should be handled much like pressure tanks for the purpose of emergency response.
- Cryogenic cargo tanks are subject to catastrophic failure (BLEVE) if exposed to flame, radiant heat, or other high temperatures. If the tank is exposed to flame, try to remove the source of the fire first. If it becomes necessary to use water to extinguish the fire, be careful not to spray water on the safety relief device. The escaping product will be cold enough to freeze the water and prevent the relief device from operating.
- If the outer tank has been damaged and the vacuum and insulation compromised, there is an added danger of the product warming much faster as either it or the inner tank is exposed to ambient air, water (from rain or firefighting efforts), a fire, or heat from any other source. Dealing with a cryogenic tank under these conditions is generally beyond the scope of the first responder. Contact the shipper, CHEMTREC, and/or a trained hazmat team for assistance.
- Cryogenic liquids are time-sensitive and cannot be stored in cargo tanks for too long before they warm up and expand.
- The tanks usually experience some normal venting as ambient temperatures cause the material to warm up and expand. Vapor “burping” from the relief value is usually not indicative of a problem, although it often causes concern from citizens.
- These products have very high expansion ratios. A large release can displace oxygen in the atmosphere and create an asphyxiation hazard, particularly in enclosed spaces or low-lying areas. In addition, hazardous gases can travel a considerable distance and greatly increase the scope of the incident.

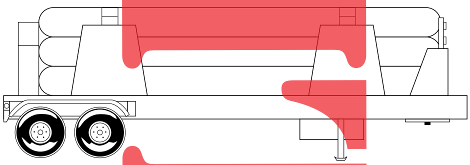
(continued next page)

Cryogenic Liquid Cargo Tank (continued)

- Cryogenic liquids are extremely cold (-130˚F/-90˚C or lower). Contact can cause severe frostbite injuries.
- Some cryogenic liquids form extremely shock-sensitive mixtures when in contact with combustible materials (e.g., liquid oxygen on asphalt).
- The vehicles usually have an inner steel tank surrounded by a vacuum insulation and a thin aluminum jacket. Fittings are contained in a cabinet at the center or rear of the truck.
- Cryogenic liquid cargo tanks can contain up to 9000 gallons (34,069 liters) of liquid product.
- Cryogenic liquid cargo tanks are generally designed to withstand pressures of 25.3 to 500 psi.
- The tanks are generally stenciled with the name of the product or the words “Refrigerated Liquid.”
- These tanks can also be referred to as MC-338.
- *(See also the general comments on pages 4-22 and 4-23.)*

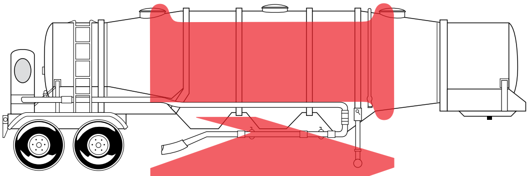
Cargo Tanks (continued)

Compressed Gas Trailer (Tube Trailer)



- Tube trailers carry multiple cylinders of compressed gases, such as oxygen, nitrogen, and hydrogen.
- Pressures range from 3000 to 5000 psi.
- Direct flame impingement can cause cylinders to fail catastrophically. Consider making an immediate withdrawal.
- These trailers are often found at construction and industrial sites.
- *(See also the general comments on pages 4-22 and 4-23.)*

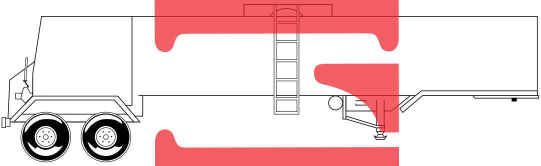
Pneumatically Offloaded (Dry Bulk) Hoppers



- Pneumatically offloaded hoppers, also known as dry bulk hoppers, carry dry materials such as ammonium nitrate fertilizer, dry caustic soda, plastic pellets, and cement.
- Many rollovers are caused by centrifugal force due to the very heavy loads these tanks carry.
- Static electricity is a common hazard with these cargo tanks. All equipment must be bonded and grounded when transferring product.
- *(See also the general comments on pages 4-22 and 4-23.)*

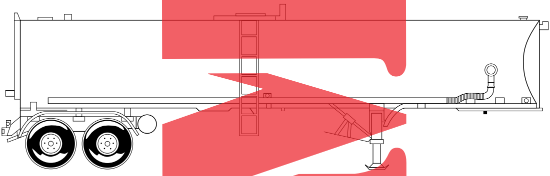
Cargo Tanks (continued)

Molten Sulfur Cargo Tanks



- Molten sulfur cargo tanks are hazardous primarily because the product is very hot (in excess of 250˚F/121˚C). It is not unusual for a fire to start once a spill occurs, because the sulfur runs down between the tank and the outer jacket, igniting the insulation.
- The tanks contain steel coils inside the shell to heat the sulfur.
- The tanks are required to be stenciled on the sides and ends with the words “Molten Sulfur.”
- *(See also the general comments on pages 4-22 and 4-23.)*

Asphalt Trailers

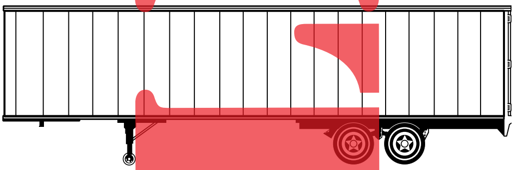


- Asphalt trailers transport asphalt cutback (a mixture of asphalt and a flammable or combustible liquid).
- Asphalt cutback may be regulated as a flammable liquid or a combustible liquid, depending on the flash point.
- These vessels consist of an inner tank covered by insulation and an outer jacket.
- Although these tanks do not have steam coils like the molten sulfur cargo tanks, some have burner tubes and carry propane bottles to fuel the burners.
- The tanks are required to be marked on each side and each end with the word “HOT” in black or white lettering on a contrasting background.
- *(See also the general comments on pages 4-22 and 4-23.)*

Cargo Tanks (continued)

Van Trailers and Trucks

Hazardous materials are often transported in nonbulk or bulk containers inside van trailers or trucks.



Source: Union Pacific Railroad

- Trailers and trucks may or may not be placarded, depending on the hazardous material and the quantity being transported.
- Even when a placard is required, there is no guarantee that the shipper or driver applied the placards or applied the correct placards. Assume that any van trailer or truck is transporting hazardous materials until proven otherwise.
- Van trailers and trucks might carry a mixed load of different chemicals. Check the shipping papers carefully.
- The contents of a trailer or truck can change over the course of a driver's route. The driver might deliver a partial load to a facility and pick up other materials or empty containers before going to the next destination. Always check with the driver to confirm that the shipping papers are accurate.
- It can be difficult to determine which container is leaking or how many containers are leaking because of the way they are arranged in the trailer or truck.
- *(See also the general comments on pages 4-22 and 4-23.)*

Delivery Trucks

Hazardous materials are sometimes transported in ordinary delivery trucks. These shipments may or may not be in compliance with 49 CFR. However, the trucks are not placarded. Often the driver does not know what he or she is carrying. There may be no shipping papers to indicate the presence of hazardous materials. This is where you need to be especially alert to clues that something isn't right. When in doubt, assume the worst and err on the side of safety. Request a trained hazmat team to manage the incident and identify the product(s) involved.

Rail Cars

Hazmat incidents involving rail cars are relatively infrequent. But when they do occur, they can be very serious because of the potential to have numerous cars damaged in a derailment and because of the quantity of material in each rail car—generally up to 34,500 gallons (130,597 liters) of liquid product, but some as high as 45,000 gallons (170,344 liters). A release from a rail car transporting a compressed or liquefied gas will fill an even greater volume due to the expansion ratio.

Most leaks are due to something as simple as a loose valve. Overpressurization incidents and derailments are less common.

General Incident Guidelines

In general, first responders should not attempt offensive control options for a hazmat incident involving rail cars. The following are some basic guidelines to supplement your department SOPs:

- View all rail car incidents from a safe distance.
- Use binoculars to look for placards, car markings, and other clues that might indicate the presence of hazardous materials.
- Be cautious around the locomotive. It is another source of hazardous materials, including powerful batteries and up to 6000 gallons (22,172 liters) of fuel.
- Request assistance from railroad personnel and a trained hazmat team. Provide them with an accurate description of placards, rail car shape and markings, condition of the rail car(s), and circumstances of the incident.
- Obtain the shipping papers (waybill and/or consist) if possible. They are kept with the conductor or engineer either on the engine or in the caboose (if there is one). The conductor or engineer should bring those papers to you in an emergency.
- If you haven't already identified a rail car's contents, check the Standard Transportation Commodity Code (STCC) number on the shipping papers. If this seven-digit number begins with 49, it signifies a hazardous material. If it begins with 48, it signifies hazardous waste. (It's beyond the scope of this book to provide further information on how to interpret the waybill or consist. If you need assistance, contact the shipper, railroad personnel, or your hazmat team.)

Rail Cars (continued)

Rail Car Markings

Some rail car markings are very similar to those found in other forms of transportation.

- Standard *UN/DOT placards* are used on rail cars. However, some particularly hazardous products (certain flammable gases, explosives, and poisons) are identified by setting the placard against a square white background.
- *Company names or logos* may be found on tank cars owned by the shipper or manufacturer.
- A *commodity stencil* (product name) is required for materials that are particularly hazardous. However, a shipper can also add it voluntarily. The commodity stencil, if present, will be on the right side of the tank as you face the car.

The illustrations on the following page show some of the other information stenciled on rail cars. It is beyond the scope of this book to go into detail as to what these markings mean. At the first responder level, it is more important that you know what to look for so that you can relay that information to railroad personnel or a trained hazmat team. Don't hesitate to ask them for help if you need someone to walk you through how to find these markings.

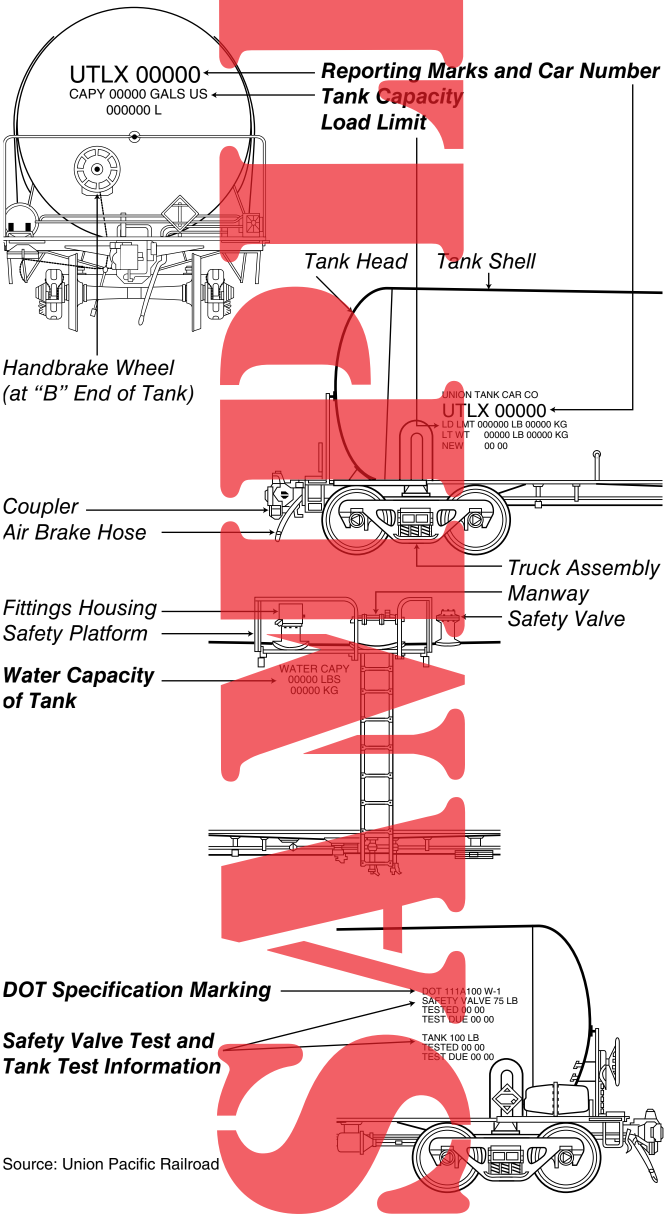
- *Reporting marks and number* are stenciled on both sides (left) and both ends of the tank. The reporting marks and number are now also being stenciled on the top so that a rail car can be identified if it is on its side after an accident. They can be used to obtain information about the contents from the railroad, shipper, or CHEMTREC.
- The *capacity stencil* found on the ends of the tank indicate the volume of the tank car. The load limit is stenciled on the sides below the reporting marks. Some cars have the water capacity (water weight) stenciled near the center of the car.
- The *specification marking* indicates the standard to which the tank was built. It will be stenciled on both sides (right) of the rail car. It also includes information on the tank test pressure.

Also shown on the next page are basic tank features. The ends of the tank are described as the A end and the B end. The B end is the end with the handbrake wheel. (Think "B" for brake).

(continued next page)

Rail Cars (continued)

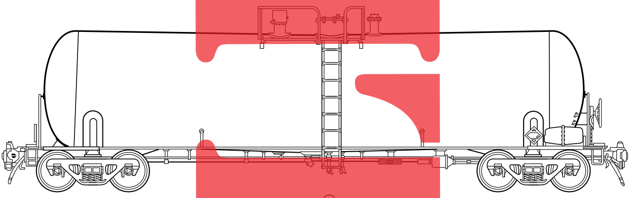
Rail Car Markings (continued)

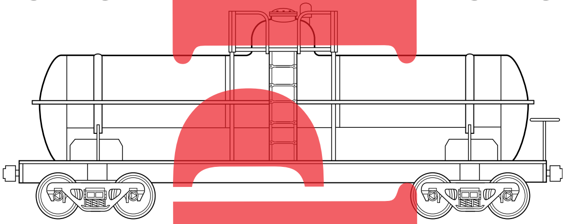


Source: Union Pacific Railroad

Rail Cars (continued)

Nonpressure Tank Cars (General Service or Low-Pressure)



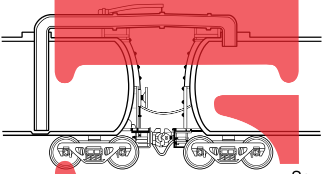


Source: Union Pacific Railroad and NFPA

- Nonpressure tank cars, also known as general service or low-pressure tank cars, transport a variety of hazardous materials, including flammable and combustible liquids, flammable solids, oxidizers, organic peroxides, poisons, corrosives, water-reactive products, and molten solids. They can also carry some flammable, nonflammable, and poison gases with low vapor pressures.
- Nonpressure tank cars also carry nonhazardous materials such as tallow, fruit juice, vegetable juice, tomato paste, corn syrup, and other food products.
- These tanks can generally be distinguished by at least one manway for access to the tank's interior and by visible fittings on top of the tank (upper illustration). Some have a bottom outlet valve underneath the car. Older nonpressure cars have at least one expansion dome with a manway (lower illustration).
- Tank test pressures range from 35 psi to 100 psi.
- Capacities range from 4000 to 45,000 gallons (15,142 to 170,344 liters).
- These tank cars can also be recognized by a specification marking that begins with any of the following: DOT-103, DOT-104, DOT-111, DOT-115, AAR-201, AAR-203, AAR-206, or AAR-211.
- *(See also the general comments on pages 4-33 to 4-35.)*

Rail Cars (continued)

Tank Train®

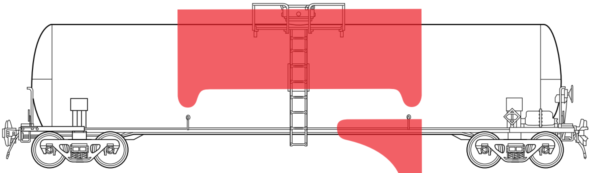


Source: Union Pacific Railroad

- The Tank Train® System transports fuel oil and pesticides.
- It is a series of nonpressure cars connected with flexible hoses to allow for loading and unloading the cars from one end.
- It has a spring-loaded butterfly valve arrangement on each car that is pneumatically controlled from the loading/unloading point.
- After loading, the hoses are purged of liquid and the valves close automatically, isolating each car.
- *(See also the general comments on pages 4-33 to 4-35.)*

Rail Cars (continued)

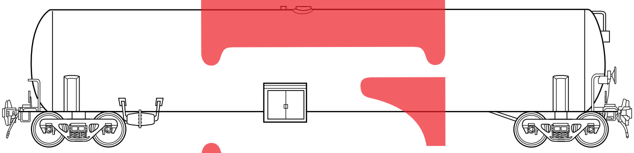
Pressure Tank Cars



Source: Union Pacific Railroad and NFPA

- Pressure tank cars transport flammable, nonflammable, or poison gases under pressure. Common examples include LPG, chlorine, and anhydrous ammonia. However, they can also transport other products, such as ethylene oxide, pyrophoric liquids, sodium metal, motor fuel antiknock compounds, bromine, anhydrous hydrofluoric acid, and acrolein.
- Tank pressures range from 100 to 600 psi.
- Capacities range from 4000 to 45,000 gallons (15,142 to 170,344 liters).
- Pressure tank cars typically have all fittings out of sight under a single protective housing on the top of the tank, unlike the nonpressure tank cars that have visible fittings or one or more expansion domes.
- Pressure tank cars will have some form of thermal protection: white paint on the top two-thirds of the tank, insulation, and/or jacketed thermal protection.
- Direct flame impingement on the vapor space can cause catastrophic failure (BLEVE). Large pressure vessels can fail within 10 to 20 minutes or even days after the container is first stressed. BLEVEs have been known to throw debris almost a mile (1.6 km). The greatest danger is generally at the ends of the tank, but there is still significant risk at the sides. If an adequate water supply is not available to cool the upper part of the tank (vapor space) and any areas of direct flame impingement within the first 10 minutes, consider making an immediate withdrawal to a distance of 1 mile (1.6 km).
- A liquid released from a pressure tank will expand significantly as it returns to its gaseous state. Flammable or toxic gases can travel a considerable distance from the source and greatly increase the scope of the incident.
- These tank cars can also be recognized by a specification marking that begins with any of the following: DOT-105, DOT-109, DOT-112, DOT-114, or DOT-120.
- *(See also the general comments on pages 4-33 to 4-35.)*

Cryogenic Liquid Tank Cars



Source: Union Pacific Railroad and NFPA

- Cryogenic liquid tank cars contain gases that have been liquefied through temperature reduction. Examples include liquid oxygen (LOX), nitrogen, hydrogen, ethylene, and argon.
- These tanks should be handled much like pressure tanks for the purpose of emergency response.
- These tanks are subject to catastrophic failure (BLEVE) when exposed to flame, radiant heat, or other high temperatures. If the tank is exposed to flame, try to remove the source of the fire first. If it becomes necessary to use water to extinguish the fire, be careful not to spray water on the safety relief device. The escaping product will be cold enough to freeze the water and prevent the safety relief device from operating.
- If the outer tank has been damaged and the vacuum and insulation compromised, there is an added danger of the product warming much faster as either it or the inner tank is exposed to ambient air, water (from rain or firefighting efforts), a fire, or heat from any other source. Dealing with a cryogenic tank under these conditions is generally beyond the scope of the first responder. Contact the shipper, a railroad representative, CHEMTREC, and/or a trained hazmat team for assistance.
- Cryogenic liquids are time-sensitive and cannot be stored in tank cars for too long before they warm up and expand.
- These products have very high expansion ratios. A large release can displace oxygen in the atmosphere and create an asphyxiation hazard, particularly in enclosed spaces or low-lying areas. In addition, hazardous gases can travel a considerable distance and greatly increase the scope of the incident.
- Some cryogenic liquids form extremely shock-sensitive mixtures when in contact with combustible materials (e.g., liquid oxygen on asphalt).

(continued next page)

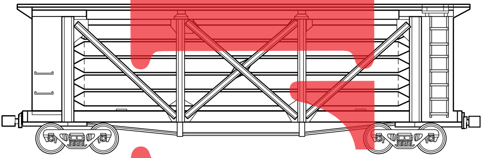
Rail Cars (continued)

Cryogenic Liquid Rail Cars (continued)

- Cryogenic liquids are extremely cold (-130˚F/-90˚C or lower). Contact can cause severe frostbite injuries.
- These tanks are actually a tank within a tank, with insulation and a vacuum space between the two.
- Cryogenic liquid tank cars can be recognized by a ground-level cabinet that houses all the fittings.
- The tanks are generally stenciled with the name of the product or the words “Refrigerated Liquid.”
- These tank cars can also be recognized by a specification marking that begins with DOT-113 or AAR-204W.
- *(See also the general comments on pages 4-33 to 4-35.)*

Rail Cars (continued)

High-Pressure Tube Cars



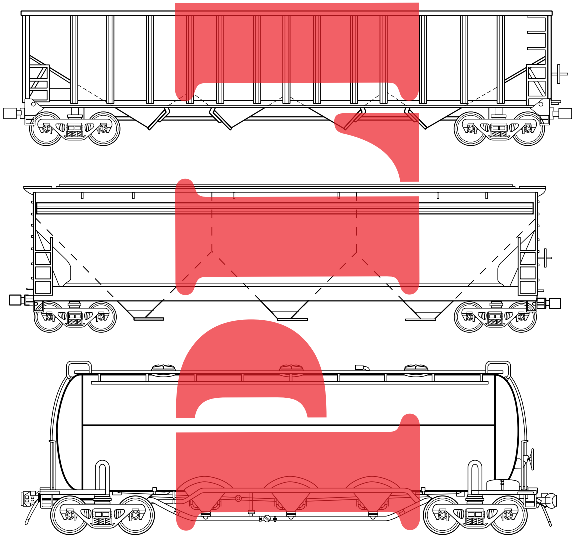
Source: Union Pacific Railroad

High-pressure tube cars have been mostly phased out in recent years, but this page is included so that you'll have information about high-pressure tube cars should you encounter one.

- Tube modules are used for pressurized gases, such as helium, hydrogen, and oxygen.
- These units were designed with 30 seamless steel cylinders permanently mounted inside an open frame car. Loading and unloading fittings and safety devices are located in a walk-in cabinet at the end of the car.
- Test pressures of these cylinders range from 3000 to 5000 psi.
- The few high-pressure tube cars that transport flammable gases have safety relief devices that are equipped with ignition devices which automatically burn off any released vapors.
- Direct flame impingement can cause these cylinders to fail catastrophically. Consider making an immediate withdrawal.
- These tank cars can also be recognized by a specification marking that begins with DOT-107.
- *(See also the general comments on pages 4-33 to 4-35.)*

Rail Cars (continued)

Hopper Cars



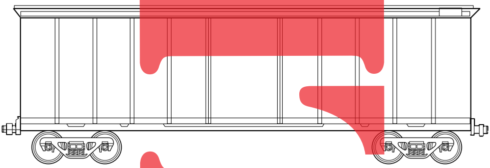
Source: Union Pacific Railroad

Hopper Car (top), Covered Hopper Car (middle), Pneumatically Unloaded Covered Hopper Car (bottom)

- All of these hopper cars carry dry products.
- The first hopper car shown above can be either open or closed on top. It is used for bulk commodities, such as coal.
- Covered hoppers can carry nonhazardous materials (such as cement and grain) or hazardous materials (such as arsenic acid, ammonium nitrate, sodium hydroxide, and calcium carbide). Some of these materials are water-reactive.
- Pneumatically unloaded covered hopper cars frequently transport hazardous materials such as ammonium nitrate fertilizer, dry caustic soda, and adipic acid. Some of these are water-reactive. These cars are unloaded by air pressure.
- The pneumatically unloaded covered hopper cars can also be recognized by a specification marking that begins with AAR-207.
- *(See also the general comments on pages 4-33 to 4-35.)*

Rail Cars (continued)

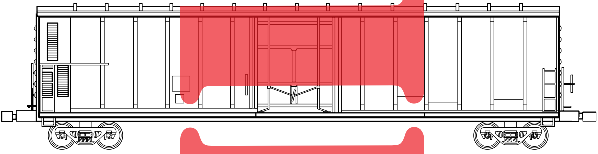
Box Cars



Source: Union Pacific Railroad

- Box cars can carry nonbulk and bulk packages of chemicals, but they are also used to transport nonhazardous materials.
- *(See also the general comments on pages 4-33 to 4-35.)*

Refrigerator Cars

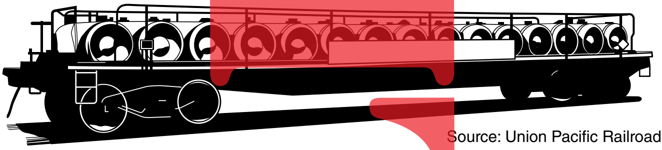


Source: Union Pacific Railroad

- Refrigerator cars are designed to handle commodities that require heating or cooling during transport.
- Although they generally do not transport hazardous materials, they do run on chemicals that can become a problem in an emergency.
- Diesel power units provide power to operate the cooling system. These units can act as ignition sources in flammable atmospheres. Refrigerator cars also carry up to 500 gallons (1893 liters) of diesel fuel that can be a fire hazard in the event of an accident.
- Some cars are cooled by cryogenic liquids that are stored in the area where the diesel power units are normally located.
- Refrigerated cars typically carry Freon or carbon dioxide in their cooling systems. Freon can produce toxic phosgene gas when burning.
- These cars look similar to box cars, but can be differentiated by the refrigeration equipment enclosed at one end of the car.
- *(See also the general comments on pages 4-33 to 4-35.)*

Rail Cars (continued)

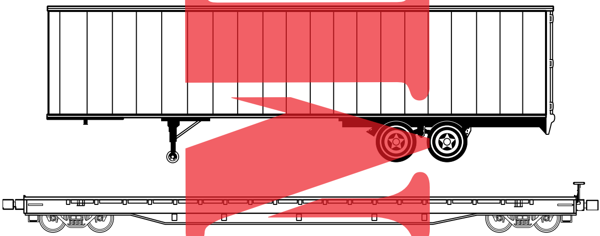
Multiunit Tank Car Tanks



Source: Union Pacific Railroad

- Multiunit tank cars transport ton containers (sometimes referred to as "one tons," "MC-110s," or "high-pressure drums") with liquefied gases such as chlorine, sulfur dioxide, and phosgene.
- Because of the severe health hazards associated with such gases, first responders should not attempt to handle an incident involving ton containers. Request assistance from a trained hazmat team or CHEMTREC.
- These tanks may contain a specification marking that begins with DOT-106 or DOT-110.
- *(See also the general comments on pages 4-33 to 4-35.)*

Trailers and Containers on Flat Cars



Source: Union Pacific Railroad

A Fifth-Wheel Trailer and a Flat Car

Hazardous materials are also transported in various types of containers loaded onto flat cars. A trailer-on-flat-car (TOFC) is an ordinary fifth-wheel trailer that can be towed by a tractor unit on the highway. A container-on-flat-car (COFC) may be a box type unit or an intermodal container without wheels. Some containers can be double-stacked (two units high). Refer to the information on trailers (page 4-32) or intermodal containers (pages 4-16 to 4-21) for more information.

Facility Containers

Hazardous materials can be found at fixed facilities in many types of containers. The next few pages will focus only on large storage tanks and piping systems, since nonbulk and smaller bulk packages were covered earlier in this chapter.

The capacity of these tanks can range from a few hundred gallons or liters to millions of gallons or liters, depending on the facility. A release from a tank containing a compressed or liquefied gas will fill an even greater volume due to the high expansion ratios.

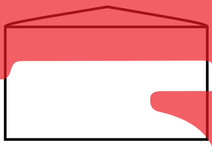
General Incident Guidelines

In general, first responders should not attempt offensive control options for a hazmat incident involving large storage tanks. The following are some basic guidelines to supplement your department SOPs:

- Evacuate the facility as appropriate. Whenever possible, use site evacuation alarms and paging systems rather than enter a potentially contaminated area. Work with facility personnel to determine if everyone has been accounted for.
- Identify the product and quantity through markings on the tank (NFPA 704 system, tank number, stencilling, signs, etc.), MSDSs, information from on-site personnel, and/or facility preplans.
- Request assistance from a trained hazmat team. Provide an accurate, detailed description of placards, container shape and markings, condition of the tank, and circumstances of the incident.
- Dike around the area if appropriate. Large facility tanks are required to have secondary containment sufficient to hold both the product and a limited amount of firefighting water. However, in a prolonged fire, it might be necessary to contain the additional overflow.
- Let fixed suppression systems do their job. It's usually far safer than trying to put the fire out yourself.
- Don't underestimate empty tanks. Empty tanks can be just as hazardous as full ones (if not more so) unless they have been cleaned or purged. They can contain dangerous levels of flammable or toxic vapors. There can also be a significant amount of vapor pressure within the tank.

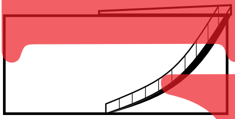
Facility Containers (continued)

Atmospheric (Nonpressure) Fixed-Roof Tanks



- Atmospheric fixed-roof tanks store flammable, combustible, or corrosive liquids.
- Many have weak roof-to-shell seams that are designed to fail when internal pressure becomes too high (e.g., if exposed to fire).
- Roofs that are designed to fail in a fire might also fail if excess weight is applied (e.g., people walking on the tank roof).
- If the roof fails during a fire involving crude oil, there is a danger of a violent boilover caused by steam expansion beneath the hot oil. This requires a combination of the right conditions: a fuel with a wide range of boiling points, the roof being off, and water at the bottom of the tank. It generally takes a few hours to develop. However, boilovers are extremely dangerous, and the risk should not be underestimated. There are documented incidents where numerous lives have been lost. Follow your department SOPs. Consider evacuating to a distance of at least 1/2 mile (0.8 km) in a fire.
- *(See also the general comments on page 4-45.)*

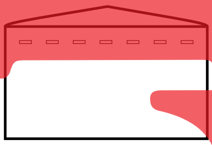
Open-Top Floating Roof Tank



- Floating roof tanks store flammable and combustible liquids that readily vaporize.
- The floating roof is designed to move up and down on top of the liquid to limit the vapor space and reduce the risk of a fire.
- Seal (gasket) fires can be very dangerous. It is easy to get trapped when fighting a fire, since there is only one way off the roof. Stay off the roof and use aerial apparatus to fight the fire if possible.
- Putting too much water on the roof in a fire can compound the problem. The weight of the water on top of the roof can sink the roof and turn a seal fire into a full surface fire.
- If an open-topped tank of crude oil is burning, there is a danger of a violent boilover caused by steam expansion beneath the hot oil. This requires a combination of the right conditions: a fuel with a wide range of boiling points, the roof being off, and water at the bottom of the tank. It generally takes a few hours to develop. However, boilovers are extremely dangerous, and the risk should not be underestimated. There are documented incidents where numerous lives have been lost. Follow your department SOPs. Consider evacuating to a distance of at least 1/2 mile (0.8 km) in a fire.
- An open-top floating roof tank can be a confined space and should be treated as such. Follow your department SOPs for confined space operations. Do not walk on a floating roof.
- *(See also the general comments on page 4-45.)*

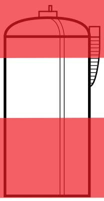
Facility Containers (continued)

Covered Floating Roof Tanks



- Covered floating roof tanks contain flammable and combustible liquids.
- They have a fixed roof with an internal floating roof underneath.
- The covered floating roof tanks can be distinguished by large vents at the top of the tank shell.
- *(See also the general comments on page 4-45.)*

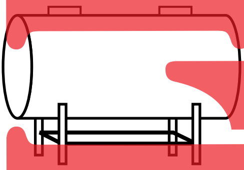
Vertical Dome Roof Tanks



- Vertical dome roof tanks contain flammable and combustible liquids, fertilizers, chemical solvents, etc.
- They operate at pressures of 2.5 to 15 psi.
- The fixed dome roof might be designed to fail in a fire.
- *(See also the general comments on page 4-45.)*

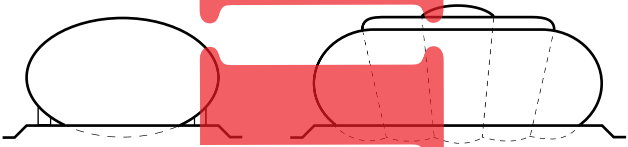
Facility Containers (continued)

Low-Pressure Horizontal Tanks



- Low-pressure horizontal tanks can contain flammable and combustible liquids, corrosives, or poisons.
- A horizontal tank mounted on unprotected steel supports or stilts can fail quickly during fire conditions. Failure of these supports or stilts can cause the tank to collapse and rupture.
- *(See also the general comments on page 4-45.)*

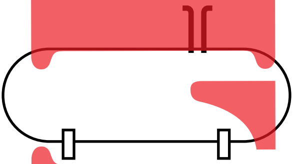
Spheroid and Noded Spheroid Tanks



- Spheroid and noded spheroid tanks are low-pressure storage tanks used to store liquid petroleum gas (LPG), methane, propane, and some flammable liquids, such as gasoline and crude oil.
- *(See also the general comments on page 4-45.)*

Facility Containers (continued)

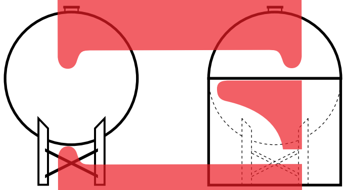
High-Pressure Horizontal Tanks



- High-pressure horizontal tanks contain gases under pressure, such as liquefied petroleum gas (LPG), liquefied natural gas (LNG), anhydrous ammonia, chlorine, sulfur dioxide, and hydrogen chloride.
- These tanks are easy to identify by their rounded (spherical) ends, a pressure relief device, and their white or other highly reflective color.
- Direct flame impingement on the vapor space can cause catastrophic failure (BLEVE). The greatest danger is generally at the ends of the tank, but there is still significant risk at the sides. If an adequate water supply is not available to cool the upper part of the tank (vapor space) and any areas of direct flame impingement within the first 10 minutes, consider making an immediate withdrawal to a distance of 1/2 to 1 mile (0.8 to 1.6 km), depending on the size of the tank.
- A liquid released from a pressure horizontal tank will expand significantly as it returns to its gaseous state. Hazardous gases can travel a considerable distance from the source, greatly increasing the scope of the incident.
- These tanks are generally designed for pressures of 100 to 500 psi. However, a few tanks are designed for pressures of several thousand psi.
- The tanks might have deluge systems for fire protection.
- *(See also the general comments on page 4-45.)*

Facility Containers (continued)

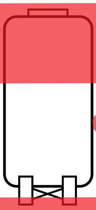
High-Pressure Spherical Tanks



- High-pressure spherical tanks contain gases under pressure, such as LPG or vinyl chloride.
- These tanks are easy to identify by their ball-like shape, a pressure relief device on the top, and their white or other highly reflective color. Some have a layer of sheet metal surrounding the lower half.
- Direct flame impingement on the vapor space can cause catastrophic failure (BLEVE). If an adequate water supply is not available to cool the upper part of the tank (vapor space) and any areas of direct flame impingement within the first 10 minutes, consider making an immediate withdrawal to a distance of 1 mile (1.6 km).
- A liquid released from a pressure tank will expand significantly as it returns to its gaseous state. Hazardous gases can travel a considerable distance from the source, greatly increasing the scope of the incident.
- These tanks are generally designed for pressures of 100 to 500 psi. However, a few tanks are designed for pressures of several thousand psi.
- The tanks might have deluge systems for fire protection.
- *(See also the general comments on page 4-45.)*

Facility Containers (continued)

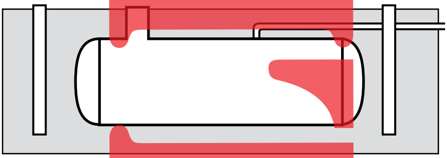
Cryogenic Liquid Tanks



- Cryogenic liquid tanks contain gases that have been liquefied through temperature reduction. Examples include liquid oxygen (LOX), nitrogen, argon, and carbon dioxide.
- These tanks should be handled much like pressure tanks for the purpose of emergency response.
- These tanks are actually a tank within a tank, with insulation and a vacuum space between the two. They rest on legs to help insulate the product from the warmer ground surface.
- These tanks are subject to catastrophic failure (BLEVE) when exposed to flame, radiant heat, or other high temperatures. If tanks are exposed to flame, try to remove the source of the fire first. If it becomes necessary to use water to extinguish the fire, be careful not to spray water on the safety relief device. The escaping product will be cold enough to freeze the water and prevent the safety relief device from operating.
- If the tank has been damaged and the vacuum and insulation compromised, there is an added danger of the product warming much faster as either it or the inner tank is exposed to ambient air, water (from rain or firefighting efforts), a fire, or heat from any other source. These conditions are generally beyond the scope of the first responder. Contact a facility representative, industry experts, CHEMTREC, and/or a hazmat team for assistance.
- The cryogenic liquids are extremely cold (-130˚F/-90˚C or lower). Contact can cause severe frostbite injuries.
- These products have very high expansion ratios. A large release can displace oxygen in the atmosphere and create an asphyxiation hazard, particularly in an enclosed space. In addition, hazardous gases can travel a considerable distance and greatly increase the scope of the incident.
- Some cryogenic liquids form extremely shock sensitive mixtures when in contact with combustible materials (e.g., liquid oxygen on asphalt).
- *(See also the general comments on page 4-45.)*

Facility Containers (continued)

Underground Storage Tanks



- Underground storage tanks store primarily petroleum products.
- They might be entirely or partially underground. (Any tank with greater than 10% of its surface area underground is considered an underground tank.)
- Visible clues that indicate the presence of an underground tank are vents, fill points, and the type of occupancy (e.g., service stations).
- Tanks that are completely underground are protected from fire and mechanical damage, unlike their aboveground counterparts.
- Underground tanks are more subject to corrosion and can develop leaks that can go undetected unless they have proper double containment and monitoring systems.
- *(See also the general comments on page 4-45.)*

Facility Containers (continued)

Piping Systems

Many facilities have hazardous materials running through piping systems. A burst pipe, a loose fitting, or a worn or missing gasket can cause tremendous problems. It may or may not be possible for first responders to get a good look at what is leaking. These pipes can be hidden either behind walls or above ceilings or located someplace within the building where it is unsafe to enter without chemical protective clothing.

The following are some general guidelines to supplement your department SOPs:

- Request assistance from a trained hazmat team and facility personnel responsible for these systems.
- Evacuate areas of the facility as appropriate. Work with facility personnel to determine if everyone has been accounted for.
- Whenever possible, use site evacuation alarms and paging systems rather than enter a potentially contaminated area.
- Obtain information about the product through facility preplans or detail drawings, information from on-site personnel, labels on the pipes, remote monitoring or alarm systems, and/or material safety data sheets.
- Determine if any on-site personnel were able to observe the leak. Try to get information about the location and nature of the leak so that the hazmat team is better able to plan its mitigation actions.

Other Large "Vessels"

Aircraft, ships or barges, and pipelines can also hold large quantities of hazardous materials. Like any other vessel or container, they can fail due to mechanical damage or fire.

It is beyond the scope of this book to provide detailed information as to how to deal with these incidents. Each agency should have plans in place for responding to aircraft, ship, and pipeline incidents as applicable to the particular jurisdiction. The following pages contain some general guidelines to help you get started.

Other Large "Vessels" (continued)

Aircraft

Most aircraft are limited in the amount of hazardous materials they can transport. The military is an exception. The biggest hazard, however, is the large quantity of fuel used to fly the plane. There can be as much as 60,000 gallons (227,125 liters) of fuel, depending on the particular aircraft. Other hazardous materials include fuel mixtures containing products such as hydrazine, ammonia, hydrogen, and aniline; hydraulic fluids; deicing fluids; and oxygen in either gas or liquid (LOX) form.

Any department that has an airport in its jurisdiction or is located in a flight path should have emergency plans in place to deal with an aircraft incident. As a general rule, due to the high life hazard, first responders will be required to take some offensive actions at the scene of an aircraft accident. The following are some basic guidelines to supplement your department SOPs:

- Request assistance from airport crash rescue crews and a specially trained and equipped hazmat team.
- Use full protective clothing and SCBA.
- Conduct a rescue if possible. Attempt to provide egress and access to the victims.
- Use foam to extinguish fires if possible. Do not disturb the foam blanket once it is established.
- Try to identify if there are any hazardous materials being transported on the aircraft. The *airbill* is kept in the cockpit with the pilot. If the accident has not destroyed that part of the plane, the pilot should be able to bring that information to you.

Other Large “Vessels” (continued)

Ships and Barges

Many hazardous materials are transported by water. Any department that has hazardous materials transported through its jurisdiction by water should have specific plans established for dealing with a release or fire. The following are some general guidelines only.

As a general rule, first responders should request assistance from the U.S. Coast Guard and a specially trained and equipped hazmat team to handle shipboard hazmat incidents. The Coast Guard has three national strike teams that are activated through the National Response Center. (See pages 14-34 to 14-38 for more information.) Provide as much information as possible about the ship itself, its cargo, and circumstances of the incident.

Several documents can help emergency responders deal with a shipboard incident:

- The *dangerous cargo manifest* (shipping papers) is kept in a designated holder on or near the bridge of a *ship* or in a readily accessible location on a *barge* (with a copy furnished to the person in charge of the towing vessel).
- A *hatch plan* contains a schematic of the ship’s load and may be useful in determining what cargo is affected by a release or fire. (The hatch plan might not be accurate while the vessel is loading or unloading at dock, because the cargo is being moved.)
- The ship’s *fire plan* will provide information about fire protection systems.

Incident command authority will vary depending on where the incident is located. The local fire department has incident command authority for incidents involving ships moored at facilities and for the facilities themselves. The Coast Guard has incident command authority for incidents involving vessels under way or at anchor. (The Coast Guard uses the term “on-scene coordinator.”) Generally, the best way to manage an incident on-board ship is with a unified command post.

Other Large "Vessels" (continued)

Pipelines

Examples of materials transported by pipeline include petroleum products, natural gas, anhydrous ammonia, nitrogen, and chlorine. Pipeline incidents can present some unique challenges:

- Some products are under relatively high pressure.
- Some products are pumped through pipelines in cycles, meaning that an incident can start with one hazardous material and change to another. (Products are separated by a plug-like device called a "pig" that flows with the liquids. A pig's location can be tracked via its internal transmitter.)
- Shutting down a pipeline can cause problems elsewhere in the line. Lines should not be shut down without first contacting the pipeline company.
- Once a pipeline is shut down, there could be enough product in the line to continue leaking or burning for several hours.
- Sometimes it will be safer to allow a pipeline fire to continue burning as long as it does not threaten life or other facilities.

The ERG2008 lists the following indications of a pipeline leak:

- Liquids bubbling from the ground
- Oil slick on flowing or standing water
- Flames that appear to be coming from the ground
- Vapor clouds
- Hissing, roaring, or blowing sound
- Dirt or water being blown in the air
- Continuous bubbling in wet or flooded areas
- Dead or brown vegetation in an otherwise green field
- In winter, melted snow over the pipeline

All fire jurisdictions are required by law to have an emergency plan to deal with a pipeline accident in their area. The following are general guidelines to supplement your department SOPS:

- Request assistance from the pipeline company and a trained hazmat team.
- Try to identify the product involved. Look for pipeline markers at public road crossings, railroad crossings, and at various spots along the line. (See page 3-35 for examples.)
- Close off traffic and isolate the area. Evacuate if necessary.
- Eliminate all sources of ignition *if you can do so safely*.

Assessing the Hazards

This chapter is designed to help you assess the hazards at a hazmat or WMD incident. Almost everything in this chapter comes from the operations level responder and incident commander competencies outlined in NFPA 472.

This chapter provides information on ways in which hazardous materials cause harm, toxicity and risk, toxicological terms, occupational exposure limits, properties of flammable liquids, other chemical and physical properties, and atmospheric monitoring. Finally, it goes over special concerns, such as high-risk situations, illicit laboratories, and hazmat triage.

How Hazardous Materials and WMDs Cause Harm

Hazardous materials and weapons of mass destruction can cause harm in many ways. The following is a brief overview of the potential hazards and how you can protect yourself.

Thermal Hazards

Thermal injuries from temperature extremes (either hot or cold) can occur in several ways:

- Thermal burns from a chemical fire or hot materials.
- Frostbite from contact with cryogenic materials.
- Hypothermia from working in cold environments without sufficient PPE.
- Heat stress from inadequate heat dissipation:
  - Heat stress is the most common cause of injury to personnel working in chemical protective clothing.
  - Structural firefighting clothing also retains a lot of heat.
  - Other risk factors include temperature, humidity, level of exertion, and one's own health.

To protect yourself:

- Maintain a safe distance (upwind, uphill, and upstream).
- Monitor for potentially flammable atmospheres.
- Avoid contact with heated or cryogenic materials.
- Wear appropriate PPE for the hazards present, but do not attempt to wear chemical protective clothing unless you have been trained and authorized to do so. Leave these incidents for a trained hazmat team.
- Monitor personnel wearing PPE for signs of heat stress or hypothermia. Follow your department SOPs regarding medical monitoring and work guidelines.
- Drink plenty of fluids before and after operations requiring the use of PPE. However, do not eat, drink, or smoke in the incident area. Wash hands thoroughly before eating, drinking, or smoking.
- Limit the amount of time working in PPE. Rotate personnel frequently if the temperature is extreme or the work is difficult.
- Provide rest areas where personnel are protected from heat, cold, wind, rain, etc.

How Hazardous Materials and WMDs Cause Harm (continued)

Mechanical Hazards

Mechanical trauma is physical impact (pressure) to the body:

- Being struck by debris from an explosion or from catastrophic failure of a pressurized container.
- Scratches, cuts, or puncture wounds from a sharp object.
- Abrasions to the skin from rubbing against protective clothing.
- Injuries from slips, trips, and falls.
- Hearing damage from excessive noise.

To protect yourself:

- Maintain a safe distance from impact hazards.
- Avoid contact with sharp objects.
- Wear properly fitting PPE that is appropriate for the hazards.
- Use hearing protection as needed.
- Protect against slips, trips, and falls as needed.

Poisonous (Toxic) Hazards

Poisons can act on the entire body or specific target organs. (See "Target Organ Effects" on pages 5-10 and 5-11.) Fire often changes the risks. Many materials release toxic products of combustion that are more hazardous than the original substance. Conversely, fire sometimes destroys a material's toxic properties, as can happen with pesticides. Assume the worst until proven otherwise.

To protect yourself:

- Maintain a safe distance (upwind, uphill, and upstream).
- Monitor for toxic atmospheres if trained to do so.
- Wear proper respiratory protection. Hazmat emergencies normally require using SCBA or supplied-air respirators. APR is permissible as part of a Level C ensemble only if all applicable criteria are met. (See pages 2-48 to 2-50.)
- Wear proper protective clothing. Structural firefighting clothing and work uniforms can absorb chemicals and trap them next to the body. Chemical protective clothing may be required.
- Leave toxic incidents for a trained hazmat team if your level of training or PPE is not adequate.

How Hazardous Materials and WMDs Cause Harm (continued)

Corrosive Hazards

Acids and bases can cause severe chemical burns to skin and eyes. In gas or vapor form, corrosives can also damage the respiratory system. When corrosives react with other materials, they often produce toxic or flammable gases, thus increasing the dangers. (See pages 3-17, 5-46, and 5-47 for more information.)

To protect yourself:

- Maintain a safe distance (upwind, uphill, and upstream).
- Monitor for corrosive atmospheres using pH paper.
- Wear proper PPE. Protection from corrosives may require the use of chemical protective clothing and SCBA or supplied-air respirators.
- Leave these incidents for a trained hazmat team if your level of training or PPE is not adequate.

Asphyxiation Hazards

Asphyxiants can lead to suffocation in one of two ways:

- *Simple asphyxiants* displace oxygen in the atmosphere.
- *Chemical asphyxiants* affect the blood and prohibit the body from using the oxygen once inhaled.

To protect yourself:

- Maintain a safe distance (upwind, uphill, and upstream).
- Monitor the oxygen concentration in the atmosphere.
- Monitor for specific chemical contaminants if trained to do so.
- Wear proper respiratory protection. Oxygen-deficient atmospheres (less than 19.5% oxygen) require the use of SCBA or supplied-air respirators. Air purifying respirators (APR) and powered air purifying respirators (PAPR) are not acceptable.
- Wear proper PPE.
- Leave these incidents for a trained hazmat team if your level of training or PPE is not adequate.

How Hazardous Materials and WMDs Cause Harm (continued)

Radiation Hazards

Radiation is covered in much more detail in Chapter 11, "Nuclear Events." However, the following is a basic overview.

Radiation effects vary depending on the type of radiation, the dose rate, the body part exposed, and the total dose received. Effects may include external burn injuries or signs and symptoms similar to poisoning. Radiation can also cause cancer.

To protect yourself:

- Maintain a safe distance. Doubling your distance from the radioactive source reduces your exposure by 75%.
- Stay upwind, uphill, and upstream to protect against airborne particles.
- Keep exposure time to a minimum.
- Use any available shielding. For example, stay behind buildings or vehicles if possible.
- Wear proper PPE. Structural firefighting clothing and SCBA will generally protect against external exposure to alpha and low-energy beta particles and against internal exposure from inhalation, ingestion, or contamination through breaks in the skin. They will not protect against external exposure to more penetrating forms of radiation.
- Monitor for radiation with a survey meter, and wear self-reading dosimeters whenever possible. (Note: Most radiation monitors don't detect all types of radiation, so more than one monitor may be needed.)
- Take precautions when treating radiation victims. Although the victims themselves are not radioactive, they may be contaminated with radioactive material.

It is generally safe to perform priority response actions (life saving, control of fire and other hazards, and first aid) before taking radiation measurements. However, consult your department SOPs, applicable hazmat contingency plans for your area, the *Emergency Response Guidebook*, or other appropriate resources for specific guidance.

How Hazardous Materials and WMDs Cause Harm (continued)

Etiological Hazards

Etiological harm can occur from exposure to a microorganism or its toxin, resulting in disabling diseases such as AIDS, hepatitis, and tuberculosis. The most common source of exposure is through contact with blood or other body fluids. However, etiologic agents may also be present in biological or medical laboratories.

Resources for detecting etiologic agents (infectious substances) in the field are limited. Suspect etiologic agents when blood or other body fluids are present, when you see an infectious substance label, or at any incident in a biological or medical laboratory. (See also Chapter 10 for information on biological warfare agents.)

To protect yourself:

- Use universal precautions during patient care. Wear gloves, a mask, eye protection, and other protective garments as needed. Use barrier masks with one-way valves for rescue breathing or, better yet, use mechanical resuscitation equipment. Wash hands thoroughly after contact with blood or body fluids.
- Wear proper PPE. Some etiologic agents require using chemical protective clothing and SCBA or supplied-air respirators.
- Decontaminate or dispose of contaminated equipment.
- Leave these incidents for a trained hazmat team if your level of training or PPE is not adequate.

Other Hazards

- *Irritants* cause a reversible inflammatory effect, primarily on the respiratory system, but they can also affect the skin, eyes, and mucous membranes. *Upper* respiratory irritants affect the mouth, nose, and throat. *Lower* respiratory irritants affect the system from the trachea to the lungs.
- *Sensitizers* cause an allergic reaction after repeated exposure.
- *Convulsants* are poisons that cause seizures.

Additionally, people may experience psychological and physical effects collectively called critical incident stress disorder (CISD) or posttraumatic stress disorder (PTSD).

Carcinogens, Mutagens and Teratogens

Carcinogens, mutagens, and teratogens, while all slightly different, each cause some form of cell mutation. Although you may occasionally see a TLV (threshold limit value) associated with some of these materials, it's generally considered that no exposure to carcinogens, mutagens, or teratogens is safe. You should request assistance from a specially trained and equipped hazmat team. Special protective clothing and mitigation measures are generally required.

Carcinogens

Carcinogens are substances that cause cancer. Many substances are known or suspected carcinogens. It may take only one very small exposure to get cancer, yet the effects of exposure may not appear for years. Whenever a known or suspected carcinogen is involved, it will require using the highest level of protection. Examples of known or suspected carcinogens include asbestos, vinyl chloride, benzene, some pesticides, and many of the materials used to manufacture plastics.

Mutagens

Mutagens are toxins that cause changes to the genetic material of cells (DNA and RNA) that can be inherited by offspring. These genetic changes can have numerous effects, including the failure of important biochemical processes. In some cases they can cause cancer. Examples of known mutagens include ethylene oxide, ethylene dibromide, and benzene.

Teratogens

Teratogens are agents known to cause malformations in an unborn child. Exposure to teratogens during the embryonic stage (the first 8 weeks after implantation) can result in deformed or absent limbs. Exposure during the fetal stage (after the 8th week) can result in physiological and behavioral effects. Examples of teratogens include ionizing radiation, lead compounds, ethyl alcohol, methyl mercury, thalidomide, and dioxins.

Toxicology: Exposure Potential

Routes of Entry into the Body

Inhalation is the most hazardous route of entry because the lungs are so vulnerable to damage and because chemicals can be rapidly absorbed into the bloodstream from the lungs. In addition, the comparatively large surface area of the lungs (approximately 900 square feet) makes the lungs a bigger target than the skin (averaging 20 square feet of surface area). Wear respiratory protection whenever inhalation hazards are present.

Absorption can occur through direct contact between a hazardous material (solid, liquid, or gas) and the skin or eyes. The risk of skin absorption is enhanced where the skin is compromised (e.g., with cuts or abrasions) and in parts of the body rich in hair follicles (e.g., scalp, underarms, and genital areas). Eye absorption is particularly rapid because the eye has a high absorbency rate. Some materials are strictly a contact hazard, causing harm at the injury site only. Others can penetrate the skin and be absorbed directly into the bloodstream. Wear the appropriate PPE, or remain at a safe distance.

Ingestion at a hazmat/WMD incident occurs most often due to poor hygiene. Do not eat, drink, or smoke near hazardous materials. Wash hands thoroughly before eating, drinking, or smoking.

Injection can occur through a cut, scratch, or puncture wound from a contaminated object. Wear appropriate personal protective equipment. Be careful around sharp objects or high pressure gases.

Toxicology: Exposure Potential (continued)

Acute and Chronic Exposures

Exposures can be either acute (one-time or short-term) or chronic (repeated or long-term). Hazmat emergencies generally result in acute exposures.

Acute exposures can result in effects such as difficulty breathing, dizziness, nausea and vomiting, burns, damage to specific target organs or body systems, or death. The effects may manifest themselves immediately or may not show up until hours or days later.

The effects of **chronic exposures** are often not detectable for years. Chronic exposures can result in effects such as respiratory disease, damage to specific target organs or body systems, cancer, birth defects in unborn children, or death.

Local and Systemic Effects

Local effects are those that occur directly to the area exposed. A chemical burn to the skin due to contact with a corrosive material is an example of a local effect.

Systemic effects are those that impact the entire body. Carbon monoxide poisoning is an example of a systemic effect. Carbon monoxide combines with the hemoglobin in the red blood cells and deprives the body of oxygen.

Target Organ Effects

Some target organs and body systems are particularly sensitive to damage from chemicals. The following examples are not intended to be all-inclusive. Rather, they're designed to illustrate the range and diversity of health effects and hazards.

- **Hepatotoxins** - chemicals that damage the liver
  Signs & Symptoms - jaundice, liver enlargement
  Chemicals - carbon tetrachloride, nitrosamines

(continued next page)

Toxicology: Exposure Potential (continued)

Target Organ Effects (continued)

- **Nephrotoxins** - chemicals that damage the kidneys
  Signs & Symptoms - edema, excess protein in the urine
  Chemicals - halogenated hydrocarbons, uranium
- **Neurotoxins** - chemicals that damage the central and/or peripheral nervous system
  Signs & Symptoms (central) - drooping eyelids, respiratory difficulties, seizures, unconsciousness
  Signs & Symptoms (peripheral) - numbness, tingling, decreased sensation and motor strength, change in reflexes
  Chemicals - mercury, carbon disulfide, organophosphates
- **Blood hazards** - chemicals that act on the blood or the system that forms the blood, that decrease hemoglobin function, or that deprive the body tissues of oxygen
  Signs & Symptoms - cyanosis, loss of consciousness
  Chemicals - carbon monoxide, cyanides, benzene
- **Respiratory hazards** - Agents that irritate or damage the lung and pulmonary tissue
  Signs & Symptoms - cough, tightness in the chest, shortness of breath
  Chemicals - silica, asbestos, hydrochloric acid
- **Reproductive toxins** - chemicals that harm reproductive capabilities, including chromosomal damage (mutations) and effects on fetuses (teratogenesis)
  Signs & Symptoms - birth defects, sterility
  Chemicals - lead, DBCP
- **Cutaneous hazards** - chemicals that affect the dermis
  Signs & Symptoms - defatting of the skin, rashes, irritation
  Chemicals - ketones, chlorinated compounds
- **Eye hazards** - chemicals that affect the eye or visual capacity
  Signs & Symptoms - conjunctivitis, corneal damage
  Chemicals - organic solvents, acids

Synergistic Effects

The health effects of most chemicals are fairly predictable. However, when two or more chemicals are involved, the synergistic effect can produce dramatically different signs and symptoms. Synergism is also a concern when patients have other injuries (e.g., blast injuries) in addition to chemical exposure. The combination can be far more serious than either condition alone.

Toxicity and Risk

Before we define the toxicological terms that can help you determine the health hazards, let's look at the relation between toxicity and risk.

Toxicological Risk Factors

Generally, the more toxic a substance is, the more dangerous it is. However, a good risk assessment takes into account the inherent hazards of the material (which you can determine through MSDSs and other reference sources), the exposure potential, and vulnerabilities of the target population.

- **Form of the material**. Gases and vapors are the most dangerous due to their mobility and the ease with which they can be inhaled. Materials that are weaponized (e.g., chemical warfare agents that have been aerosolized) present a greater risk of exposure than they do in their natural forms.
- **Particle size**. Solids in a finely divided state (e.g., dusts and powders) are more easily inhaled than are larger particles and can travel further through the respiratory system.
- **Persistence**. Liquids that are slow to evaporate remain in the environment longer and can be harder to decon than those that are less persistent.
- **Dose** (or concentration) to which a person is exposed. All chemicals are toxic to some degree, but dose makes the poison. A high exposure to a material with low toxicity can be just as harmful as a low exposure to a highly toxic material.
- **Duration and frequency** of exposure.
- **Gender**. Pregnant women are more vulnerable to teratogens and mutagens (e.g., lead, formaldehyde, PCBs, and benzene). Men are more susceptible to toxins that target rapidly growing sperm cells (e.g., lead, ethylene dibromide, and hexane.)
- **Age**. Young children and the elderly are often more susceptible to harm from chemical exposures. However, sometimes older persons have an advantage due to their slower metabolisms.
- **Individual susceptibilities** (e.g., allergies or pregnancy).
- **Nutrition/health**. Illness or poor health can make a person more susceptible and can mask symptoms of exposure.

Once an exposure does occur, another factor that affects the degree of risk is whether the victim receives prompt, thorough, and appropriate decon and follow-up medical care.

Toxicological Terms and Exposure Values

The following pages provide an overview of various toxicological terms and what they mean to the first responder. Often this information will be more significant to the hazmat technician with a higher level of training. However, if you have access to MSDSs or other resources, you can begin gathering this information prior to the arrival of a hazmat team. If you have the training and equipment, you may also be able to monitor the atmosphere to determine contaminant concentration.

Remember, when evaluating *exposure* or *concentration*, the higher the number, the greater the risk. However, when looking at *toxicological properties*, the lower the number, the more hazardous the material, because it takes a smaller quantity to produce harmful effects.

Exposure Versus Contamination

The terms *exposure* and *contamination* are often used interchangeably, in part because a person can be both exposed and contaminated. However, the words mean different things. A *contaminated* person is one who has the hazardous material on his or her body, posing a risk of *secondary contamination* to others. Someone who is contaminated would also be considered exposed (although proper PPE can prevent exposure even when an individual's outer garment is contaminated).

On the other hand, a person can be *exposed* without being contaminated. For example, a person who inhales a gas or vapor is seldom contaminated unless the concentration of gas or vapor is so heavy that it also condenses onto the person's skin, hair, or clothing. Similarly, a person can be exposed to radiation without being contaminated. A strong dose of gamma or x-ray radiation can cause tissue damage, but it doesn't make an exposed person radioactive. He or she would pose a threat to others only if a radioactive substance has contaminated his or her body.

Injury can result from either exposure or contamination. However, only contamination poses the risk of continued exposure (continued injury) to patients and secondary contamination (transfer) to others who come in contact with these patients.

Toxicological Terms and Exposure Values (continued)

Lethal Dose (LD) or Lethal Concentration (LC)

Lethal dose (LD) and *lethal concentration (LC)* reflect the exposure required to kill a given percentage of a test population. Lethal dose is used for solids and liquids and is expressed in milligrams of chemical per kilogram (mg/kg) of body weight. Lethal concentration is used for gases and vapors and is usually expressed in parts per million (ppm), parts per billion (ppb), or milligrams per cubic meter (mg/m^3) in air. It is independent of body weight.

The subscript notation refers to the percentage of test population affected. LD_{50} or LC_{50} is the number most often cited in reference sources. It means that 50% of the test population died from exposure to the specified dose or concentration of the material. LD_{100} or LC_{100} means that 100% died. (LD_{hi} and LC_{hi} mean the same thing.) LD_{lo} or LC_{lo} is the exposure that killed the first individual in a test study.

These numbers are derived from laboratory studies on animals, so they're only an approximation of how humans may be affected. And the information is very limited. If the number cited in reference sources is the LD_{50} or LC_{50}, there's no way to tell what exposure levels killed the first 49% of the test population. It's the first fatality (the LD_{lo} or LC_{lo}) that matters most to emergency responders. Additionally, the data shows only fatalities, with no regard for debilitating health effects suffered by the survivors. It also shows only those fatalities that occurred within the test period (typically 14 days). So if test subjects die a month later as a direct result of the exposure, they're not factored into the statistic.

The distinction between *toxic* and *highly toxic* materials is based on LD_{50} and LC_{50} when albino rats are subjected to ingestion, absorption, and inhalation of the chemicals being studied. The precise definitions of *toxic* and *highly toxic* can be found in 29 CFR 1910.1200, Appendix A, but the down-and-dirty distinction is that highly toxic materials are deadly at far lower exposures.

Proper PPE is required to protect against exposures in the lethal ranges. SCBA will be necessary to prevent airborne exposures. Structural firefighting clothing may not be adequate; chemical protective clothing may be required.

Toxicological Terms and Exposure Values (continued)

Immediately Dangerous to Life and Health (IDLH)

Immediately dangerous to life and health (IDLH) means an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere.

IDLH values were initially developed as part of a joint project by NIOSH and OSHA as a tool for selecting respirators in the workplace. As a safety margin, IDLH values were based on effects that might occur from a 30-minute exposure, but it was not meant to imply that workers should stay in the environment without proper PPE any longer than necessary. In fact, every effort should be made to exit immediately. IDLH should be thought of like an SCBA low-air alarm. It's a window for escape, not a window for squeezing in additional mitigation measures in the time remaining.

IDLH is often used to distinguish between a rescue and a body recovery operation. If a victim has been exposed to the product at or above an IDLH concentration for more than 30 minutes, the chances of survival drop significantly. However, IDLH is only part of the risk-versus-gain analysis. It is generally not possible to make a positive determination of death from a distance.

IDLH is generally based on toxicological data. However, where flammability is a significantly greater risk than toxicity, IDLH may be set at 10% of the lower explosive limit (LEL).

Level of Concern (LOC)

Level of concern (LOC) is generally defined as 10% of the IDLH. Unlike the other limits, LOC has no associated description of health effects that might be expected. It is simply a safety margin of 10%—just like 10% of a lower explosive limit (LEL) provides a safety margin to keep from entering the flammable range.

Toxicological Terms and Exposure Values (continued)

Protective Action Criteria (PAC): AEGLs, ERPGs, and TEELs

Level of Concern (LOC), described on the previous page, is a rough way of setting community exposure limits when one has no other information. Whenever possible, emergency planning and community protection should be based on one of the following:

- Acute Exposure Guideline Levels (AEGL) (first choice if available)
- Emergency Response Planning Guidelines (ERPG) (second choice, if no AEGL exists)
- Temporary Emergency Exposure Limits (TEEL) (third choice, if there is no AEGL or ERPG)

Protective Action Criteria (PAC)—AEGLs, ERPGs, or TEELs—for more than 3200 chemicals are published in what is called the *PAC Data Set*. Major revisions are released every year or two.

- The PAC Data set is available either in printed form or as a searchable database at: http://orise.orau.gov/emi/scapa/teels.htm
- The U.S. EPA's official AEGL web site is: http://www.epa.gov/oppt/aegl/index.htm

Acute Exposure Guideline Levels (AEGL)

There are three *Acute Exposure Guideline Levels (AEGLs)*, each representing the maximum airborne concentration above which it is predicted that the general population, including susceptible individuals, could experience ...

Level	**Description**
AEGL-1	discomfort, irritation, or certain asymptomatic nonsensory effects. The effects are not disabling. They are transient and reversible upon cessation of exposure.
AEGL-2	irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
AEGL-3	life-threatening health effects or death.

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Protective Action Criteria (PAC) (continued)

Acute Exposure Guideline Levels (AEGL) (continued)

The process for developing Acute Exposure Guideline Levels is the most comprehensive process for determining short-term exposure limits for acutely toxic chemicals. Therefore, depending on where in the review process specific substances are, AEGLs may be identified as draft AEGLs, proposed AEGLs, interim AEGLs, or final AEGLs.

AEGLs listed in the PAC Data Set represent 60-minute exposures. However, unlike ERPGs and TEELs, AEGLs are available for five time frames (10 minutes, 30 minutes, 60 minutes, 4 hours, and 8 hours). The following is an example of how AEGLs are identified at the EPA's web site.

Chlorine 7782-50-5 (Final)					
ppm					
	10 min	30 min	60 min	4 hr	8 hr
AEGL 1	0.50	0.50	0.50	0.50	0.50
AEGL 2	2.8	2.8	2.0	1.0	0.71
AEGL 3	50	28	20	10	7.1

Sample AEGL Data from EPA's Web Site

Emergency Response Planning Guidelines (ERPG)

Emergency Response Planning Guidelines (*ERPGs*) are developed by the American Industrial Hygiene Association (AIHA). ERPGs provide an estimate of concentrations where one might reasonably anticipate adverse effects for exposures that exceed an hour in duration. ERPGs reflect only acute health effects, not long-term complications.

(continued next page)

Toxicological Terms and Exposure Values (continued)

Protective Action Criteria (PAC) (continued)

Emergency Response Planning Guidelines (ERPG) (continued)

ERPG levels are the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to one hour without experiencing or developing ...

Level	Description
ERPG-1	other than mild transient adverse health effects or perceiving a clearly defined objectionable odor
ERPG-2	irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action
ERPG-3	life-threatening health effects

Temporary Emergency Exposure Limits (TEEL)

Temporary Emergency Exposure Limits (*TEEL*) are developed by the Subcommittee on Consequence Assessment and Protective Actions (SCAPA) under the U.S. Department of Energy (DOE). TEELs are *temporary* limits designed to facilitate the emergency planning process for chemicals that don't have AEGLs or ERPGs. TEELs are an approximation derived from other data; they don't undergo the extensive study and peer review associated with AEGLs or ERPGs.

TEELs have the same definitions as ERPGs, with two exceptions. TEELs do not specify a one-hour time frame, because of the way DOE adjusts for the differences between exposures that are concentration-dependent versus dose-dependent. Also, TEELs have a fourth level (TEEL-0), which is the threshold concentration below which most people will experience no appreciable risk of health effects.

Workplace Environmental Exposure Limits (WEEL)

Workplace environmental exposure limits (WEEL) apply more to normal occupational exposures than to emergency response. However, these values may become significant in a protracted incident.

Workplace environmental exposure limits are established for workers without any special protective equipment. The first three below represent the maximum concentration to which an average person in average health may be exposed repeatedly on a day-to-day basis (40 hours per week, 8 to 10 hours per day) with no adverse health effects. Each is established by a different agency. Often the limits established by each agency are the same, but that's not always the case. Some of these published limits will have a "[skin]" notation, meaning that there's a potential for dermal absorption and that workers should protect against skin exposure.

Permissible Exposure Limits (PEL)

Permissible Exposure Limits (PEL) are established by the Occupational Safety and Health Administration (OSHA). These are time-weighted average (TWA) concentrations that, unless otherwise noted, must not be exceeded during any 8-hour shift of a 40-hour workweek. (*Time-weighted average* means that one can exceed the identified concentration, within limits, as long as the average exposure over an 8-hour shift does not exceed the PEL.) Because PELs are OSHA limits, compliance with PELs is mandated by law.

Recommended Exposure Limits (REL)

Recommended Exposure Limits (REL) are similar to PELs in that they are also time-weighted averages for a 40-hour workweek. However, RELs differ from PELs in that they allow for a 10-hour shift versus an 8-hour shift and RELs are recommended limits established by the National Institute for Occupational Safety and Health (NIOSH), not regulatory limits from OSHA.

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Workplace Environmental Exposure Limits (WEEL) (continued)

Threshold Limit Value (TLV-TWA)

Threshold Limit Value—Time-Weighted Average (TLV-TWA) is also a recommended limit, one from the American Conference of Governmental Industrial Hygienists (ACGIH). It's based on an 8-hour shift and 40-hour workweek.

Short-Term (TLV-STEL) and Ceiling (TLV-C) Exposure Limits

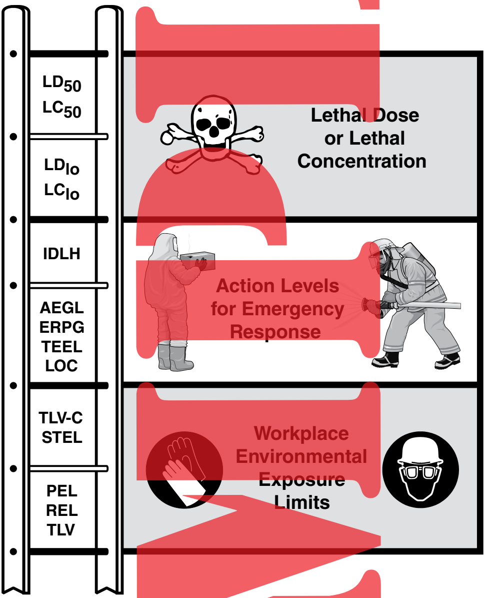
Workers can exceed the permitted or recommended exposure limits if they stay within the short-term and ceiling exposure limits explained below. Short-term and ceiling exposure limits may be either regulatory limits or recommended limits, depending on whether they're established by OSHA or another agency. (If reference books don't cite the source, err on the side of safety and assume it's a regulatory limit.)

A *Short-Term Exposure Limit (STEL)* is the maximum concentration to which a worker may be exposed for short durations (15 minutes, unless otherwise noted). Exposures above the STEL should be at least 60 minutes apart and not repeated more than 4 times per day. (Often this is written as TLV-STEL.)

A *Ceiling Exposure Limit* is the concentration that may not be exceeded at any time. (Often this is written as TLV-C.)

Exposure Values Compared

Because the exposure values covered on the previous pages can be confusing, it often helps to see them on a "hazard ladder" that shows an approximate relation between them. This is obviously not to scale, but it does provide a quick visual representation of how these values stack up against one another.



A Simple Hazard Ladder Shows the Approximate Relation Between Exposure Values (not to scale)

Unfortunately, there may be times when you can't find all of these values in your reference books, particularly books geared toward workplace exposures. For those occasions, you can estimate IDLH or LOC if you know the TLV-TWA. Remember, however, that these are approximations only.

- LOC is generally defined as 10% of the IDLH or 3 times the TLV-TWA.
- Thus, IDLH is 10 times the LOC or 30 times the TLV-TWA.

Exposure Values Compared (continued)

Odor Threshold

One more value, odor threshold, can *sometimes* be plotted on a hazard ladder. Odor threshold is the lowest concentration of a substance in air that can be smelled. If a substance has an odor threshold, it's helpful to know where it stacks up against the toxicity values. Does the substance have adequate warning properties, alerting people to danger before they can be harmed? Or is it dangerous at concentrations well below the odor threshold?

Of course, some substances have no odor. Others, like chlorine, produce olfactory fatigue. When responders stop smelling chlorine, it's not necessarily because the chlorine has dissipated. It may be because olfactory fatigue has obstructed their ability to detect chlorine by smell alone. Additionally, people vary in their ability to detect odors. For example, at least 25% of the population is genetically unable to smell the bitter almond odor of hydrogen cyanide. So odor threshold is nice to know, but it's far from reliable in judging one's potential exposure.

Properties of Flammable Liquids

Flammable liquids are the most common hazardous materials encountered by emergency response personnel. Understanding the properties of flammable and combustible liquids can help you to predict the degree of danger in a spill.

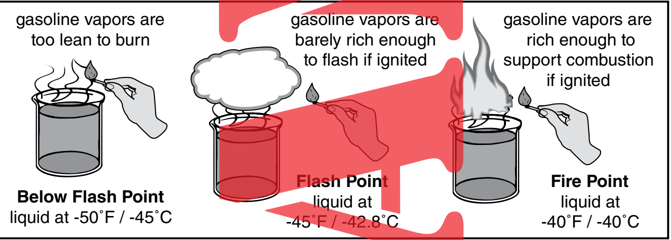
Warning: The word *inflammable* means *flammable*. It does *not* mean *nonflammable*.

Flash Point and Fire Point

Flash point is the minimum temperature at which a liquid produces enough vapor to form an ignitable mixture in air. The vapors may ignite if an ignition source is present. However, the flame does not continue to burn when the source of ignition is removed; rather, the vapors flash and are consumed by the fire. (Flammable gases don't have flash points because they are already in a gaseous state.)

Flash point is generally considered to be the most important temperature in assessing the hazards of flammable and combustible liquids. The lower the flash point, the greater the hazard. (If different sources list different temperatures, assume the worst and err on the side of safety.)

Fire point is the temperature at which enough vapors are given off to support continuous burning after the source of ignition has been removed. It's generally just a few degrees above the flash point.



Flash Point and Fire Point of Gasoline

An important safety measure at any incident where flammable vapors may be present is to eliminate possible ignition sources (e.g., open flames, pilot lights, smoking materials, heated surfaces, electrical sparks, or static electricity) *if you can do so safely*.

Properties of Flammable Liquids (continued)

Ignition (Autoignition) Temperature

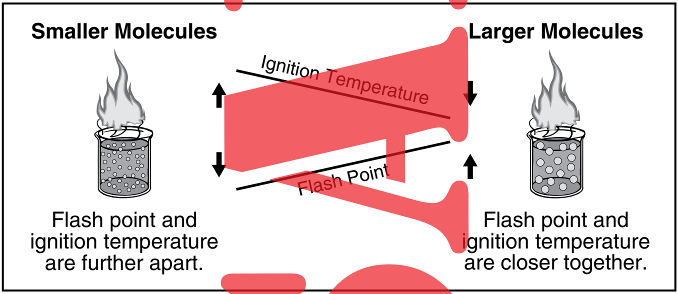
The *ignition (autoignition) temperature* of a substance is the minimum temperature required to cause self-sustained combustion, independent of an ignition source. Simply put, it's the temperature a material must reach before it will ignite. (It's also the temperature the ignition source must be.)

Ignition temperature is sometimes difficult to measure and should be considered an approximation. Ignition comes in two forms:

- *Pilot ignition* involves an external ignition source (e.g., a lit cigarette or a pilot light igniting gasoline vapors).
- *Autoignition* requires only an elevated temperature. In a fire, for example, convection carries hot air and gases to other parts of a building. When the atmosphere becomes hot enough that these gases reach their ignition temperatures, they will ignite without the introduction of any other ignition source. This is called *flashover*.

Effect of Molecular Size on "Like" Compounds

Molecular size directly affects physical and chemical properties. Understanding the relation between these properties can help you predict the hazards of "like" compounds, such as propane (C_3H_8) and octane (C_8H_{18}). In smaller compounds, the flash point and ignition temperature are further apart, while in larger compounds, these properties are closer together.



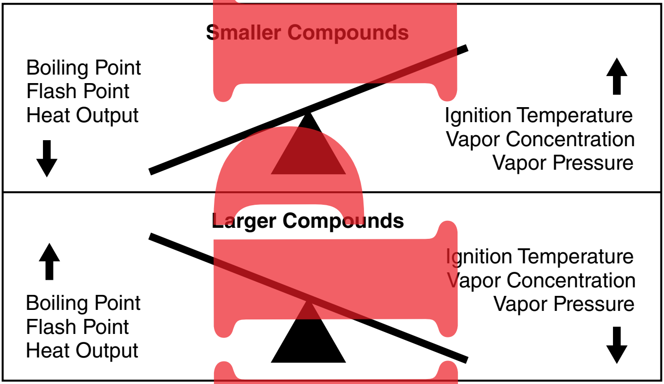
The Relation Between Flash Point and Ignition Temperature

(continued next page)

Properties of Flammable Liquids (continued)

Effect of Molecular Size on "Like" Compounds (continued)

Several properties are directly or indirectly proportional to molecular size. (Again, this assumes one is comparing "like" compounds—ones with similar chemical compositions.)



The Effect of Molecular Size on "Like" Compounds

Smaller compounds are more active than larger compounds are. Thus they vaporize more easily, so less heat is required to reach the flash point or boiling point. Heat output is also lower, because these compounds contain fewer hydrogen atoms (fuel). Because smaller compounds are more active, the vapor pressure and vapor concentration are both higher. Ignition temperature is also higher, because it takes more heat energy to ignite molecules with less hydrogen.

Larger compounds are less active than smaller compounds are. They don't vaporize as easily, so it takes more heat to reach the flash point and boiling point. Heat output is also higher because these compounds contain more hydrogen. Because larger compounds are less active, the vapor pressure and vapor concentration are both lower. However, when an ignitable mixture is produced, the vapors are closer to their ignition temperature; thus is takes less heat to cause ignition.

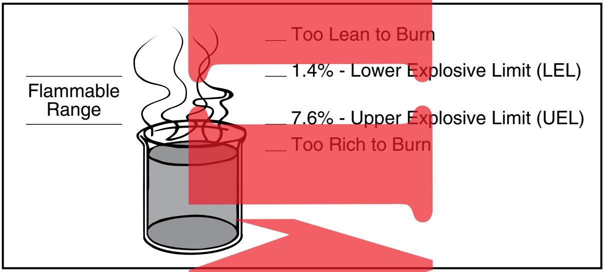
(See pages 5-41 to 5-42 for information on vapor pressure and boiling point.)

Properties of Flammable Liquids (continued)

Flammable (Explosive) Range

Flammable (explosive) range is the percentages of vapor in air within which ignition is possible. Below the *lower explosive limit (LEL)*, the vapors are too lean to burn, whereas above the *upper explosive limit (UEL)*, the vapors are too rich to burn. Sometimes you will see the terms *lower flammable limit (LFL)* and *upper flammable limit (UFL)* instead. They mean the same thing as lower and upper explosive limits.

The wider the flammable range, the greater the span at which ignition is possible and the greater the potential risk. Conversely, products with narrower flammable ranges will present less of a fire hazard. Gasoline, for instance, has a relatively narrow flammable range (1.4% to 7.6%). Compare that, for example, to methyl alcohol (6% to 36%) or acetylene (2.5% to 100%).



The Flammable Range of Gasoline

The lower the LEL, the greater the risk. For example, hydrogen (4% to 75%) reaches its LEL before carbon monoxide (12.5% to 74%) does.

Other factors, like flash point and vapor pressure, also affect the overall flammability risk. However, all things being equal, the greater the flammable range and the lower the LEL, the greater the fire danger. (When different sources list different LEL and UEL values, assume the worst and err on the side of safety.)

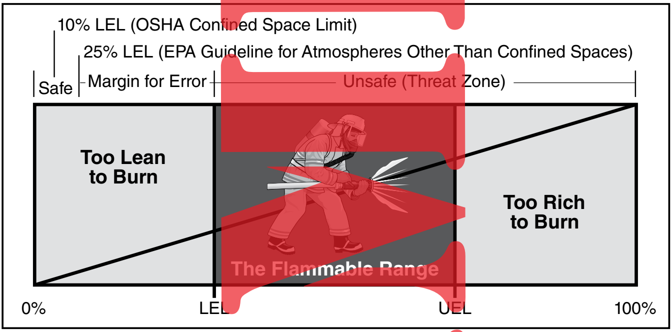
(continued next page)

Properties of Flammable Liquids (continued)

Flammable (Explosive) Range (continued)

Only atmospheres that are well below the LEL are safe to enter. Consequently, many response agencies have SOPs or SOGs that prohibit working in an atmosphere greater than 10% of the LEL. (That's 10% of the LEL, not a 10% contaminant concentration in the atmosphere.)

In part, this comes from OSHA regulations that prohibit working in *confined spaces* with more than 10% of the LEL. However, when the environment does not meet the definition of a confined space, the EPA's guidelines suggest that responders can keep working up to 25% of the LEL if they're cautious and use continuous monitoring. Both limits (10% and 25%) still leave a good margin of error to guard against everything from fluctuations in the chemical concentration to defective monitors or errors in interpreting the meter readings.



Flammable Range

Even though the vapors are too rich to burn *above* the UEL, never consider that to be a safe atmosphere, because the vapor concentration may drop to within the flammable range during emergency operations.

Properties of Flammable Liquids (continued)

The Effect of Temperature

A combustible liquid will be below its flash point at normal temperatures. The combustible liquid is relatively safe because it does not generate an ignitable mixture of vapors. However, on a hot day or in a hot environment, a combustible liquid may easily reach its flash point. Both flammable and combustible liquids will be much easier to ignite when the temperature is elevated.

Spontaneous Combustion

A few substances are subject to *spontaneous combustion*. Animal and vegetable oils (e.g., mink oil or linseed oil) are good examples. The oil will slowly oxidize when exposed to air, generating heat in the process. If the heat cannot dissipate fast enough, it will accelerate the production of flammable vapors, then spontaneously ignite those vapors. This is why oily rags left lying in a pile are a fire hazard. Oil-soaked rags should be either kept in tightly closed metal containers that exclude air or hung outdoors (e.g., on a clothesline) where air movement would prevent the buildup of heat.

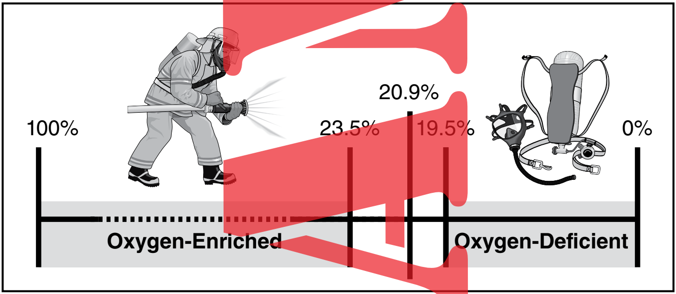
Tools for Comparing Three Primary Threats

We often evaluate hazmat incidents in terms of three primary threats: oxygen deficiency, toxicity, and flammability. To some extent, this is an oversimplification. All the information in this chapter proves that there are many more factors to consider. However, the tools provided on the following pages can help you compare these three threats to see where the greatest risk is. They can also be modified as needed to show other factors.

Review of the Three Primary Threats

The normal atmosphere contains roughly 20.9% oxygen. If the oxygen level is above 23.5% (oxygen-enriched), the atmosphere is considered potentially explosive. (This can be evaluated as part of the flammability question.)

Oxygen Deficiency: An oxygen concentration of 19.5% is considered by OSHA and NIOSH to be the minimum safe level. Below that, the atmosphere is oxygen-deficient and responders must wear self-contained breathing apparatus (SCBA) or supplied air respirators (SAR). Air purifying respirators (APR) are not acceptable, even if they are capable of filtering the specific contaminants in the atmosphere, because they don't provide responders with a source of oxygen.



Oxygen-Enriched and Oxygen-Deficient Threat Zones

(continued next page)

Tools for Comparing Three Primary Threats (continued)

Review of the Three Primary Threats (continued)

An atmosphere with less than 19.5% oxygen is not an immediate threat to life. There's still a margin of safety. However, oxygen deficiency does impair mental and physical abilities, including the ability to recognize and escape from potentially hazardous situations.

Oxygen Level	Effects of Oxygen Deficiency
20.9%	*normal concentration*
19.5%	*minimum safe level per OHSA and NIOSH, but doesn't address possible contaminant concentration*
↓	increasing impairment to breathing, coordination, perception, and judgment
6%	difficulty breathing, convulsions, death in minutes

Any oxygen displacement is also an indication that there may be a contaminant present in the atmosphere. Since oxygen comprises roughly one fifth (1/5) of the normal atmosphere, a 1% displacement (from 20.9% to 19.9% oxygen) means there is roughly a 5% concentration of a contaminant gas or vapor.

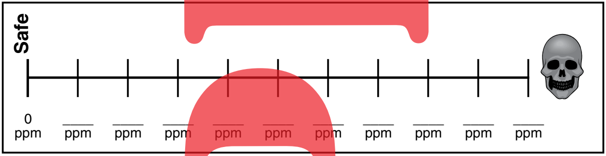
Flammability: If the contaminant is flammable, how close is it to its flammable range? And what is its flash point? (See pages 5-23, 5-26 and 5-27 for explanations of flash point and flammable range.)

Toxicity: If the contaminant is toxic (or otherwise hazardous to health), how does the concentration compare to known exposure limits and toxicity values? (See pages 5-13 to 5-21 for explanations of the terms.) Equally important, what limit gives you the data you need to assess risk? It changes based on the circumstances. For example, to distinguish between a rescue and a body recovery operation, you probably want to use IDLH. To assess the need for protective actions, you might want to use one of the protective action criteria (AEGL, ERPG, or TEEL).

Tools for Comparing Three Primary Threats (continued)

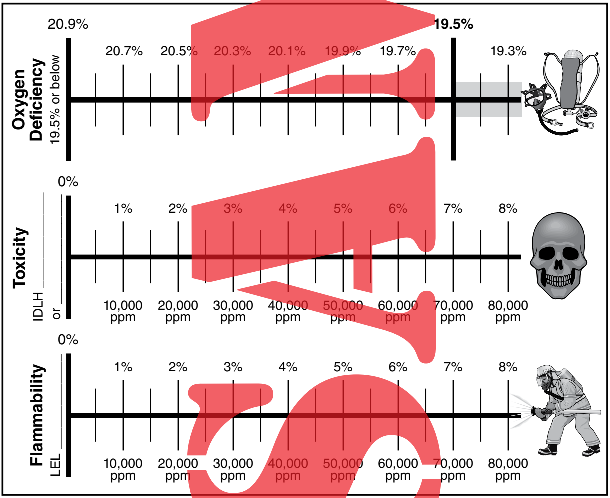
Hazard Ladders

Hazard ladders can help you visualize the threats. Determine a scale appropriate for the material in question. For highly toxic materials, you might use 0 to 0.10 ppm. For others, you might want to go from 0 to 100 ppm or 0 to 1000 ppm. Then plug in exposure limits, toxicity values, and meter readings as appropriate.



A Simple Hazard Ladder to Plot Toxicity

Hazard ladders can be customized as needed. For example, you can draw one from 0% to 100% to plot flammable range and a different one to plot flash point, ignition temperature, and ambient temperature. The illustration below allows you to see the relation between oxygen deficiency, toxicity, and flammability (flammable range). Which threat will you encounter first?



Three Parallel Hazard Ladders

Tools for Comparing Three Primary Threats (continued)

Decision Matrices

Looking only at numbers on a hazard ladder can be misleading. You must also identify your escape window if something goes wrong. An LEL atmosphere presents an immediate risk if vapors ignite. An IDLH atmosphere provides an escape window of up to 30 minutes, although immediate exit is encouraged. An oxygen-deficient atmosphere has an extended escape window with a good safety margin at the OSHA limit of 19.5%.

Flammability (LEL)
immediate risk if vapors ignite

Toxicity (IDLH)
escape window up to 30 minutes, although immediate exit is encouraged

Oxygen Deficiency (<19.5%)
extended escape window with no escape-impairing symptoms at OSHA limit of 19.5%

The Impact of Time on Three Threats

A simple decision matrix that weighs probability of risk against potential consequences is another good tool that can be easily adapted to evaluate the dangers associated with flammability, toxicity, and oxygen deficiency.

Consequences	Probability of Risk: Low	Probability of Risk: High
High	1	2
Low	0	1

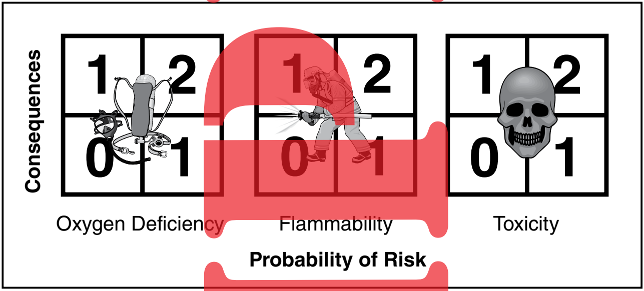
A Simple Decision Matrix That Can Be Easily Adapted

(continued next page)

Tools for Comparing Three Primary Threats (continued)

Decision Matrices (continued)

The text below gives examples of how to use decision matrices to evaluate flammability, toxicity, and oxygen deficiency. However, you can easily customize them by changing the criteria to fit the needs of the incident. Consider, too, individual objectives. Your criteria for protecting emergency responders engaged in mitigation efforts may differ from those for protecting the public.



Decision Matrices Modified for Hazmat Incidents

Oxygen Deficiency: On the probability side, what is the likelihood of reaching an oxygen-deficient atmosphere: low or high? On the consequence side, are responders (or the public) adequately protected: yes or no? Based on your answers, score oxygen-deficiency at 0, 1, or 2.

Flammability: On the probability side, what is the likelihood of reaching a flammable atmosphere: low or high? On the consequence side, are you able to eliminate all ignition sources: yes or no? Based on your answers, score flammability at 0, 1, or 2.

Toxicity: This category is the most variable, because there are so many things you can measure. First determine your objective, then place the right question on the probability side. What is the probability of reaching an IDLH atmosphere? or a protective action limit? or a workplace exposure limit? On the consequence side, are responders (or the public) adequately protected: yes or no? Based on your answers, score toxicity at 0, 1, or 2.

Chemical and Physical Change

Hazmat and WMD incidents often involve materials undergoing a physical or chemical change.

Physical Change (Physical Reaction)

When a substance changes form (solid, liquid, or gas/vapor), but not chemical composition (the elements that comprise it), it undergoes a *physical change* (or physical reaction). A common example is the way water, a liquid in its natural state, becomes a solid (ice) below 32˚F (0˚C) or a vapor (steam) above 212˚F (100˚C). Water is still H_2O in all three states, even though it has changed form and appearance.

A BLEVE (boiling liquid expanding vapor explosion) is a very violent example of what can happen when a liquid changes to a gas inside a container that cannot accommodate the corresponding increase in pressure. The causative factor in physical change is usually temperature. However, pressure is sometimes used to induce a change in state, as is the case with liquefied compressed gases.

The types of physical change are as follows:

- **Melting**—a change from solid to liquid (e.g., ice melting to water). The temperature at which this happens is called the *melting point*.
- **Freezing**—a change from liquid to solid (e.g., water freezing to ice). The temperature at which this happens is called the *freezing point*.
- **Vaporization**—a change from liquid to vapor (e.g., water boiled to steam). The point of maximum vaporization (or vapor production) is called the *boiling point*.
- **Condensation**—a change from vapor to liquid (e.g., steam condensing to water).
- **Sublimation**—a change from the solid state to a vapor state without the material ever passing through a liquid state. Sublimation is less common than the four reactions above. However, examples of materials that sublime are dry ice (carbon dioxide) and napthalene (used in mothballs).
- **Deposition**—a change from gas to solid. This rare reaction can occur as a result of a nuclear blast.

Chemical and Physical Change (continued)

Chemical Change (Chemical Reaction)

Chemical reactivity describes a material's propensity to release energy or undergo change either on its own or in contact with other materials. What distinguishes chemical reactions from physical reactions is that with chemical reactions, the material undergoes a change in composition; a new substance is formed, one that has its own chemical and physical properties and hazards.

Chemical reactions are often *exothermic*, meaning they release heat. Combustion (fire) is an example of an exothermic reaction. Fire causes many materials to change chemically, often creating *products of combustion* that are more toxic than those produced by nonhazardous materials. Sometimes, however, the combustion by-products are less hazardous than the original material. That's why, for example, it may be better to let pesticides burn than to extinguish the fire. *Endothermic* reactions are far less common. These are reactions in which heat is absorbed (e.g., a chemical ice pack becoming cold when the contents are mixed).

Chemical Change ... Air Reactivity

Materials that are *air-reactive* will ignite, decompose, or release energy when exposed to air. Some of these reactions can be quite violent.

Air-reactive materials may also be referred to as *pyrophoric*. Technically, pyrophoric materials are those that react in dry air versus moist air. However, one should never assume that the word *pyrophoric* on a warning label, on an MSDS, or in other reference sources is meant to exclude reactivity to moist air. Not everyone writing these documents will check the precise definition of a word before using it. Assume that pyrophoric materials will also react with moisture until you've determined otherwise by checking at least three reference sources.

Materials that are air-reactive but not water-reactive (white and yellow phosphorus, for example) may be stored under water to prevent contact with air. But when materials are also so water-reactive that they will react with moisture in the air (for instance, sodium and potassium), they must be stored under some other substance, such as an inert gas, mineral oil, or kerosene.

Chemical and Physical Change (continued)

Chemical Change ... Water Reactivity

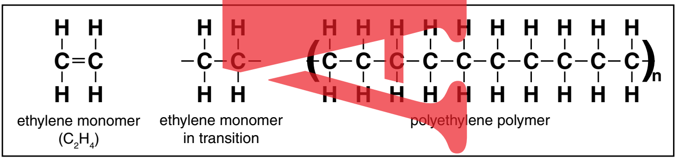
Water reactivity is the tendency of a material to react, or chemically change, upon contact with water. Reactions can range from mild to severe. The more reactive chemicals can release flammable gases, toxic gases, and/or corrosive solutions, generating a lot of heat in the process. Some materials can react explosively when exposed to water, ripping the water molecules apart to liberate oxygen. Examples of water-reactive substances include sulfuric acid, sodium, and aluminum chloride.

Water reactivity affects how a spilled material will behave on rainy or humid days. Even on a dry day, water-reactive materials present a significant health risk when in contact with the moisture on your skin, in your eyes, or in your respiratory system.

Water reactivity also affects how you handle a fire. For example, Class D extinguishers can be used on a *small* fire involving combustible metals. A *large* fire may require using a defensive attack and protecting exposures instead or withdrawing to a safe distance while the incident runs its course. Using water on the burning material itself can be disastrous.

Chemical Change ... Polymerization

Polymerization is a chemical reaction in which small compounds called *monomers* react with themselves to form larger molecules called *polymers*. These polymers are “repeating units” that resemble the original molecule. The illustration below shows how ethylene (C_2H_4), the most common monomer, is transformed into polyethylene, a chain of C_2H_4 repeating units. Polyethylene is a very common manmade plastic.



The Making of a Polymer

(continued next page)

Chemical Change ... Polymerization (continued)

Ethylene has a double bond between two carbons atoms. Double bonds between carbon atoms are not as stable as single bonds, so ethylene is prone to polymerization on its own. Human intervention is not necessarily required. However, to create polyethylene, manufacturers initiate a chemical reaction through the careful application of heat, pressure, and a catalyst. The reaction breaks one of the bonds between the carbon atoms, leaving an open bonding site on each. Open bonding sites (unpaired electrons) create a very unstable situation that nature doesn't allow to exist for very long, so these incomplete molecules combine to create more stable compounds (polymers). Different polymers can be created by varying the monomer used and the rate of the reaction.

Polymerization is not dangerous if done in a controlled manner. However, because polymers are not as dense as monomers, they take up more space. The reaction also generates heat. Heat and overpressurization can cause catastrophic container failure in uncontrolled or runaway polymerization.

Catalysts and inhibitors are substances added to other products to control their chemical reactions. *Catalysts* are usually added to speed up the chemical reactions, for instance, to coax individual monomers to hook up and become long-chain polymers. The catalysts themselves are not used up in the reaction; they can be recovered and reused. In the plastics industry, for example, organic peroxides are used to initiate the polymerization process. If catalysts are used improperly, they can increase the speed of a reaction beyond the point where the container can withstand the buildup of pressure and heat.

Inhibitors, sometimes referred to as *stabilizers* or *negative catalysts*, are added to stop or slow a reaction, such as to prevent uncontrolled polymerization. Inhibitors have a limited shelf life, meaning that they won't stop or slow a reaction indefinitely. If an inhibitor is allowed to degrade, escape, or drop below the necessary concentration, the resulting polymerization can cause the container to rupture violently. Likewise, if an inhibitor is not added where needed, it can spell disaster.

Chemical and Physical Change (continued)

Chemical Change ... Incompatibility

Incompatible chemicals are those that react with each other in ways that generally produce negative consequences. The reactions can range from relatively mild to catastrophic, depending on the type and quantity of chemicals involved. Acids and bases, for example, are incompatible with each other. If the two mix, they can generate a tremendous amount of heat. However, under controlled conditions, weak corrosives can be added to neutralize a spill of the opposite pH (i.e., a weak acid added to a base or a weak base added to an acid). Doing so still involves mixing incompatible chemicals, but the reaction is less violent than one that would result from mixing strong corrosives.

You must also consider incompatibilities with anything *brought to the scene* to manage the incident, including protective clothing, monitoring equipment, overpack containers, and other tools.

Some compatibility problems aren't apparent right away. Rather, they show up at the *next* incident. For example, structural firefighting clothing contaminated with an oxidizer at one incident may burn furiously at a subsequent fire. Clothing or other equipment that can't be adequately decontaminated must be disposed of and replaced.

Other Chemical and Physical Properties

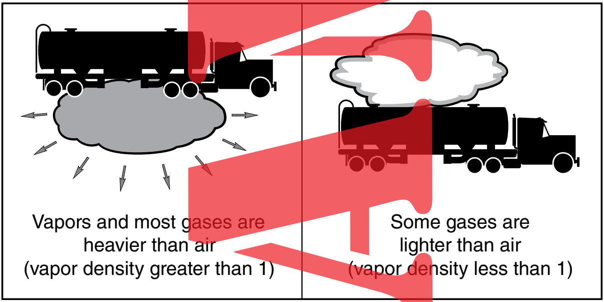
Vapor Density

Vapor density is the relative weight of vapors or gas compared to a like volume of air. Air has a molecular weight of 29, but since it is the standard against which all other gases and vapors are measured, it is said to have a vapor density of 1.

Vapors or gases with vapor densities greater than 1 (>1) are heavier than air and will settle in low-lying areas. Gases with vapor densities less than 1 (<1) are lighter than air. They will rise and dissipate more readily than those that are heavier than air.

If you don't know the vapor density of a gas or vapor, but do know its molecular weight, you can divide the molecular weight by 29 to determine its vapor density.

All *vapors* are heavier than air. (A vapor is a dispersion of molecules in air from a material that is normally a solid or a liquid.) Gasoline vapors, for example, are almost 4 times heavier than air. In a gasoline spill, most of the vapors will be close to the ground and will likely accumulate in low-lying areas. Most *gases* are also heavier than air, with the exception of some very small compounds. (See next page.)



Vapor Density of Vapors and Gases

Other Chemical and Physical Properties (continued)

Vapor Density (continued)

The chart below shows the vapor densities of the few gases that are lighter than air, many of which are very close to the weight of air.

Gases That Are Lighter Than Air

Gas	Vapor Density
Hydrogen	0.07
Helium	0.138
Natural Gas *	0.550
Methane	0.553
Ammonia **	0.589
Hydrogen Fluoride	0.690
Neon	0.696
Acetylene	0.898
Hydrogen Cyanide	0.932
Diborane	0.954
Nitrogen	0.966
Ethylene	0.967
Carbon Monoxide	0.967

* Natural gas consists mostly of methane, with varying amounts of other gases and odorizers.

** Ammonia becomes heavier and will hover near the ground if it absorbs moisture.

Although vapor density is independent of other factors, external conditions can have an effect on where a vapor or gas is found. Wind and air currents affect how well gases and vapors mix with the atmosphere and how easily they disperse. Moisture in the atmosphere can be absorbed by gases and vapors, causing them to be less buoyant. Temperature affects vapor pressure, which will cause gases and vapors to disperse at different rates. Likewise, atmospheric pressure at different elevations will either hold gases and vapors down or allow them to disperse more readily. Even concentration plays a part; lower concentrations of heavy gases and vapors won't hug the ground as much as higher concentrations do.

Other Chemical and Physical Properties (continued)

Vapor Pressure and Volatility

Vapor pressure is the force exerted by vapors of a liquid against the atmosphere or the sides of a container. The higher the vapor pressure, the greater the risk.

Vapor pressure is normally measured in *millimeters of mercury* (mmHg) at 68˚F (20˚C) at sea level. If the vapor pressure of a substance equals or exceeds 760 mmHg at sea level, the product is a gas in its normal state.

While there is no official dividing line between a "safe" vapor pressure and an "unsafe" vapor pressure, common sense tells us that a product whose vapor pressure is less than that of water (17.5 mmHg at 68˚F/20˚C) probably isn't going to "reach out and touch someone" who follows the basic principles of isolating the scene and denying entry. Obviously, you must look at a product's other properties and incident-specific factors to evaluate overall risk, but if you know the material has a low vapor pressure, it should take your stress level down a notch.

Atmospheric pressure decreases as elevation increases. Therefore, liquids will vaporize more readily at higher elevations. Take this into consideration when looking up vapor pressure (which, again, is normally measured at sea level).

While vapor pressure is normally measured in millimeters of mercury (mmHg), it may be reported in other units of measurement, particularly when the vapor pressure of a substance is very high. The following chart shows equivalent pressures in some of the most common units.

Vapor Pressure Equivalents

760 millimeters of mercury (mmHg)
29.9 inches of mercury
14.7 pounds per square inch (psi)
1 atmosphere (atm)
760 torr
1.01 bars
101.325 kilopascals (kPa)

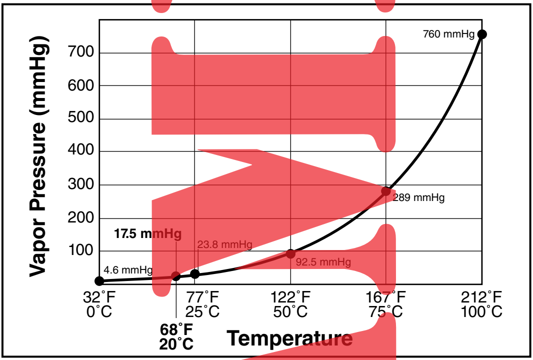
Other Chemical and Physical Properties (continued)

Vapor Pressure and Volatility (continued)

Vapor pressure is directly related to *volatility*. The higher the vapor pressure, the more volatile a material is and the more readily it will evaporate. A material is considered volatile if it evaporates quickly.

Caution: The nerve agent sarin is often described as being volatile because it has the highest vapor pressure of the nerve agents. However, with a vapor pressure of only 2.1 mmHg, it is far less volatile than water. It's a good reminder of why it's important to look beyond the sometimes misleading English descriptions to determine the chemical and physical properties of a substance.

Vapor pressure is temperature-dependent. The greater the temperature, the higher the vapor pressure. The chart below shows the vapor pressure of water at various temperatures.



The Vapor Pressure of Water at Different Temperatures

Boiling Point

Boiling point is the temperature at which the vapor pressure equals the surrounding atmospheric pressure at the surface of the liquid. It is the point of maximum vapor production, the point at which the liquid rapidly becomes a vapor. The lower the boiling point, the greater the hazard potential, because it takes less heat to vaporize the liquid.

Other Chemical and Physical Properties (continued)

Vapor Expansion Ratio

Expansion ratio is the comparison between the volume of a product in a gaseous state versus the volume of that same product in a compressed or liquefied (cryogenic) state. The higher the expansion ratio, the more volume a gas will occupy once released from its container. There are several hazards associated with a high expansion ratio.

- Hazardous gases can travel a considerable distance from the source and greatly increase the scope of the incident.
- When the product expands, it can also displace oxygen in the atmosphere, immediately creating an asphyxiation hazard, particularly in enclosed spaces and low-lying areas.
- When gases are released quickly from a cylinder, the cylinder cools. Contact with frost on the outside of the container can cause frostbite. Contact with cryogenic liquids also causes severe frostbite injury.
- Some gases in the cryogenic state can be so reactive that they form extremely shock-sensitive mixtures when in contact with combustible materials (e.g., liquid oxygen on asphalt).
- Direct flame impingement on the vapor space of a pressure vessel can cause catastrophic failure as it weakens the metal. When the vessel is no longer able to withstand the rising internal pressure, it will fail in what is known as a BLEVE (boiling liquid expanding vapor explosion). If flame is impinging on the vapor space, consider making an immediate withdrawal.
- Cylinders or tanks containing cryogenic liquids may fail catastrophically (BLEVE) when exposed to flame, radiant heat, or other high temperatures. If the cylinder or tank is exposed to flame, try to remove the source of the fire first. If it becomes necessary to use water to extinguish the fire, be careful not to spray water on the safety relief device. The escaping product will be cold enough to freeze the water and prevent the safety relief device from operating.
- If the tank has been damaged and the vacuum and insulation compromised, there is an added danger of the product warming much faster as either it or the inner tank is exposed to ambient air, water, a fire, or heat from any other source. Dealing with a cryogenic tank under these conditions is generally beyond the scope of the first responder.

Other Chemical and Physical Properties (continued)

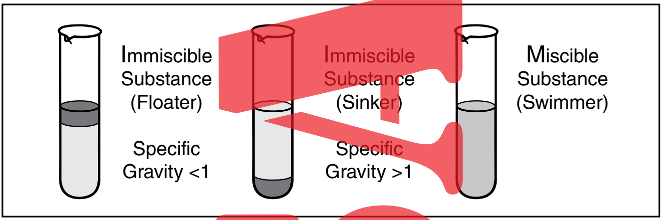
Specific Gravity / Solubility / Polarity

Specific gravity is the weight of a liquid as compared to an equal volume of water. Water weighs 8.345 pounds per gallon. However, since it is the standard against which all other liquids are measured, it is said to have a specific gravity of 1. If you don't know the specific gravity of a liquid, but do know how much it weighs, you can divide its weight (in pounds per gallon) by 8.345 to determine its specific gravity.

In general, a liquid that has a specific gravity greater than 1 (>1) will sink in water, whereas one with a specific gravity less than 1 (<1) will float on water. These liquids may be referred to as *sinkers* and *floaters*, respectively.

Specific gravity, however, is not the sole factor in determining how a substance behaves with water. For example, ethyl alcohol (drinking alcohol) has a specific gravity of 0.79, but it doesn't float on water; it mixes with it. It's what is known as a *miscible* substance.

The terms *miscibility* and *solubility* are often used interchangeably. *Miscibility* refers to the ability of products to mix, or form a uniform blend. *Solubility* refers to the ability of a product to dissolve. We usually refer to products mixing with or dissolving in water, but many chemicals can be dissolved in other solvents. Chemicals that mix in water are called *miscible* or *soluble* (water-soluble), while those that don't are called *immiscible* or *insoluble*. Chemicals that mix with water may also be called *swimmers*.



Specific Gravity and Miscibility

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Specific Gravity / Solubility / Polarity (continued)

Solubility is determined by *polarity*. In polar substances, such as water (H_2O) and ethyl alcohol (C_2H_5OH), the electrons are drawn more strongly to one element in the compound than to others. Such is not the case in nonpolar substances. This affects how compounds interact.

Since "like dissolves like," water will dissolve other polar substances (like alcohol), but not nonpolar substances (like gasoline). Thus, polar substances are water-soluble. Nonpolar substances are not water-soluble, but they may be soluble in other nonpolar substances. For example, wax will dissolve in gasoline.

Specific gravity is usually reported as a number relative to the weight of water (e.g., benzene is 0.88). Miscibility may be indicated with relative descriptions (e.g., "slightly soluble") or by percentages. For example, the *NIOSH Pocket Guide to Chemical Hazards* lists benzene as being 0.07% soluble. Its miscibility is measurable but negligible from the first responder's standpoint.

Temperature affects solubility. In general, the warmer the solvent, the greater its capacity to dissolve a substance added to it. Thus a hazardous material may be more soluble on a hot day than it is on a cold one. (Gases behave differently; the warmer they are, the less soluble they become.)

Knowing how a liquid behaves is important for fire control. With flammable liquids that float on water, it will be necessary to use foam to smother a fire and retard vapor production. With liquids that sink in water, vapor production can be suppressed using light applications of water. Water-soluble (miscible) liquids can be managed either by diluting the product to reduce vapor production so that vapors are no longer within the flammable range or by smothering the fire with an alcohol-type concentrate (ATC) foam.

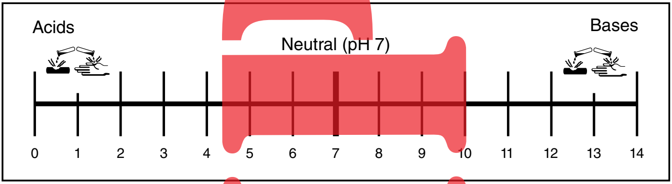
Specific gravity is important when building a dam downstream to contain a spill that has entered a waterway. Specific gravity would dictate whether to build a simple dam (for miscible liquids), an overflow dam (for sinkers), or an underflow dam (for floaters). (See pages 12-7 to 12-9 for more information on the different types of dams.)

Other Chemical and Physical Properties (continued)

Corrosivity

Corrosivity is a measure of a material's ability to corrode—to dissolve or wear away by chemical action. Corrosives are measured in terms of strength and concentration.

Strength is measured on a *pH scale*, which goes from 0 to 14, with 7 being neutral. Materials with a pH of 0 to 6.9 are acidic, while those with a pH of 7.1 to 14 are basic (or caustic or alkaline). (For the purpose of classifying hazardous waste, the EPA defines acids as those materials with a pH of 2 or less and bases as those with a pH of 12.5 or more. See 40 CFR 261.22.)



The pH Scale for Measuring Strength of a Corrosive

The pH scale is a logarithmic scale, meaning each number reflects a ten-fold difference in corrosivity. For example, a solution with a pH of 1 is ten times more acidic than one with a pH of 2 and a hundred times more acidic than one with a pH of 3. At the opposite end of the scale, a solution with a pH of 13 is ten times more alkaline than one with a pH of 12 and a hundred times more alkaline than one with a pH of 11.

Concentration is the amount of acid or base in water. Concentration may be expressed in several ways. The most common measurement is percentage (by weight) of an acid or base to water. The higher the percentage, the more concentrated the solution. *Molarity* and *normality* are two other ways of expressing concentration. Again, the higher the number, the more concentrated the solution. For example, a 4M (molar) or 4N (normal) solution is more concentrated than a 3M or 3N solution.

(continued next page)

Other Chemical and Physical Properties (continued)

Corrosivity (continued)

Solutions with more than 35% acid by volume are considered "concentrated," while those with less than 10% acid by volume are referred to as "dilute." Other terms used to identify concentrated acids include *anhydrous*, *glacial*, and *fuming*.

There is no easy way to measure concentration in the field. However, it is possible to do a quick estimate by comparing the weight of a solution with an equal amount of water. Corrosives are typically much heavier than water. The more concentrated the solution, the heavier that solution is.

It is important to consider both strength and concentration, but concentration is more significant. A strong acid or base in low concentrations (dilute) may pose little risk. However, weak acids or bases in concentrated solutions can be quite dangerous.

Acids and bases damage human tissue in slightly different ways. An acid will cause the tissue to harden even as it eats away at that tissue, thereby limiting the damage to some degree. A base will soften and dissolve the tissue, creating far more penetrating and severe injuries. (This softening of the tissue produces a slippery or soapy sensation.) With both acids and bases, however, the damage will continue until the corrosive is thoroughly flushed from the body. And often the extent of the injury is not immediately obvious, something corrosive burns have in common with thermal burns.

Corrosives often produce immediate irritation, but it's not uncommon for pain to be delayed with corrosives in solid form, which don't start eating away at the tissue until they react with the moisture on the skin. Such a corrosive on dry skin might not be noticed until a person starts sweating or takes a shower.

Atmospheric Monitoring

Atmospheric monitoring is generally beyond the scope of this book, but the following are some key points.

Key Points and Safety Guidelines

- Follow your training and department SOPs.
- Do not attempt to perform atmospheric monitoring if it is unsafe to do so or you have not been properly trained.
- Wear appropriate PPE.
- Operate monitoring equipment properly, in accordance with the manufacturer's instructions, to ensure accurate readings and to avoid damaging the equipment.
- Allow for lag time (a delay before readings are displayed) inherent in all monitors, particularly when using extension hoses.
- Monitor throughout the area (high, low, and anywhere vapors may accumulate) to get an accurate assessment.
- Avoid using monitoring equipment near exhaust fumes (e.g., from vehicles or heaters) since this can cause false readings.
- Periodically purge monitoring instruments with clean air, if necessary, to avoid getting an accumulated reading.
- Use only intrinsically safe equipment in potentially flammable atmospheres.
- Use a combination of detectors. No single instrument can provide sufficient information about an unknown atmosphere.

Monitoring Priorities for Unknown Atmospheres

Neither 29 CFR 1910.120 nor NFPA 472 specify the order in which monitoring instruments should be used. However, it's important to have a logical and systematic approach to monitoring an unknown atmosphere. You must assess the hazards and adjust accordingly. Many factors can affect your safety and the accuracy of your instruments. Examples include, but are not limited to:

- Some monitors are not intrinsically safe and cannot be used in potentially flammable atmospheres.
- Combustible gas indicators (CGIs) will not function properly in oxygen-deficient atmospheres. It is best to use an instrument that monitors for both oxygen level and combustible gases.
- Corrosive vapors can damage electronic devices and cause erroneous readings. You may need to check for corrosive vapors while using other monitoring equipment. (See next page.)

Monitoring an Unknown Atmosphere

Do not attempt atmospheric monitoring that is beyond the scope of your training, resources, PPE, or department SOPs. The following guidelines are provided for general information only; the order in which these are done will vary depending on the potential hazards and the equipment available.

Check for **radioactive materials** using a survey meter. (This step may not be needed if radioactive materials aren't likely to be present. However, when in doubt or when faced with an explosives incident, monitor for radioactive materials.) Warning: Many radiation detectors are not intrinsically safe for use in potentially flammable atmospheres.

Check the unknown atmosphere for **flammable gases or vapors** as soon as possible using a combustible gas indicator (CGI). CGIs measure flammable or combustible vapors in relation to their lower explosive limits (LEL). They may also measure concentration in parts per million (ppm). Anything over 10% of the LEL should be carefully evaluated before taking further action. Refer to department SOPs for guidelines regarding where to draw the line between taking action and withdrawing to a safe distance until the flammability risk can be reduced.

Check for **oxygen levels**. An *oxygen-deficient* atmosphere (<19.5%) requires the use of SCBA or supplied-air respirators. Keep in mind that any drop in the oxygen level, even a small one, could mean that oxygen was displaced by dangerous levels of a contaminant. Further monitoring may be required. An *oxygen-enriched* atmosphere (>23.5%) should be considered potentially explosive.

Check for **corrosive gases or vapors** using a wet piece of pH or litmus paper. This can be done simultaneously with the other tests by attaching a wet strip of pH or litmus paper to a long stick and holding it out in front of you. (Corrosive liquids or solids can also be detected using pH or litmus paper.)

Check for **toxic materials** with electrochemical sensors, colorimetric tubes, ionization detectors, or other appropriate devices.

Atmospheric Monitoring (continued)

Understanding Meter Readings

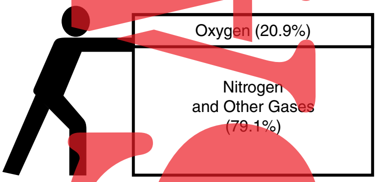
Although it is beyond the scope of this book to address how to use atmospheric monitors, there are a few basic concepts you should be familiar with so that you don't misinterpret meter readings and put yourself in danger.

If atmospheric monitors are designed to measure a specific contaminant concentration in either parts per million or percent by volume in air, meter readings are easy to understand. The chart below shows the relation between percent by volume and parts per million (ppm) or parts per billion (ppb).

% by volume	ppm	ppb
0.1%	1,000	1,000,000
1%	10,000	10,000,000
10%	100,000	100,000,000

Often, however, meter readings are not so simple. For example, the percentage reading on a combustible gas indicator reflects percentage of the lower explosive limit, not total percentage of a contaminant gas or vapor by volume in air. Many meters provide data based on a calibrant gas; contaminant concentration must be calculated using conversion factors supplied by the manufacturer.

If you have equipment to monitor oxygen levels, you must understand the relation between oxygen displacement and contaminant concentration. A contaminant gas or vapor will displace both oxygen and other gases normally present in the atmosphere. Because oxygen comprises 20.9% of the normal atmosphere, a 1% oxygen displacement means the contaminant concentration is roughly 5% (50,000 ppm), not 1%.



Oxygen comprises 20.9% of the atmosphere; thus a 1% displacement indicates a contaminant concentration of roughly 5%.

High-Risk Situations

The following situations can be extremely hazardous. Some are dangerous enough that even trained hazmat teams must call for additional assistance. Unless you have the specific training and protective equipment required to handle high-risk situations, leave them for someone with more training and experience.

- **Explosives or explosively unstable chemicals**. Examples include crystallized picric acid, peroxided ethers from clandestine drug labs, or old dynamite. Do not move or touch these materials. Call for assistance from personnel trained in explosives disposal.
- **Explosive atmospheres**. Potentially explosive conditions exist when a product is at or near its flammable range or when the atmosphere is oxygen-enriched (>23.5% oxygen). It may be possible to manage these conditions by remote product control, foam or water application, or ventilation.
- **Oxygen-deficient atmospheres**. Atmospheres containing less than 19.5% oxygen require the use of SCBA or supplied-air respirators. Keep in mind that any drop in the oxygen level, even a small one, could mean that oxygen was displaced by dangerous levels of a toxic contaminant. Further monitoring may be required.
- **Pressure vessels**. A release from a pressure vessel can cause oxygen displacement. Pressure vessels are also subject to catastrophic failure (BLEVE) when exposed to fire. Call the shipper or CHEMTREC for guidance.
- **Cryogenic materials**. Hazards of a cryogenic release include oxygen displacement and extreme cold (less than -130˚F/-90˚C). Some cryogenic materials are also extremely flammable or reactive. Cryogenic containers may be subject to catastrophic failure (BLEVE) when exposed to fire. Contact the shipper or CHEMTREC for guidance.
- **Etiologic agents**. Incidents involving infectious materials should be reported to your county health officer and the U.S. Centers for Disease Control and Prevention (CDC).
- **Overpressurized drums**. Overpressurized drums are subject to catastrophic failure when disturbed even slightly. Often they must be opened by remote mechanical devices.
- **Terrorist events**. Terrorist events (WMD incidents) may involve hazardous materials far more dangerous than common household or industrial chemicals. There is also the added risk of possible secondary events aimed at killing or injuring responders.

Illicit Laboratories

Illicit laboratories for the manufacture of drugs, WMDs, and other weapons can be found virtually anywhere in your community—in structures (e.g., homes, hotels/motels, businesses, laboratories, or rental storage facilities), in vehicles (e.g., motor homes, trucks, boats, or cargo containers), or in remote outdoor locations (e.g., farms, campgrounds, or parklands). Waste products from these operations can also be dumped anywhere. Since illicit laboratories will not be readily identified as such, you must be alert to warning signs of possible criminal or terrorist activities.

Warning Signs

Incidents involving illicit laboratories are generally reported as other emergencies. The following are examples:

- Medical aid calls with burn or smoke inhalation victims
- A structure fire, perhaps accompanied by an explosion
- Investigation calls (smoke investigation, odor complaint, illegal dumping, etc.)

The following are some additional clues:

- Covered or painted windows
- Bars on doors or windows
- Chemical odors
- Chemical containers and glassware
- Stains on walls or ceilings
- Corrosion on metal surfaces
- Unusual pipes or ducts coming from windows or walls
- Fans in inappropriate locations
- Portable generators for outdoor sites
- Trip wires, pipe bombs, IEDs, or other booby traps
- Weapons
- Guard dogs
- Propane tanks with unusual valves or attachments
- Unusual discoloration on tanks or valves (A green tint or discoloration to brass valves or fittings on an LPG tank or similar container is a red flag that the cylinder contains ammonia for methamphetamine production. This is very dangerous. Leaking anhydrous ammonia can cause severe respiratory injuries or death. If the cylinder is knocked over and the valve damaged, the cylinder can become a missile, killing or injuring anyone in its path.)

Illicit Laboratories (continued)

Chemical Dangers at Drug Labs

Chemicals used in clandestine drug labs vary depending on the drugs being processed, but most of the chemicals can be very dangerous. The information on the following three pages is provided to help you recognize a possible drug lab. However, dealing with these chemicals is usually beyond the role of the first responder. Call for trained assistance right away.

Warning Odors

The previous page listed a number of visual clues that may alert you to the presence of an illicit laboratory. Sometimes, however, the most obvious clues are characteristic odors associated with chemicals typically used at clandestine drug labs:

- Solvent (antiseptic, hospital-like)
- Fuel (gasoline, paint thinner-like)
- Ether-like (characteristic, sweet, pleasant)
- Vinegar-like (strong, biting)
- Ammonia-like (strong, irritating)
- Sour (metallic, irritating)
- Pungent (acrid, sour)
- Baby diapers or cat urine (unpleasant)

Let odors be a warning, but don't rely too heavily on them. You can be exposed to dangerous levels of a chemical without ever smelling it.

- Some chemicals are odorless.
- Some chemicals are harmful at concentrations below the odor threshold.
- Some chemicals cause olfactory fatigue.
- Some people are less sensitive to odors than are other people.
- It may be difficult to discern one chemical odor from another, particularly where there are multiple chemicals or someone has tried to mask the chemical odor with something else.

Remember, too, that these chemical odors are not proof that you have found a clandestine drug lab. But whether the chemicals are being used legally or illegally, they still present a danger if released from their containers.

Illicit Laboratories (continued)

Chemical Dangers at Drug Labs (continued)

Listed below are examples of chemicals commonly found in drug labs. Remember, many chemicals have multiple hazards. And some present added risks due to the environment. For example, the inert gas Freon, which used to be common in drug labs, will displace oxygen in an enclosed atmosphere.

Examples of Flammable and Combustible Chemicals

Because people operating clan labs rarely adhere to proper safety procedures, you must anticipate that a flammable concentration of vapors exists until you can prove otherwise through atmospheric monitoring. The following are **flammable** materials.

Acetaldehyde	Dioxane	Nitromethane
Acetic acid	Ethanol	Pentane
Acetic anhydride	Ethyl acetate	Petroleum distillates
Acetone	Ethyl ether	Petroleum ether
Acetonitrile	Hexane	Picric acid
Acetylene	Hydrogen	Piperidine
Allyl chloride	Hydrogen sulfide	Pyridine
Ammonia	Isopropanol	Pyrrolidine
Benzene	Methanol	Red phosphorus
Butylamine	Methylamine	Tetrahydrofuran
Carbon disulfide	Methyl ethyl ketone	Toluene
Cyclohexane	Morpholine	Vinyl chloride
Dimethylamine	Nitroethane	Xylene

The following are **combustible** materials.

Aniline	Dimethylformamide	Formamide
Benzyl chloride	Dimethyl sulfate	Kerosene
Cyclohexanone	Ethylene chlorohydrin	o-Toluidine

Examples of Oxidizers

Oxidizers in contact with flammable or combustible materials can create explosive combinations.

Nitric acid	Nitroethane	Perchloric acid	Trinitrotoluene

(continued next page)

Chemical Dangers at Drug Labs (continued)

Examples of Corrosive Chemicals (Acids and Bases)

Not only do corrosives cause severe chemical burns, most are water-reactive.

Acetic acid	Nitric acid	Ammonium hydroxide
Bromine	Perchloric acid	Potassium hydroxide
Hydriodic acid	Phosphoric acid	Sodium hydroxide
Hydrochloric acid	Sulfuric acid	(Drano or Red Devil Lye)
Formic acid		

Examples of Reactive Chemicals

The following chemicals can react violently with water, air, and/or organic solvents.

Lithium	Raney nickel
Lithium aluminum hydride	Sodium
Magnesium (turnings or powder)	Sodium borohydride
Palladium black	Thionyl chloride
Phenyl magnesium bromide	White phosphorous

Examples of Poisonous (Toxic) Chemicals

Many of the chemicals found at drug labs are toxic by inhalation, ingestion, and/or skin absorption. Some are known or suspected carcinogens.

Acetaldehyde	Chloroform	Perchloroethylene
Acetamide	Hexane	Phosphine
Acetic anhydride	Hydrogen bromide	Phosphine cyanide
Acetylanthranilic acid	Hydrogen chloride	Potassium cyanide
Allyl chloride	Iodine	Raney nickel
Ammonia	Lead acetate	Sodium cyanide
Benzene	Mercuric chloride	o-Toluidine
Benzyl chloride	Mercuric nitrate	1,1,1 Trichloroethane
Benzyl cyanide	Mercury	(methyl chloroform)
Carbon disulfide	Methylene chloride	Trichloroethylene
Carbon tetrachloride	Methylformamide	Vinyl chloride
Chlorine	Nitric acid	
Chloroacetyl chloride	Nitrotoluene	

Illicit Laboratories (continued)

Common Chemicals at Illicit Chemical Labs

Listed below are examples of chemicals commonly found in illicit chemical labs.

Examples of Flammable and Combustible Chemicals

Acetone	Ethylene	Nitromethane
Acetylene	Ethylene dichloride	Toluene
Cyclohexanol	Methyl chloride	Vinyl chloride
Dimethylamine		

Examples of Corrosive Chemicals (Acids and Bases)

Bromine	Phosphorus trichloride
Hydrofluoric acid	Sulfuric acid

Examples of Poisonous (Toxic) Chemicals

Arsenic	Carbon tetrachloride	Malonitrile
Arsenic trichloride	Chlorine	Sodium cyanide
Benzyl chloride	Potassium cyanide	

Illicit Biological WMD Labs

You may not recognize biological warfare agents in an illicit lab, but you should be able to recognize laboratory equipment (such as incubators, fermentors, and agar growth plates) used to grow biological materials. Some hazardous chemicals might also be present.

Illicit Laboratories (continued)

Dealing with illicit laboratories is beyond the scope of the first responder. However, the following guidelines are provided because you need to know what to do if you encounter an illicit lab.

General Safety Considerations

- Do not enter known or suspected illicit laboratories. If you've already unknowingly entered one, evacuate immediately.
- Beware of hostile suspects and booby traps (inside and out).
- Wear full PPE, including SCBA.
- Do not turn utilities or electrical switches on or off until it is determined that it is safe to do so. Your actions may provide an ignition source or interrupt a critical cooling process.
- Treat illicit labs like a bomb ready to explode. Some illicit labs contain chemicals that are extremely explosive.
- Do not eat, drink, or smoke at any hazmat/WMD incident. Wash hands thoroughly before eating, drinking, or smoking.
- Do not touch, taste, smell, or disturb chemicals, containers or apparatus. Do not remove materials from ice baths.
- Observe illegally dumped containers from a safe distance.
- Do not trust container labels. They are frequently wrong.

General Tactical Considerations

- Once you've identified a possible illicit laboratory, pull back immediately, secure the scene, and establish an isolation zone. Request assistance from a hazmat team, narcotics officers, the FBI, and/or other appropriate resources.
- Position response vehicles at a safe distance, pointing in the direction of egress if possible.
- Preserve evidence as much as possible.
- For small fires, use dry chemical or carbon dioxide extinguishers. If necessary to use water on larger fires, try to contain runoff water. If possible, protect exposures and let the chemicals burn instead. Consider evacuating areas downwind of the fire.
- In the event of a fire, discontinue overhaul and leave the structure once chemicals or drug apparatus are discovered.
- Use positive pressure ventilation to clear the structure.
- If the drug lab is in a confined space, follow your department's SOPs for confined spaces.
- Isolate and decon contaminated personnel and equipment.
- Expect significant quantities of waste product requiring proper disposal.

Hazmat Triage

Large-scale disasters such as earthquakes, floods, and hurricanes may create numerous hazmat incidents. These incidents will need to be prioritized (triaged).

Area and Population Impacted

Many factors affect the decision making process, not the least of which are the hazards associated with the chemical(s). The area and population threatened is another very significant factor. You should assess the potential impact and relay this information to the incident commander.

Direct life hazards involve people in the direct area of the release. Can these people move themselves to a safe refuge area or must they be rescued? Do they need medical care? How many people need assistance?

Extended life hazards refer to exposed populations downwind or downstream from the release. How many people are impacted? What protective actions are required or recommended? What options are available if you do not have sufficient resources to implement protective actions? How much time do you have?

Exposure hazards deal with the spread of the incident. What is the risk of the incident escalating? Can the chemicals reach areas where victims are trapped or enter storm drains or other water sources? What can be done to prevent these things?

Resources Required

Another factor to consider is the level of mitigation needed. Will the incident mitigate itself without the need for intervention? Can the problem be handled by first responders using defensive actions, such as damming, diking, or diverting? Or does this require offensive actions performed by a trained hazmat team wearing chemical protective clothing?

It may be necessary in a major disaster to implement partial solutions, such as slowing a release to a more acceptable level rather than stopping it entirely. You can help to identify intermediate measures that can buy time until other resources arrive.

Medical Management of Hazmat Exposures

This chapter provides general information on the risk of secondary contamination, patient decon guidelines, triage, common signs and symptoms of hazmat exposure, EMS treatment protocols, handling the dead, coordinating with other medical providers, and medical support for hazmat response personnel (including treatment of heat and cold emergencies). Remember, however, that your standard operating procedures (SOPs) and local protocols take precedence over these general guidelines.

Note: Medical information specific to terrorist events involving chemical warfare agents, biological warfare agents, and nuclear events is covered in Chapters 9, 10, and 11 respectively.

Secondary Contamination

A person exposed to a hazardous material is not necessarily contaminated with it. However, if the person is contaminated, in other words, has the material on his or her body, there may be a risk of secondary (cross) contamination (or transfer) to others.

The Risk to EMS Personnel (Based on Type of Chemical)

Listed below are examples of materials that pose a risk of secondary contamination to EMS personnel from contact with product on a patient's skin or clothing. The information is adapted from the *Hazardous Materials Medical Management Protocols* published by the California EMS Authority.

Chemicals That Present a High Risk

- Concentrated corrosives (acids or bases)
- Cyanide salts
- Hydrofluoric acid
- Hydrogen cyanide
- PCBs (polychlorinated biphenyls)
- Pesticides and herbicides
- Phenol and phenolic compounds
- Radioactive liquids and dusts
- Many products that contain nitrogen (e.g., nitrates, nitrites, nitriles, aniline, and amines)
- Many other oily or adherent toxic dusts and liquids

Chemicals That Present a Low Risk

- Asbestos
- Most gases and vapors (unless they condense in significant amounts on clothing, skin, or hair)
- Weak acids and bases (except hydrofluoric acid) in low concentrations
- The vapors of weak acids and bases (except hydrofluoric acid), unless clothing is soaked with the product
- Gasoline, kerosene, and related hydrocarbons
- Smoke and by-products of combustion (excluding those from chemical fires)
- Small quantities of common hydrocarbon solvents (e.g., toluene, xylene, paint thinner, ketones, and chlorinated degreasers)

Secondary Contamination (continued)

The Risk to EMS Personnel (Based on Patient Care Activities)

- Patients exposed to only gases or vapors (even those that are highly toxic) are not likely to pose a risk of secondary contamination unless the gas or vapor has condensed in significant amounts on clothing, skin, or hair.
- Patients whose skin, hair, or clothing is grossly contaminated with a solid or liquid (including condensed vapor) may contaminate responders by direct contact or by off-gassing vapor.
- Once patients have been thoroughly decontaminated, they generally do not present a risk of secondary contamination.

Author's Commentary

Most experts tell us that once patients have been thoroughly decontaminated, they no longer present a risk of secondary contamination. This is good information, but it falls short of answering some important questions.

First, how do we know that a patient has been thoroughly decontaminated? There are some things we can do to test our results. For example, pH paper can be used to check for presence of corrosives, and a radiation detector can be used to check for residual radioactive materials. However, in most cases, we're relying on the judgment of the decon team (or the patients themselves if we allow them to self-decon). Thus it's important to understand the basic principles of decon, the extent of patient contamination, and what decon solutions and procedures are appropriate for the hazardous material involved. Without this knowledge, we might either be unnecessarily fearful of caring for patients who don't present a risk of secondary contamination or be too quick to touch those who do. And we must never be hesitant to question the adequacy of decon if we have any doubts.

Second, what about those times when patients are not thoroughly decontaminated—when we decide to cut short our decon efforts because the patient is in critical condition, deteriorating rapidly, or in danger of hypothermia or because the sheer number of patients requires us to work more expediently?

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Secondary Contamination (continued)

Author's Commentary (continued)

Decon efforts shouldn't be cut short where there's a significant risk of secondary contamination. Doing so puts us and our patients in danger. (Refer to page 6-3 for a list of chemicals that present a high risk of secondary contamination.) At minimum, you should remove contaminated clothing and run these patients through emergency decon. If you must postpone more thorough decon efforts, you should use universal precautions and body substance isolation procedures (page 6-8) and take precautions to protect the ambulance (page 6-9). It's also a good idea to seek advice from a toxicologist or poison control center.

Third, what is the risk of secondary contamination from the patient's exhaled air, blood, emesis, or other body fluids? Most other authors don't even ask this question, let alone answer it. However, it's a very important question. I've discussed this with several medical professionals and hazmat specialists to get their input. I believe the following comments represent the predominant thinking across the country.

It's rare for EMS personnel to be at risk of secondary contamination from residual hazardous materials in a patient's exhaled air, blood, emesis, or other body fluids. *However, it is not impossible*. Occasionally we'll hear stories of isolated incidents where EMS or hospital personnel suddenly become ill while caring for a patient. Often the exact cause of the problem is undetermined, leaving us to wonder if it was truly a hazmat exposure or something else (perhaps even hysteria). When we hear about such incidents, it tends to shake our confidence.

Amount and route of exposure to a hazardous material are important factors in determining our degree of risk. For example, a patient who ingested an organophosphate pesticide in an attempt to commit suicide presents a greater risk than one who inhaled a minute quantity of a nerve agent during a terrorist attack, even though nerve agents are far more deadly than ordinary pesticides are. A patient who intentionally ingested a hazardous material in an attempt to commit suicide will have far more of it in his or her

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Secondary Contamination (continued)

Author's Commentary (continued)

body than one whose exposure was accidental. If that patient vomits soon after ingesting the material, much of it will be in the patient's emesis because there hasn't been time for it to be absorbed into the bloodstream. The more time that passes before the patient vomits, the lower our risk of secondary exposure.

The volatility of a hazardous material is also an important factor. The higher the vapor pressure, the faster the material will dissipate into the atmosphere, even materials carried in a patient's body fluids or exhaled air.

We also need to consider how hazardous materials act on the body. Let's once again look at the scenario of a terrorist attack using a deadly nerve agent. First, there's a limit to how much patients can inhale without the exposure becoming fatal, and once a patient stops breathing, he or she won't inhale any more of the agent. Respiratory arrest becomes a limiting factor. Second, nerve agents do their damage by inhibiting the acetylcholinesterase enzyme in the nervous system. The agents aren't roaming around free in body fluids waiting for an opportunity to attack someone else. What little remains in the lungs will be exhaled after a few breaths. So our risk is truly minimal. One can do the same kind of analysis with any hazardous material to determine the relative risk, although it's best to consult with a toxicologist or your local poison control center for better input.

Some of the biological warfare agents are different in that the diseases they ultimately produce can be easily transmitted from one person to another (e.g., smallpox and, to a lesser degree, pneumonic plague and viral hemorrhagic fevers).

Universal precautions and body substance isolation procedures (page 6-8) go a long way toward protecting us from any residual hazardous materials in a patient's exhaled air, blood, emesis, or other body fluids. For example, using pocket masks provides a barrier against chemicals on the lips or in emesis. Using mechanical devices for artificial respiration allows us to keep our faces away from the patient, further reducing the risk of exposure to

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Secondary Contamination (continued)

Author's Commentary (continued)

anything in the patient's exhaled air. Double-bagging emesis basins or articles contaminated with the patient's blood or body fluids contains the materials in those fluids and allows us to function safely.

Finally, the textbook *Medical Aspects of Chemical and Biological Warfare*, published by the U.S. Army Office of the Surgeon General, addresses the risk of secondary contamination to surgeons handling wounds contaminated with chemical warfare agents. The information in this book can give us further confidence in being able to safely care for patients. It indicates, first of all, that only the nerve agents and blister agents present a hazard from wound contamination. The only other agent addressed, cyanide, is volatile enough that it's unlikely cyanide will remain in the wound.

The book indicates that the risk from nerve agent or mustard vapor off-gassing from a wound is very low or not significant. However, direct contact with liquid agent in the wound (specifically "chemical agent on foreign bodies" and "thickened agents") is a concern. Thickened agents are not dissolved as quickly in biological fluids, nor are they absorbed by tissue as rapidly as other agents. Thickened mustard has delayed systemic toxicity and can persist in wounds even when large fragments of clothing have been removed. VX, although not a thickened agent, is absorbed less quickly than other nerve agents are and may persist in a wound longer than other nerve agents do.

Because vapor off-gassing is not a concern, no respiratory protection is required. However, personnel are advised to wear a pair of well-fitting (thin) butyl rubber gloves or double latex surgical gloves and to change them often until they are certain there are no foreign bodies or thickened agents in the wound. Thin butyl rubber gloves will have no breakthrough for 60 or more minutes in an aqueous base. Double latex gloves will have no breakthrough for 29 minutes in an aqueous medium, but should be changed every 20 minutes to provide a safety buffer. This is especially important where puncture is likely.

Secondary Contamination (continued)

Universal Precautions and Body Substance Isolation Procedures

If patients have been thoroughly decontaminated, you shouldn't need any special PPE to treat patients in the cold zone; universal precautions (barriers, handwashing, precautions to prevent injuries) should suffice. When in doubt, use additional body substance isolation procedures.

- Remove all leather items and other materials that cannot be easily decontaminated.
- Wear medical exam gloves. Double-glove if appropriate. (Use leather gloves over exam gloves for extrication or other activities where there is a risk of being cut by sharp objects. Dispose of contaminated leather gloves afterwards.)
- Change gloves between patients.
- Use a NIOSH-certified HEPA filter respirator (or equivalent) when caring for patients with a disease infectious by airborne transmission. (If possible, place masks on these patients also.)
- Wear eye protection or a face shield.
- Wear a full-sleeve disposable isolation gown or apron, disposable shoe covers, and a disposable head cap. (If possible, these items should be impervious to water.)
- Replace wet or contaminated masks and other protective clothing as soon as practicable, and wash exposed skin.
- Use pocket masks or mechanical devices to provide artificial respiration. Do not use mouth-to-mouth resuscitation.
- Do not recap, cut, or bend used needles. Dispose of them into puncture-resistant "sharps" containers.
- Promptly double-bag emesis basins and other articles contaminated with the patient's blood or body fluids.
- Wash hands thoroughly after patient contact. Use plain soap for routine handwashing. Use an antimicrobial agent or waterless antiseptic agent if patients are known or suspected to be infected with a highly contagious disease. Pay special attention to the areas under the fingernails and between fingers.
- If patients have undergone only gross decon, consider using duct tape to secure openings in your protective equipment.
- If patients are contaminated by concentrated corrosives or substantial amounts of oily or fat-soluble liquids, consider wearing chemical-resistant coveralls and gloves (over exam gloves). (Check with your hazmat team for chemical compatibility.)

Secondary Contamination (continued)

Transporting Patients / Preparing the Ambulance

If patients are thoroughly decontaminated and do not present a risk of secondary contamination, no special precautions are needed to prepare the ambulance. However, if that's not the case, take the following precautions as needed.

- Transport patients only to "appropriate receiving centers" that meet the requirements for dealing with hazmat exposures.
- Consider transporting patients in vans, buses, or other vehicles that are easier to decontaminate than ambulances are.
- Use multiple ambulances if needed—some for patients who have been fully decontaminated and some for those who haven't.
- Wear appropriate PPE. (See page 6-8.)
- Get equipment or supplies you will need for patient care ready in advance to minimize the risk of contaminating other equipment by reaching into cabinets with dirty gloves.
- If appropriate, use plastic to wrap or cover exposed equipment that is not disposable or difficult to decon (e.g., backboards, straps, leather products, and ribbed seat covers.) (While some agencies promote protecting the ambulance with plastic, others prefer not to do so because it provides only limited protection and can delay patient care. Follow your department SOPs or local protocols.) Consider removing the gurney mattress and placing patients on covered backboards instead.
- If appropriate, cover patients with plastic. (Some agencies recommend using plastic to contain residual contaminants. Others recommend against this practice because it increases the risk of chemical absorption and can hamper patient care. Follow your department SOPs or local protocols.)
- Double-bag containers (e.g., poison bottles) that you bring with patients to the hospital.
- If possible, leave windows open to provide fresh air.
- Don't bring patients into the emergency department until told to do so by hospital personnel.
- Decontaminate or discard contaminated equipment afterwards. Inventory discarded equipment for cost recovery.
- Conspicuously mark contaminated ambulances, and don't put the ambulances back in service until they have been decontaminated. (Exception: In mass casualty incidents, it's acceptable to keep ambulances in service until all contaminated patients have been transported.)
- Update all documentation as needed.

Patient Decontamination

The following pages focus only on patient decon. Other decon information can be found on pages 2-57 to 2-60.

General Concepts

- Assume patients are contaminated until proven otherwise.
- Promptly remove contaminated clothing, shoes, jewelry, etc. Doing so can remove 60% to 90% of the contamination.
- Prevent inhalation exposures by not lifting clothing over the face. Cut clothing off if necessary, being careful not to cut through evidence (e.g., holes from bomb fragments).
- Have conscious patients assist to the extent that they are able.
- If the material poses a threat to life, start with emergency decon. You can set up a more thorough decon operation afterwards.
- Make patients as clean as possible before transporting them to a hospital. Only if they are in critical condition, deteriorating rapidly, or in danger of hypothermia, should you transport patients who have not been *thoroughly* decontaminated. First, however, remove contaminated clothing, do emergency decon, and take precautions to protect EMS and hospital personnel. (Most hospitals have only limited decon capabilities, if any.)
- If possible, use detection equipment (e.g., pH paper or radiation detectors) to check for residual contamination on patients.
- Monitor patients' medical conditions during decon.
- Protect patients' modesty as much as possible. Shield them from onlookers and photographers. Once decon is complete, provide patients with disposable clothing or blankets.
- Make plans to deal with psychological effects to responders and patients, including frightened children.
- Have law enforcement personnel manage criminal suspects or other potentially violent people.
- If emergency responders need decon, leave their SCBA masks in place until protective clothing has been decontaminated.
- If police officers need decon, ensure their weapons are properly handled and rendered safe.
- Transfer patients to clean backboards or stretchers before handing them to EMS personnel in the cold zone.
- Ensure that patients are medically evaluated after decon.
- Decon service animals (e.g., seeing-eye dogs and rescue dogs). If possible, use their human partners to help keep the animals calm and prevent injury to decon personnel.
- If possible, preserve and secure evidence found during decon.
- Document the decon done for each patient.

Patient Decontamination (continued)

Decon Versus Medical Care

The recommendations in NFPA 473 for prioritizing medical treatment and decontamination are summarized in the chart below.

Contamination		Priority Based on Medical Condition		
Level	**Toxicity**	**Critical**	**Unstable**	**Stable**
heavy	high	both	decon	decon
heavy	low	medical	both	both
light	high	both	decon	decon
light	low	medical	medical	both

Critical: Airway compromised, serious shock, cardiac arrest, life-threatening trauma or burns.
Unstable: Shortness of breath, unstable vital signs, altered level of consciousness after exposure, significant trauma or burns.
Stable: Stable vital signs, no altered level of consciousness, no significant trauma or burns.

Chemical in eyes: Flush eyes immediately and thoroughly.

Summary of NFPA 473 Recommendations for Prioritizing Medical Care and Decontamination

Medical Care: When patients have life-threatening injuries, the need for medical care often outweighs the need for decontamination. However, gross decon should be done while treating the injuries and before transporting patients to a hospital.

Decon: Unless patients are in critical condition, if they're contaminated with a highly toxic substance, decon is a higher priority than medical care. It might not be safe to render care without PPE that protects against exposure.

Both (Combined Priorities): Often there's no clear winner; medical care and decon are equal priorities for the protection of the patients and EMS providers alike. Treatment for life-threatening injuries should be rendered along with rapid decon. Again, however, it might not be safe to render care without PPE that protects against exposure.

Patient Decontamination (continued)

Decon Solutions

Your primary objective should be to remove the materials from the body as quickly and completely as possible by the best means available. It's helpful to have decon protocols with standard solutions you can use for any incident, but you should make it a practice to consult your poison control center, material safety data sheets, and other appropriate resources to determine the best way to decontaminate patients based on the material involved. Realize also that you may not have enough of any one decon solution to flush the skin or eyes for several minutes. That in it itself may make it necessary to use plain water for the bulk of your decon efforts.

The Preferred Options

- **Water**: Flushing with copious amounts of plain water works well to remove most materials from the skin and eyes. Water is usually readily available, it can't harm the body the way hypochlorite or other solutions can, and you don't have to worry about incompatibility with contaminants. (Even the residue of water-reactive chemicals can be flushed with water once the majority has been blotted or wiped off.) However, water is not as effective as soap and water at removing oily or insoluble materials. Nor will it deactivate any contaminants the way other solutions sometimes can. But when in doubt, use plain water or seek advice from your local poison control center. Use lukewarm water if possible. Hot water can cause skin pores to open, allowing the contaminant to penetrate deeper. Cold water can cause pores to close, trapping contaminants in the body. It also increases the risk of hypothermia. Use low water pressure and a gentle spray to avoid forcing materials into the pores.
- **Soap and water**: Mild liquid soap or detergent is safe to use under most conditions and works well to remove oily or insoluble materials. It doesn't have to be diluted like hypochlorite. Nor is soap likely to harm the body unless someone has an allergy to soap. Do keep soap out of the eyes, however.
- **Saline**: Saline solutions are good for flushing the eyes and open wounds.
- **Surgical irrigation solutions**: Surgical irrigation solutions are recommended for open wounds.

(continued next page)

Decon Solutions (continued)

Other Possibilities (Though Usually Less Desirable)

- **Hypochlorite solutions**: Many sources suggest using a freshly mixed 0.5% hypochlorite (sodium or calcium) solution. However, many medical experts *strongly* recommend using plain water or soap and water instead. If your decon protocols call for using hypochlorite, understand the following concerns:
  - Hypochlorite can cause blindness and tissue irritation; therefore, it should be used on skin and soft-tissue wounds only. It must never be used in abdominal wounds, in open chest wounds, on nervous tissue, or in the eyes.
  - It can cause skin irritation, particularly in concentrations greater than 0.5%, so you must make it correctly and should flush the body with plain water afterwards. If you use household bleach (5.25% hypochlorite), use a 10:1 dilution.
  - It often requires a contact time of 10 to 15 minutes to be effective, which increases the potential for skin irritation.
  - Hypochlorite can react with some chemicals (e.g., riot control agents), so you should check chemical compatibility first.
- **M258A1 kit** and **M291 kit**: The military has two decon kits for use on nerve agents or mustard. However, these kits are of most value on the battlefield, where water is limited. They probably have little application for civilian use.
- **Absorbent materials**: Various references on chemical and biological warfare agents say that dry powders such as soap or detergents, earth, and flour can be used in an emergency to absorb contaminants from the skin. However, avoid using such materials when they could further contaminate open wounds.

Emergency Decon for Gases and Vapors

Patients exposed only to gases or vapors who have no skin or eye irritation need no further decon than identified below. If skin or eye irritation exists, flush the skin and/or eyes. Some gases and vapors are highly toxic by eye and/or skin absorption.

- Move the patients to fresh air.
- Remove contaminated clothing that might trap gases or vapors next to the patients.
- Give high-flow oxygen as appropriate.

Patient Decontamination (continued)

Emergency Decon for Skin Contact

- If patients are grossly contaminated, flush with copious amounts of water. Carefully remove contaminated clothing to avoid spreading the material to other parts of the body. Prevent inhalation exposures by not lifting clothing over the face. Cut clothes off if necessary, being careful to protect evidence that may be on the clothes. Then flush the patients again.
- If contamination is limited, remove contaminated clothing first, then rinse just the area involved rather than the entire body. (With products that present minimal risk, cleansing with a mister, wet towel, or moist towelette may be sufficient.)
- If the chemical is water-reactive, wipe as much as possible from the body before flushing remaining product.
- Use water or soap and water. For oily or nonsoluble chemicals, use mild liquid soap or detergent. Don't use anything harsh.
- Use lukewarm water if possible. Hot water can cause skin pores to open, allowing the contaminant to penetrate deeper. Cold water can cause pores to close, trapping contaminants in the body. It also increases the risk of hypothermia.
- Use low water pressure and a gentle spray.
- Avoid irritating or otherwise compromising intact skin.
- Do not try to neutralize chemicals on the body unless directed to do so by your poison control center or other qualified expert. Heat from neutralization can cause further injury.
- Decontaminate the head first, starting with contaminated eyes, mucous membranes, and open wounds. They will more readily absorb hazardous materials than intact skin will.
- Avoid flushing the contaminant into eyes, nose, mouth, wounds, or other uncontaminated areas of the body.
- Pay particular attention to areas of the body where chemicals may become trapped (e.g., hair, nostrils, ears, nail beds, armpits, skin folds, and private areas). Remove wigs, toupees, and artificial limbs as necessary.
- Avoid spreading contaminants through overspray or splashing.
- Limit the emergency care during decon activities to gross management of ABCs and immobilizing the cervical spine.
- Isolate contaminated clothing, shoes, and jewelry in double plastic bags labeled with each patient's name.
- Protect the patients' modesty as much as possible.
- Dry patients promptly once decon is complete, and provide them with blankets or disposable clothing. Anticipate and treat for hypothermia early. (See pages 6-37 to 6-39.)

Patient Decontamination (continued)

Emergency Decon for Eye Contact

Promptly flush the eyes if patients have gotten a solid or liquid substance in their eyes (even if the substance is water-reactive) or if patients have been exposed to a gas or vapor and are experiencing eye irritation after being removed from the hot zone.

- Flush eyes with water or sterile saline for at least 15 minutes.
- Use a low-pressure flow to avoid further injuring the eyes.
- Flush from the inside of the eyes toward the outside to avoid flushing the material from one eye to another.
- Direct patients to remove contact lenses, or carefully do it for them. Put contact lenses in a safe location.
- Have patients keep their eyes open while you are flushing.
- Keep patients from rubbing their eyes.

Emergency Decon of Mass Casualties

- Start with patients who need immediate medical attention. Send people who are asymptomatic and unsure they have been contaminated to a safe assembly area for further assessment.
- Be expeditious, or impatient people may leave to seek medical attention elsewhere, spreading contamination to others.
- Use good communication and crowd control to prevent or minimize panic and unexpected behaviors.
- If water is limited, use it carefully to ensure you have enough water to decontaminate everyone.
- Place each person's clothing and possessions in a separate bag, and tag each bag with the person's name.

Decon of Emergency Responders

The following are additional guidelines for decontaminating emergency responders.

- Have responders wear their respiratory protection and latex gloves until contaminated outer clothing has been either decontaminated or removed and secured in plastic bags.
- Have spare SCBA bottles handy so you can change air bottles during decon if needed. This will minimize the risk of responders breathing contaminants off-gassing from their PPE.
- Be alert for signs of heat stress or chemical exposure.

Triage

When there are more patients than emergency personnel can handle simultaneously, it will be necessary to triage patients. The goal is to do the greatest good for the greatest number of people. Triage may take different forms. The entry team may perform an initial triage to prioritize patients for rescue and decon. EMS personnel may triage patients again (medical triage) once they have been decontaminated and moved to the cold zone. The following are some basic guidelines to supplement your department SOPs.

Basic Guidelines

- Ensure your safety before approaching patients.
- Wear appropriate PPE.
- Call for assistance early if additional resources will be needed.
- Direct the walking wounded to move to a specific safe area. This will separate those with lesser injuries from those with more severe injuries and will make your job easier.
- Use a systematic approach to ensure you do not miss anyone. Deliberate search patterns may be necessary, depending on the number of patients, where they are located, and whether or not they are visible and easily accessible.
- Use a standard triage system and triage tags that other responding personnel will be familiar with.
- Perform a quick assessment of each patient, correct any life-threatening airway and breathing problems that can be quickly taken care of, tag the patient, and move on to the next one. Do not get stuck with any one patient.
- Periodically reassess patients during the incident. Some patients may deteriorate as time goes by. Others may improve. Priorities may change as more resources become available or as patients are transported to hospitals.
- If you pass triage responsibility to someone else, provide a briefing that includes the number of injured; an estimate of the severity of injuries; an update on triage, treatment, and transport already undertaken; and any requests already made for additional personnel and supplies.
- Maintain a record of all patients, their medical conditions, and to which facilities they have been taken.
- Consider setting up separate treatment areas based on patient priority to help you keep track of patients and better care for their injuries.

Special Triage Considerations

Several factors may make it necessary to modify your triage procedures or to adjust what category you assign patients to.

- The risk to responders. It may be necessary to write off some patients if you are unable to adequately protect yourself.
- The number of patients.
- Your ability to adequately assess patients while wearing PPE or working in an atmosphere where visibility is limited. In some cases, the best you may be able to do is distinguish between those who are still moving and those who are not.
- The toxicity of the material. The more toxic the material and the greater the exposure, the more serious the injuries may be and the greater the need for prompt decon and treatment.
- Patient condition. Patients may be in critical condition due to factors other than exposure (e.g., trauma, cardiovascular distress, or shock). The synergistic effect of hazmat exposure and other complications can decrease the patients' chances of survival even further.
- Whether children are involved. Because of their smaller size and faster respiratory rates, children can experience more rapid onset and more pronounced effects than do adults who receive an equal exposure.
- Time needed to adequately decon patients. Remember, however, if you compromise decon procedures for the sake of prompt treatment, you increase the risk of secondary contamination to others.
- Time required to transport the patients to medical facilities.
- The availability of appropriate receiving centers for hazmat exposure victims.
- The availability of special facilities (e.g., trauma centers or burn units) equipped to deal with other specific injuries.
- The ability of local medical facilities to handle the number of patients. Patients may have to be spread out among multiple facilities to avoid overwhelming medical personnel.

Triage (continued)

The Four Basic Triage Categories

Patients are normally divided into four basic categories based on the severity of their injuries and the likelihood of survival. (Different agencies may refer to these categories by different names.)

- **Immediate**. These are patients with potentially life-threatening injuries who are likely to survive if they receive immediate medical care and prompt transportation to a medical facility. Immediate patients are usually identified in the field by **red** triage tags.
- **Delayed**. These are patients who are injured and need definitive medical care, but are relatively stable. Treatment and transportation can be delayed temporarily. These patients are usually identified in the field by **yellow** triage tags.
- **Minor**. These are patients whose injuries are minor and who may need only minimal care. Minor patients are usually identified in the field by **green** triage tags.
- **Morgue (or Deceased)**. This last category is for people who are dead or whose injuries are so severe that they have little chance of survival, even with aggressive care. People who need CPR are classified as dead unless there are sufficient personnel to care for both them and other patients. This category is usually identified in the field by **black** triage tags.

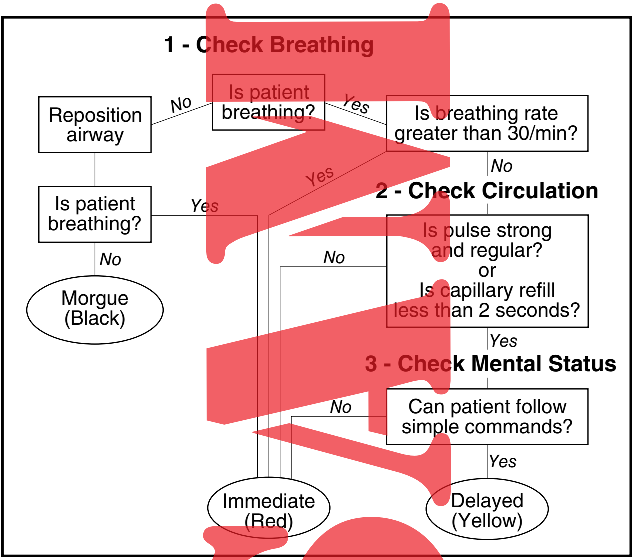
Triage (continued)

The START System

There are several different methods for triage. The START (Simple Triage and Rapid Treatment) system is used by many response agencies. It is provided here for your convenience. However, you should follow your department SOPs.

Start by directing the walking wounded to move to a safe area. The walking wounded are automatically categorized as minor until you can assess them further. Their injuries are generally less severe than those of nonambulatory patients.

Perform a quick assessment of the patients who were unable to move themselves, preceding in an orderly and systematic manner so that you do not miss anyone. Your assessment should take no more than one minute per patient. The chart below is a quick reference to the START system. (The chart has been modified by this author to fit the format of this book.) More detailed instructions are provided on the following page.



Quick Reference Guide to the START System

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Triage (continued)

The START System (continued)

Assess Breathing

If the patient is not breathing, open the airway and clear the mouth of foreign matter. (In mass casualty incidents, you may have to forego normal precautions to protect the spine.) If these simple steps do not prompt the patient to start breathing, consider the patient dead and attach a black tag. Move on to the next patient.

Consider patients to be immediate if (1) they are breathing faster than 30 breaths per minute or (2) they were not breathing on their own but began breathing when you opened the airway. Attach a red tag, then move on to the next patient.

If patients are breathing on their own at a rate slower than 30 breaths per minute, go on the next step (circulation).

Assess Circulation

You can assess circulation in one of two ways. One is to check the carotid pulse. If the carotid pulse is weak or irregular, tag the patient as immediate (red tag), then move on to the next patient. If the pulse is strong, go on to the next step (mental status). The other option is to check capillary refill by pressing on the nail beds (or the fleshy part of the fingers), then watch for return of color once you release pressure. If capillary refill is slower than two seconds, circulation is inadequate. Tag the patient as immediate (red tag), then move on to the next patient. If capillary refill is faster than two seconds, go to the next step (mental status).

You can quickly check for bleeding here as well. If the patient is bleeding severely, put a dressing in place and direct the patient or one of the walking wounded to apply direct pressure.

Assess Mental Status

Ask the patient to follow simple commands, such as “blink your eyes” or “squeeze my hand.” If the patient is unresponsive or cannot follow simple commands, tag the patient as immediate (red tag) and move on. If the patient can follow simple commands, tag the patient as delayed (yellow tag) and move on.

Common Signs and Symptoms of Hazmat Exposure

Per NFPA 473, EMS personnel should know the signs and symptoms of exposure to common and high-risk chemicals. Presenting signs and symptoms may be immediate or delayed and may vary depending on the specific product involved, amount (dose) and duration of exposure, and the patient's size and general state of health.

Note: When two or more chemicals are involved, the synergistic effect may produce dramatically different signs and symptoms.

(Common signs and symptoms associated with chemical warfare agents, biological warfare agents, and nuclear weapons are addressed in Chapters 9,10, and 11, respectively.)

Corrosives

Corrosive materials (acids and bases) produce **skin damage** that generally resembles thermal burns:

- Pain, tenderness, and swelling
- Redness or other discoloration
- Sloughing (shedding)

Acids and bases damage the skin in slightly different ways. An acid will cause the tissue to harden even as it eats away at that tissue, making it harder for the acid to penetrate. A base will soften the tissue, creating more penetrating and severe injuries. (This softening of the tissue produces a slippery or soapy sensation.) Often the extent of the injury is not immediately obvious, something corrosive burns (acids and bases) have in common with thermal burns.

Eye involvement can result in:

- Pain and photophobia (abnormal sensitivity to light)
- Tearing
- Spasmodic winking
- Decreased visual acuity

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Common Signs and Symptoms of Hazmat Exposure (Continued)

Corrosives (continued)

Effects to the **respiratory system** can include:

- Pain in the nose, mouth, throat, and chest
- Difficulty swallowing and breathing
- Coughing
- Hoarseness
- Abnormal breath sounds
- Weakness, dizziness, and fainting
- Tachycardia (very rapid heartbeat)
- Tachypnea (very rapid breathing)
- Cyanosis (bluish color of the skin and mucous membranes)

Where there is **gastrointestinal involvement**, signs and symptoms can include:

- Chest pain
- Abdominal pain and tenderness
- Oropharyngeal burns
- Difficulty swallowing
- Drooling
- Muffled or slurred speech
- Vomiting (sometimes with blood)

Pulmonary Irritants

Pulmonary irritants, such as ammonia and chlorine, attack primarily the respiratory system. Signs and symptoms include:

- Coughing
- Airway and pulmonary edema
- Difficulty breathing
- Hoarseness or stridor (a harsh, high-pitched breath sound)
- Fatigue
- Cyanosis (bluish color of the skin and mucous membranes)
- Increased mucous secretions
- Chest pain
- Altered level of consciousness
- Respiratory arrest

Common Signs and Symptoms of Hazmat Exposure (Continued)

Pesticides

Pesticides, such as organophosphates and carbamates, primarily attack the central nervous system, producing:

- Salivation
- Lacrimation (tearing)
- Tremor
- Loss of bladder and bowel control
- Miosis (pinpoint pupils)
- Abdominal cramps
- Bradycardia (very slow heartbeat)
- Vomiting and diarrhea
- Headache
- Anxiety
- Respiratory depression
- Seizures

Nerve agents (e.g., sarin, tabun, soman, and VX) are similar to organophosphate pesticides, but are 100 to 500 times more potent. For more information on nerve agents, see pages 9-13 to 9-16.

Chemical Asphyxiants

Chemical asphyxiants, such as cyanide and carbon monoxide, commonly produce the following:

- Anxiety
- Headache
- Hyperventilation
- Dizziness and fainting
- Muscle weakness
- Chest pain
- Difficult or labored breathing
- Seizures
- Coma

Common Signs and Symptoms of Hazmat Exposure (Continued)

Hydrocarbon (Organic) Solvents

Hydrocarbon (organic) solvents, such as xylene and methylene chloride, commonly produce:

- Skin irritation
- Dizziness and weakness
- Chemical conjunctivitis (inflammation of the conjunctive membrane on the eyeball and inner surface of the eyelids)
- Headache
- Drowsiness
- Chest pain
- Cough
- Tachyarrythmias (rapid, irregular heart rhythms)
- Stupor
- Respiratory depression
- Pulmonary edema
- Coma

Phenolic Compounds

Phenol and related compounds commonly cause:

- Red, inflamed skin and mucous membranes with possible burns and blisters
- Burning eyes
- Respiratory irritation
- Nausea, vomiting, diarrhea, and abdominal pain
- Headache
- Weakness, confusion, and excitement followed by coma
- Pulmonary edema

Common Signs and Symptoms of Hazmat Exposure (Continued)

Nitrogen Compounds

Nitrogen compounds, such as nitric oxide, nitrous oxide, and nitrogen dioxide, commonly produce:

- Cough
- Irritation of mucous membranes
- Rapid, weak pulse
- Difficulty breathing
- Pulmonary edema

Fluorine Compounds

Fluorine and related compounds are highly toxic, producing:

- Deep burns that are deceptively painless at first, but that later become very painful
- Eye irritation and corneal damage
- Shortness of breath
- Choking and respiratory irritation
- Pulmonary edema
- Rapid, weak pulse
- Cardiac arrhythmias
- Central nervous system depression

Opiate Compounds

Opiate compounds, such as morphine, codeine, thebaine, and heroin, in moderate doses can excite the central nervous system, producing euphoria. However, these drugs, which work on specific receptors in the brain to decrease the sensation of pain, are central nervous system depressants. They commonly produce:

- Drowsiness and lethargy
- Respiratory depression
- Nausea
- Constipation
- Miosis (constricted pupils)
- Seizures
- Coma

EMS Treatment Protocols

The following are general guidelines for any hazmat/WMD exposure. Note: Few products have specific antidotes. Patient care usually consists of treating presenting signs and symptoms.

Safety - Your First Priority

- Size up the incident for signs of criminal or terrorist activity.
- Do not go into the hot zone unless you are trained and equipped to perform a rescue and it is safe for you to do so. If patients can walk, direct them to move to a safe refuge area. Otherwise, wait until they can be rescued by appropriate personnel.
- Unless you are authorized and equipped to provide patient care in the warm zone, wait until patients have been fully decontaminated and brought out to you in the cold zone.
- Make sure patients are transferred to clean backboards or stretchers when brought out of the decontamination corridor.
- Wear proper PPE. Once patients have been thoroughly decontaminated, most present no risk of secondary contamination; thus standard universal precautions are adequate. However, if you will be in the warm zone, additional PPE may be required.
- Avoid contact with patients' exhaled air, blood, vomitus, and other body fluids.

Patient Assessment

- Determine whether additional resources (personnel, equipment, medical supplies, ambulances, etc.) are needed.
- Determine the product to which patients were exposed; the type, concentration, and duration of exposure; the number of times exposure occurred; whether patient reactions were acute or chronic; the length of time that has passed since the incident occurred; and patient activities since being exposed.
- Identify open wounds that provide a route of entry for contaminants and other associated injuries that may affect the material's interaction with the body.
- Recognize that hazmat exposures may cause an altered level of consciousness that can impact the reliability of the information you get while taking patient history. Your physical assessment may also be hampered by your PPE. Adjust accordingly.
- Evaluate the potential for delayed effects, and plan accordingly.
- Consider whether patients may have evidence on their bodies or clothing that should be preserved and secured if possible.

EMS Treatment Protocols (continued)

Basic Life Support

The instructions below are for clean patients. If contaminated patients have not already been decontaminated, refer to the patient decon guidelines on pages 6-10 to 6-15.

- Move patients to a safe area.
- Triage patients as needed.
- Administer oxygen if appropriate.
- Provide artificial respiration if patients are not breathing. Use a pocket mask with a one-way valve, a bag-valve mask, or a forced-air respirator. Do not use mouth-to-mouth resuscitation if patients pose a risk of secondary contamination.
- Provide CPR if patients have no pulse.
- Suction patients' airways as needed.
- Place patients in a position of comfort. If patients are unconscious, position them on the side to maintain an open airway.
- Keep patients quiet.
- Reassure patients and inform them of what you are doing.
- Maintain patients' normal body temperatures.
- If patients had contact with a liquefied gas or cryogenic material, thaw frosted parts with lukewarm water. Do not rub frozen parts. Handle patients gently.
- Treat chemical burns as you would thermal burns. Remember, the extent of the burns may not be immediately obvious.
- Treat other injuries as appropriate. When the greatest risk to patients is from trauma or other medical conditions, treatment of those conditions generally takes precedence over the hazmat exposure. If the greatest risk, however, is from the chemical exposure, other treatment may be delayed.
- Do not induce vomiting unless directed to do so by your local poison control center or hospital base station.
- If directed to do so, dilute ingested poisons with one glass of water or milk and give activated charcoal to absorb the poison.
- Periodically check and record patients' vital signs. Observe patients for delayed effects. Signs and symptoms of exposure to some materials may be delayed by several hours.
- Transport patients to a medical facility as soon as possible.
- Maintain a record of all patients, their medical conditions, and to which medical facilities they have been taken.

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EMS Treatment Protocols (continued)

Basic Life Support (continued)

Remember, patients should be thoroughly decontaminated, whenever possible, before being transported to a hospital. However, if they are in critical condition, deteriorating rapidly, or in danger of hypothermia, you may need to transport them sooner. There is no more merit in delivering clean patients who died from delayed treatment than there is in transporting contaminated patients who are a danger to themselves and others. But before you transport, remove contaminated clothing, do *emergency* decon, and take extra precautions to protect EMS and hospital personnel. Keep in mind, most hospitals have only limited decon capabilities, if any.

When the risks are high for the patient and low for medical personnel, prompt transport is appropriate. But if the risks are too high for medical personnel, take the extra time in decon. You must do the greatest good for the greatest number of people. Don't endanger others.

Be observant, and be diligent in your documentation. It may prove pivotal following incidents involving workplace injuries, criminal or terrorist activities, or any other liability concern.

Advanced Life Support - If Appropriate

Perform advanced life support functions if appropriate:

- Monitor pulse oximetry.
- Attach patients to cardiac monitors.
- Intubate.
- Monitor end tidal CO_2.
- Establish intravenous lines.
- Administer antidotes or other drugs based on presenting signs and symptoms and local protocols.

Unless required by life-threatening conditions, invasive procedures (such as intubation and IVs) should be performed only after patients are decontaminated. Otherwise, you may provide another route of entry for those contaminants.

Warning: Patients soaked with flammable materials cannot be treated with DC countershock until decontaminated because it might ignite flammable vapors.

EMS Treatment Protocols (continued)

Drugs and Antidotes

Few products have specific antidotes. (An example of one that does is pesticides. Atropine is used to block the effects of acetylcholine. Some chemical warfare agents also have antidotes. See Chapter 9 for more information.) Administration of drugs in the field is usually based on presenting signs and symptoms. Follow your training and local protocols, administering drugs or antidotes based on the factors listed below. (Be cautious of other field guides that list antidotes without taking these factors into consideration.)

- The specific product involved
- Amount and duration of exposure
- Time elapsed since exposure
- Age of the patient (adult, child, or infant)
- Severity of signs and symptoms
- Other medical conditions the patient may have
- Other drugs being taken by the patient
- Allergies to medications
- Availability of drugs or antidotes in a mass casualty incident

Facilities that use, store, or manufacture chemicals may have antidotes available on site, as well as health services personnel with greater knowledge of how to treat specific exposures. These private resources may or may not be used, depending on your agency's SOPs and directions received from your base station hospital, poison control center, or other local resources.

The following books are three good sources for additional information. These would be good reference books to carry on your emergency response vehicle.

- *Hazardous Materials Injuries: A Handbook for Pre-Hospital Care* by Douglas R. Stutz, Ph.D. and Scott Ulin, M.D.
- *Emergency Care for Hazardous Materials Exposure* by Alvin C. Bronstein, M.D. and Phillip L. Currance, EMT-P.
- *The Survival Guide: What to Do in a Biological, Chemical, or Nuclear Emergency* by Angelo Acquista, M.D.

Coordination with Other Medical Providers

Coordination with Hospitals and Clinics

Provide copies of container labels, MSDSs, and other applicable documents to medical facilities as needed to supplement their references. In addition, advise medical personnel of the following:

- Type and nature of the incident (e.g., fire, explosion, spill, leak).
- Material involved. Provide the name (with correct spelling), concentration, and physical state (solid, liquid, gas). If needed, identify chemical and physical properties and health effects.
- Number of patients medical providers can expect to receive and the approximate ages of those patients (e.g., a breakdown of the number of adults, children, infants).
- Extent, length, and route of exposure for each patient.
- Whether there may be walk-in patients. (Walk-in patients are more likely when the event affects a large geographical area, there is a large number of patients, or patients had an opportunity to self-transport before your arrival.)
- Condition of patients (signs and symptoms, associated injuries, vital signs, pertinent medical history).
- Treatment provided and patient response to treatment.
- Decon procedures implemented at the scene and whether further decon may be needed once the patients arrive.
- Estimated time of arrival.

Coordinate patient transfer before bringing patients into the facility. The facility may request patients be delivered to a specific area to minimize the risk of secondary contamination.

Coordination with Air Ambulances

- Do not transport patients by air ambulance unless they have been fully decontaminated and do not present a risk of secondary contamination. Contaminants brought from the scene could cause the flight crew to become ill and crash the aircraft.
- If you do request air ambulances, indicate a safe route of travel so that the flight crew doesn't fly through an unsafe area.
- Establish a safe landing zone upwind, uphill, upstream, and far enough away that downdraft from the helicopter won't spread vapors or fumes.

Handling the Dead

Handling the dead with dignity and respect is important for the well-being of families and friends and for maintaining a positive public image. However, you must balance those concerns with the need to protect others from injury and to preserve evidence.

- Unless it's necessary to protect the bodies, do not move or disturb them until a medical examiner or law enforcement personnel have completed their initial investigation. The bodies, clothing, and personal effects may contain important evidence.
- If you must move bodies before the initial investigation is complete and if there's time to safely do so, photograph each body before moving it. If you don't have a camera, sketch the scene, showing the position of each body and its location relative to surroundings. Mark the area where each body was found.
- Once removal of the bodies has been authorized, decon any contaminated bodies to prevent injury to other personnel who might handle them later. (Most of the guidelines that apply to patient decon also apply to decontaminating the dead. See pages 6-10 to 6-15 for more information.)
- Do not remove personal effects from the bodies unless the bodies need to be decontaminated. Bag and tag personal effects removed from the body prior to decon, but keep effects near the body so they don't get lost.
- Bag and tag loose personal effects separately. Do not automatically assume that items lying next to a body belong to that body, especially in a mass casualty incident.
- Attach a tag or label to each body with the date and time found, the exact location found, and the name and work telephone number of the person tagging the body. Indicate whether the body was contaminated with a hazardous material and, if so, what decontamination measures were taken.
- Place each body in a separate body bag or wrap it in plastic and tie it securely. Attach another tag containing the same information identified above to the outside of the bag. If there is any question about the thoroughness of decon efforts, the body may need to be double-bagged.
- If the bodies must be moved to another location, move them to a safe place, preferably in a cool environment with floors that can be easily decontaminated if contaminated with blood or other body fluids.
- Provide security for the bodies until custody can be transferred to a medical examiner, coroner, or other authorized personnel.

EMS Equipment and Supplies

EMS responders must be able to evaluate the incident and a patient's condition to determine the equipment and supplies needed to care for the patient both on scene and during transport. The following is a list of the minimum equipment and supplies that should be available on an ambulance. Most of these recommendations come from the fourth edition of the NFPA *Hazardous Materials Response Handbook*.

- Binoculars to assess the scene from a safe distance.
- The current edition of the *Emergency Response Guidebook* and other appropriate references.
- A copy of applicable protocols.
- Protective clothing, including long-sleeve disposable isolation gowns or aprons, surgical or examination gloves, surgical or other paper masks, splash goggles or face shields, and shoe covers. If possible, all items should be impervious to water.
- NIOSH-certified HEPA filter respirators (or equivalent).
- Clean uniform and scrubs.
- Hard hat and boots.
- Disposable gowns or Tyvek suits and slippers for patients who have been decontaminated at the scene.
- Plastic trash bags.
- Plastic sheeting (if your protocols call for covering patients or equipment to prevent the spread of residual contamination).
- A large bucket or plastic wastebasket that can be lined with trash bags to collect contaminated eye wash water or vomitus.
- Disposable plastic-coated blankets (or "chucks") to soak up and isolate fluids from a contaminated patient.
- Inexpensive stethoscopes, blood pressure cuffs, and other equipment that can be discarded if contaminated.
- A bag valve mask (BVM) or a mechanical resuscitator to protect against having to do mouth-to-mouth resuscitation. Pocket masks are generally considered unacceptable.
- A large supply of oxygen.
- Liquid soap or mild detergent for washing off oily contaminants.
- Epsom salts for soaking hydrofluoric acid burns.
- Irrigating water or saline and IV tubing for flushing the eyes.
- Shears for removing contaminated clothing.
- Duct tape for securing plastic sheets or gaps in protective clothing (e.g., between gloves and sleeves).
- Stokes basket and backboard with securing devices.
- Body bags.

Medical Support for Hazmat Response Personnel

The medical monitoring station should be located near the team dressing area, but away from noise and commotion. The basic setup should include evaluation of vital signs, pulse oximetry, weight, skin status, body temperature, and hydration.

Pre- and Post-Entry Exclusion Criteria

The 2008 edition of NFPA 473 presents a different philosophy regarding exclusion criteria than did the now-withdrawn NFPA 471. It encourages each jurisdiction to establish its own limits.

The following vital signs should be evaluated before entry to determine the medical fitness of personnel who will be working in chemical protective clothing. All of these should be rechecked post-entry.

- Core body temp: hypothermia or hyperthermia
- Blood pressure: hypotension or hypertension
- Heart rate: bradycardia or tachycardia
- Respiratory rate: bradypnea or tachypnea

Post-entry, pulse should be checked within one minute of personnel doffing the protective clothing and again three minutes later. Within three to five minutes of doffing protective clothing, all vital signs should be close to their pre-entry status.

The following additional items should be evaluated post-entry:

- Weight loss: greater than 5%
- Heart recovery: slow to return to normal rate and rhythm
- Core body temp: signs of heat stress or heat exhaustion
- Exposure: signs and symptoms of exposure to the material(s) involved

If a team member requires significant medical treatment or transport, EMS personnel must notify the appropriate persons designated in the incident action plan.

All medical monitoring must be properly documented. See pages 2-65 to 2-66 for more information.

Medical Support for Hazmat Response Personnel (continued)

Other Pre-Entry Considerations

Recent medical history can contribute to dehydration and make a person more susceptible to heat stress. Thus it's wise to also consider the following:

- Open sores, large rash, or significant sunburn
- Nausea, vomiting, diarrhea, fever, upper respiratory infection, or heat illness within the past 72 hours
- New prescription medication taken within the past two weeks
- Over-the-counter medications (e.g., cold, flu, or allergy medications) taken within the past 72 hours
- Heavy alcohol intake within the past 72 hours
- Any alcohol within the past 6 hours
- Pregnancy

Problems Observed During Entry

Problems observed during entry can signal that someone is in trouble. Entry personnel should immediately be decontaminated, doff protective equipment, and receive medical monitoring if:

- They experience changes in gait, speech, or behavior that might indicate an altered mental status; or
- They complain of chest pain, dizziness, shortness of breath, weakness, nausea, or headache; or
- They exhibit any other signs or symptoms indicative of exposure to the material(s) involved.

Exposure Potential

Although the need for medical monitoring was driven largely by the high potential for heat stress to responders working in chemical protective clothing, personnel responsible for medical monitoring must also evaluate the potential for exposure to the material(s) involved. They must be informed about the material(s), the health hazards, signs and symptoms of exposure, decontamination procedures, potential for secondary contamination, and emergency medical treatment.

Heat and Cold Emergencies

Often the greatest risk to personnel working in chemical protective clothing is that of heat stress. Consequently, the medical monitoring done on hazmat response personnel focuses primarily on the effects of heat stress. However, chemical protective clothing also offers little insulation against the cold, so this section addresses cold emergencies as well.

Signs and Symptoms of Heat Emergencies

Heat cramps are painful muscle spasms resulting from a disproportionate loss of fluid and electrolytes from the body. Leg and abdominal muscles are the most susceptible to heat cramps.

Heat exhaustion, the most common heat emergency, occurs when the body loses a significant amount of water and electrolytes through excessive sweating. Patients with heat exhaustion are in mild hypovolemic shock and will have many of the symptoms associated with hypovolemia: cold, clammy, and pale skin; nausea and vomiting; dizziness; and weakness. They may have headaches. The pulse is often rapid, but other vital signs are likely to be normal. Body temperature is usually normal or slightly elevated. If heat exhaustion is not treated promptly, it may progress to heat stroke.

Heat stroke is a life-threatening emergency that results when the body is no longer able to dissipate excess heat. It is usually characterized by red, hot, dry skin, though the patients may still be sweating in the early stages of heat stroke. As the body core temperature rises to 106˚F (41.1˚C) or more, the patient's level of consciousness drops rapidly. The pulse is strong and rapid at first, but as heat stroke progresses, the pulse becomes weaker and the blood pressure falls. The patient may experience seizures and ultimately lapse into a coma.

Heat and Cold Emergencies (continued)

Factors That Contribute to Heat Stress

Several factors can contribute to the development of heat stress in emergency responders.

- Dehydration (from sweating, illness, or other causes) *
- Heat and humidity
- Use of PPE that does not readily dissipate heat
- Long entry times (particularly during hot weather or difficult assignments)
- Tasks that require high levels of activity
- Lack of physical fitness
- Infections, illness, sunburn, recent alcohol consumption, or other conditions that already tax the body
- Recent use of medications
- Anxiety and frustration
- Cold and wind (if they hamper maneuverability)

* Hydration is critical for anyone working in protective clothing. Personnel should drink plenty of fluids both before and after entry.

Treatment of Heat Emergencies

- Remove patients from the hot environment.
- Have patients sit or lie down.
- Remove excessive clothing.
- Loosen tight clothing.
- If patients are fully alert, give them water or a diluted electrolyte solution to drink.
- Rehydrate heat exhaustion patients with intravenous fluids according to local protocol.
- With heat stroke patients, cover or sponge the body with wet towels or sheets. Use air conditioning or fans if available. Get the body temperature back down to normal using whatever means are available.
- Transport heat stroke patients to the hospital promptly. Transport heat exhaustion patients if symptoms do not clear promptly, the temperature remains elevated, or the level of consciousness decreases. Transport patients with heat cramps if cramps don't go away in response to your treatment.

Heat and Cold Emergencies (continued)

Signs and Symptoms of Cold Exposures

Hypothermia is a cooling of the body core temperature. Signs and symptoms progress as the core temperature drops.

- Mild hypothermia occurs when the core temperature is between 90˚F and 95˚F (32.2˚C and 35˚C). Patients will be shivering and may move around a lot in an attempt to generate heat. Patients are alert, but may be withdrawn.
- As the body core temperature drops below 90˚F (32.2˚C), shivering stops, muscular activity decreases, and patients become confused.
- As the core temperature drops to 85˚F (29.4˚C), patients become lethargic and sleepy and may lose interest in combating the cold. The pulse begins to slow.
- If the core temperature falls to 80˚F (26.7˚C), respiration slows, the pulse slows and becomes weaker, and cardiac arrhythmias may occur. Patients become irrational.
- Ventricular fibrillation, respiratory arrest, and cardiac arrest generally occur below 80˚F (26.7˚C). However, even when patients appear to have no pulse, the heart may be beating very slowly.

Frostbite occurs when parts of the body become frozen due to cold exposure (e.g., from contact with cryogenic liquids). Hands and feet are particularly vulnerable to frostbite, but other parts of the body can be affected. Frostbite may be superficial (affecting only the skin) or deep (involving deeper tissues). Frostbitten tissue may be white, yellow-white, or blue-white and is hard and cold to the touch. In severe cases, frozen tissue may become permanently damaged, eventually developing gangrene.

Frostnip occurs when parts of the body become very cold but not frozen. Exposed parts of the body, especially the nose and ears, are commonly affected. The skin becomes pale (blanched), but the condition is usually not painful.

Immersion foot (or trench foot) occurs after prolonged exposure to cold water, such as when someone is standing in cold water for a long time. The skin of the foot becomes wrinkled, pale, and cold to the touch.

Heat and Cold Emergencies (continued)

Factors That Contribute to Cold Exposure

Several factors can contribute to cold exposure in emergency responders, even when wearing personal protective equipment. Hypothermia is also a concern for patients in decon.

- Cold weather
- Windchill factor
- Wet clothing
- Sweating (evaporation of moisture from the body surface)
- Direct contact with cold objects (including cryogenic liquids)
- Inadequate protective clothing
- Increased respiration (exhalation of warm air from the lungs)
- Fatigue

Treatment of Cold Emergencies

General Guidelines for Any Cold Exposure

- Remove patients from the cold environment.
- Remove wet clothing.
- Cover exposed body parts, especially the head. Wrap patients with dry blankets.
- Do not allow patients to lie against any wet or cold surfaces.
- Maintain vital signs.
- Do not allow patients to smoke.
- Transport patients as quickly as possible. Do not waste time rewarming in the field if you are close to a hospital.

Additional Guidelines for Hypothermia

- If patients are conscious and alert, give warm fluids by mouth. Do not give alcohol or coffee.
- Provide warm, humidified oxygen if possible.
- Handle patients gently. Rough handling can cause a cardiac dysrhythmia, especially ventricular fibrillation.
- Unless contraindicated by other injuries, keep patients in a horizontal position or with the head slightly lower than the rest of the body to increase blood flow to the brain.

(continued next page)

Treatment of Cold Emergencies (continued)

Additional Guidelines for Hypothermia (continued)

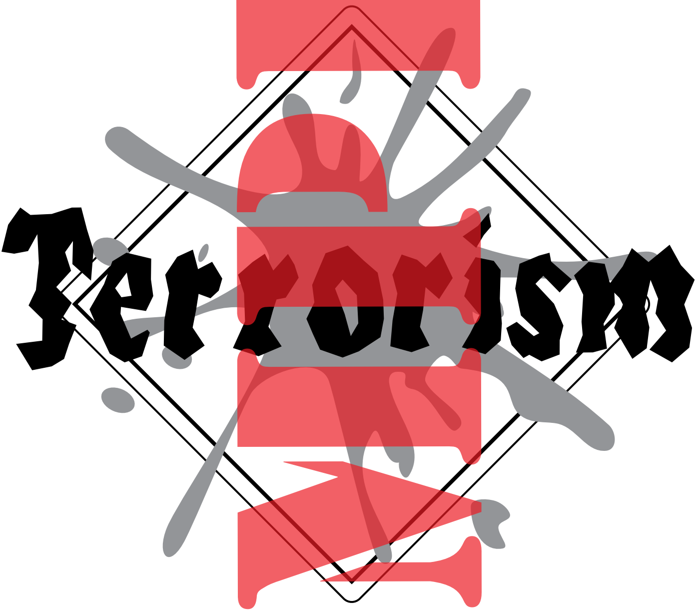
- If transport will be delayed, warm patients gently with heat packs (not to exceed 110˚F/43.3˚C) applied to the neck, groin, and armpits.
- If patients are unconscious, check the carotid pulse for at least one minute before determining if CPR is required.
- Apply an AED (automated external defibrillator) if available.
- Begin CPR if appropriate.
- Once you start CPR, don't give up. The effectiveness of CPR cannot be adequately measured until the patient is rewarmed. Remember, no one is dead until he or she is warm and dead.

The experts all agree that rescuers should begin CPR if patients have no detectable pulse or breathing. However, not everyone agrees on what to do when the patient has a very slow pulse. Many experts recommend against performing CPR if the patient has any kind of regular rhythm because external cardiac compressions can cause ventricular fibrillation. (Hooking the patient up to a monitor can help you determine whether the patient has a regular rhythm.) Follow local protocols or contact your base station hospital for guidance.

Additional Guidelines for Localized Injuries

- Gently rewarm parts that are merely cold but not frozen (frostnip or immersion foot).
- Handle frostbitten parts gently.
- Never rub frostbitten tissues.
- Do not break blisters.
- Do not allow patients to stand or walk on frostbitten feet.
- Elevate injured extremities.
- Wrap any frostbitten parts loosely with a dry, sterile dressing.
- Do not attempt to rewarm frozen parts in the field if you are close to a hospital or if there is any chance parts may freeze again before the patient reaches the hospital.
- If prompt medical care is not available, rewarm frozen parts gently by immersing them in water at 100˚F to 112˚F (37.8˚C to 44.4˚C). Continue rewarming until the redness returns.

Introduction to Terrorism



This chapter provides an overview of what terrorism is, how to distinguish a terrorist (WMD) attack from an accidental event, how to distinguish between chemical agents and biological agents (which will help guide you to other appropriate chapters in this book), special strategic and tactical considerations for dealing with a terrorist event, and the homeland security advisory system.

What Is a Terrorist Event?

The Official Definition

The Federal Bureau of Investigation (FBI) categorizes terrorism in the United States as either *domestic* or *international* and defines each as follows:

- **Domestic terrorism** is the unlawful use of force or violence committed by group(s) or individual(s) against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.
- **International terrorism** is the unlawful use of force or violence committed by group(s) or individual(s), *who are foreign based and/or directed by countries or groups outside the United States or whose activities transcend national boundaries*, against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives.

Motives for terrorism include, but are not limited to, making a political statement, drawing attention to a cause, undermining a sense of security, undermining confidence in the government, and disrupting the economy or infrastructure. Terrorism is often intended to kill or injure people, including emergency responders.

Terrorism As Addressed in This Book

For the purposes of this book, a terrorist event is any event that was intended to harm life, the environment, or property. This includes both physical harm and disruption of normal activities.

Whether or not an event fits the official definition of terrorism is immaterial to first responders whose lives may be on the line. At any intentional event, responders must be concerned about secondary devices, the risk of being assaulted by the perpetrator, or the possibility that the perpetrator will in some way interfere with efforts to aid the original target. In addition, although life safety is still the first priority, responders must be more concerned with preserving evidence than they would be at an accidental event. The information in this book is designed to be used at any intentional event, whether or not it is officially labeled as terrorism.

Accidental Event or Terrorist Attack?

It is sometimes hard to distinguish between an accidental event and a terrorist attack, especially early on. Terrorists may use a combination of weapons to confuse and harm responders. Pay particular attention to clues that don't add up. It may be an indication that more than one weapon is present.

Possible Indications of a Terrorist Event

Listed below are potential indications of a terrorist event. Also, don't ignore a gut feeling that something is not right. Sometimes the best clue is your sixth sense.

- Warnings, threats, intelligence reports, etc.
- Recent terrorist and/or suspicious activities
- Controversial or high-risk target (see next page)
- Timing of the event (see next page)
- Unusual metal debris from a bomb or munitions-like material
- Unexplained explosion, especially if it disperses a liquid, mist, or gas or it seems to destroy only the package or device itself
- Dispersion of nails, staples, or other possible shrapnel
- Suspicious hazmat releases (e.g., where equipment failure and human error have been ruled out)
- Unusual vapor clouds, mists, plumes, odors, or tastes
- Mass casualties (people and animals) without obvious trauma
- Unexplained patterns of death, illness, or injury
- Unusual fire behavior or unusually colored smoke or flames
- Presence of hazardous materials (including labels, placards, and containers) not relevant to the occupancy
- Unusual devices (wires, cell phones, circuit boards, match heads, incendiary materials, etc.) attached to containers
- Abandoned spray devices
- Unscheduled spraying or unusual dissemination of materials
- Unusual security (locks, bars on windows, barbed wire, etc.) or the presence of booby traps
- Clandestine operations (e.g., drug labs)
- Glowing material (radioluminescence caused or emitted by a strongly radioactive material)
- Material that is hot or seems to emit heat without any sign of an external heat source
- Suspicious unattended packages, objects, or vehicles
- Subsequent calls or letters from people claiming responsibility

Accidental Event or Terrorist Attack? (continued)

Common Targets for Terrorism

- Public figures, particularly high-profile or controversial ones
- Controversial businesses (e.g., abortion clinics)
- Businesses with a history of labor problems
- Government offices
- Public buildings and places of public assembly
- Infrastructure systems (e.g., transit, utilities, communications)
- Places of economic, symbolic, and/or historic significance
- Airports
- Military installations
- Industrial facilities

The Timing of an Event

Terrorist events can occur at any time. However, the possibility of a terrorist event is greater during the following time frames:

- Prior to or during high-profile or controversial events
- On anniversaries of significant events
- At a time of day when it is possible to cause greater harm or disruption (e.g., during business hours or commute hours)

Special Concerns with Terrorist Events

Although a terrorist event involving nuclear, biological, or chemical weapons is still a hazmat incident, terrorist events have some unique characteristics:

- An intent to harm a large population
- The deadlier nature of the weapons in comparison to that of hazardous materials encountered at most ordinary incidents
- The increased urgency for decon and treatment (sometimes with specialized antidotes available only in limited amounts)
- The possibility of multiple weapons being used (e.g., a chemical agent dispersed by an explosive device)
- The risk of secondary event (maybe aimed at responders)
- Initial difficulty in determining the type of agent used
- Possible delays in recognizing that a terrorist event has occurred (e.g., when biological agents are deployed)
- The need for specialized detection equipment

Distinguishing Between Chemical and Biological Agents

You must be able to distinguish between chemical and biological agents to properly protect yourself and the public and to further identify the specific agent involved. Listed below are both general distinctions and more specific indicators. The biggest distinction is usually speed of onset (rapid with most chemical agents, delayed with most biological agents). Because onset is delayed with most biological agents, a covert terrorist attack will likely manifest as an unusual outbreak of disease, impacting public health authorities more so than first responders.

General Distinctions

Most **chemical agents** are characterized by the following:

- Rapid onset of symptoms (usually minutes to hours following exposure).
- Easily observed signatures (e.g., residue, pungent odor, dead insect and animal life, and dead foliage).

Most **biological agents** are characterized by the following:

- Delayed onset (usually days to weeks after exposure).
- No characteristic signatures. Biological agents are usually odorless and colorless.
- Widespread reports of illness over a larger geographical area.
- Possible transmission of disease from one person to another.

Indicators of a Possible Chemical Agent

- The presence of hazardous materials, WMDs, or laboratory equipment that is not relevant to the occupancy.
- An intentional release of hazardous materials or WMDs.
- Numerous people exhibiting unexplained health problems that may include, but are not limited to, irritation of the eyes, nose, and throat; runny nose; difficulty breathing; tightness in the chest; nausea and vomiting; sweating; dizziness; headache; pinpoint pupils, blurred vision; blisters or rashes; disorientation; twitching; convulsions; or death.
- Rapid onset of symptoms (usually minutes to hours following exposure).

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Distinguishing Between Chemical and Biological Agents (continued)

Indicators of a Chemical Agent (continued)

- Casualties distributed in a pattern that may be associated with possible agent dissemination methods.
- Illness associated with particular geographic areas. Differences between indoor and outdoor casualty rates.
- Numerous sick or dead animals, birds, fish, and insects.
- Unusual amount of dead, discolored, abnormal, or withered plant life in the absence of drought conditions.
- Smoke, mist, or low-lying clouds that are not explained by surroundings or weather patterns.
- Unexplained odors that are out of character with surroundings. (Various chemical agents may smell like fruit, flowers, garlic, horseradish, bitter almonds, rotten eggs, peach kernels, or newly mown hay. Odors may be sharp or pungent.)
- Unusual oily droplets or oily film on various surfaces or film on water. Moisture is not associated with recent rain.
- Unusual metal debris that may indicate a delivery device (some type of bomb), especially if it contains a liquid and there has been no recent rain to account for the moisture.
- Unusual security, locks, bars on windows, covered windows, or barbed wire.

Don't forget about the standard hazmat recognition clues (page 2-5). What looks like an ordinary hazmat incident can actually be a terrorist event staged to look like an accident.

Indicators of a Possible Biological Agent

- Unusual number of sick or dying people or animals. (Consider contacting local medical facilities and veterinary clinics to see if they are treating multiple patients with similar symptoms.)
- Widespread reports of illness throughout a large area. (Flu-like symptoms are common with many biological agents.)
- Victims distributed in a pattern associated with a specific dispersal method.
- Delayed onset (usually days to weeks after exposure, although onset may be shorter with some agents, particularly toxins).
- Unscheduled or unusual spray being disseminated, especially if outdoors during periods of darkness.
- Abandoned spray devices.

Special Strategic and Tactical Considerations

You must be diligent at possible terrorist events to ensure your safety and the safety of others.

- Determine if the incident is static or dynamic. Dynamic incidents (e.g., chemical still being released) present greater risk.
- Look at the big picture. Maintain situational awareness.
- Be alert for booby traps and secondary devices.
- Avoid touching anything that might conceal an explosive device.
- Assign personnel to observe for possible criminal activities and secondary devices—people whose primary responsibility is to protect responders from secondary attack. Ideally, this should be assigned to law enforcement personnel.
- Designate and enforce scene control zones.
- Evacuate victims and nonessential personnel as quickly and safely as possible.
- Provide security for the command post and other key areas.
- Establish a safe staging area for incoming resources. Multiple staging areas can minimize losses in case of secondary attack.
- Establish secure communications for sensitive information.
- Maintain clear escape routes for rapid evacuation if needed.
- Establish a unified command post to facilitate coordination between the many agencies that will respond.
- Request appropriate local, state, and federal resources early.
- Implement your agency's mass casualty plan and mutual aid agreements if appropriate.
- Communicate your suspicions about the possible terrorist event during the notification process. Warn nearby agencies that could be affected by secondary events also.
- Call back off-duty personnel if appropriate.
- Combine teams as needed to ensure all hazards are adequately addressed. After a bombing, for example, entry into the damaged area may require the combined expertise of rescue personnel, a hazmat team, and a bomb squad.
- Attempt to preserve evidence. Treat this as a crime scene.
- Isolate potentially exposed people and animals.
- Prevent secondary contamination.
- Arrange for critical incident stress debriefings if needed. Respect that people have their own ways of coping with stress. Provide rest periods, time to grieve, time out to call families, etc. Do what you can to support responders and each other.
- Document your observations.

The Homeland Security Advisory System

After September 11, 2001, the United States implemented a homeland security advisory system. It consists of five "threat conditions," each representing an increasing risk of terrorist attacks.

Beneath the description of each threat condition below are some protective measures suggested by the U.S. Department of Homeland Security. Each set of protective measures should be considered a composite of everything that comes before it. For example, if the nation is at Threat Condition Yellow, the protective measures listed under green, blue, and yellow should all be implemented. These things should be done *in addition* to agency-specific plans that local, state, and federal agencies have developed.

Low Condition (Green) reflects a low risk of terrorist attacks.

- Refine and exercise preplanned protective measures as appropriate.
- Ensure personnel receive proper training on the Homeland Security Advisory System and agency-specific plans.
- Institutionalize a process to ensure that all facilities and regulated sectors are regularly assessed for vulnerabilities to terrorist attacks and that all reasonable measures are taken to mitigate these vulnerabilities.

Guarded Condition (Blue) reflects a general risk of terrorist attacks.

- Check communications with designated emergency response or command locations.
- Review and update emergency response procedures.
- Provide the public with any information that would strengthen its ability to act appropriately.

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The Homeland Security Advisory System (continued)

Elevated Condition (Yellow) reflects a significant risk of terrorist attacks.

- Increase surveillance of critical locations.
- Coordinate emergency plans with nearby jurisdictions as appropriate.
- Assess whether the precise characteristics of the threat require the further refinement of preplanned protective measures.
- Implement contingency and emergency response plans as appropriate.

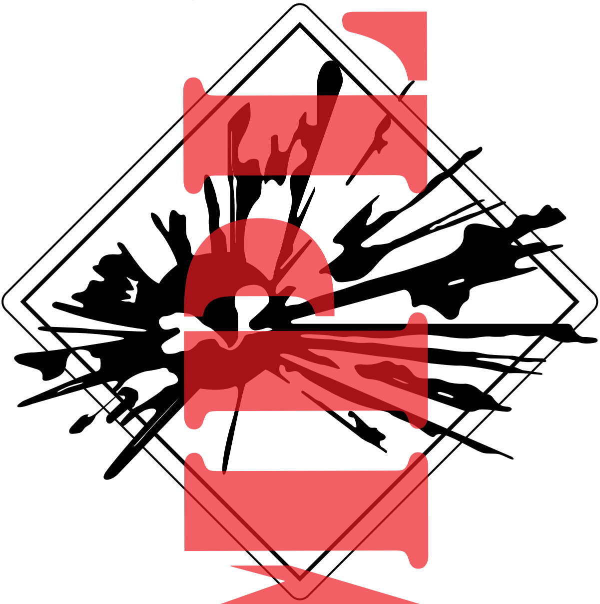
High Condition (Orange) reflects a high risk of terrorist attacks.

- Coordinate necessary security efforts with federal, state, and local law enforcement agencies, the National Guard, or other appropriate armed forces.
- Take additional precautions at public events. Consider alternative venues or even cancellation.
- Prepare to execute contingency procedures, such as moving to an alternate site or dispersing their workforce.
- Restrict access at threatened facilities to essential personnel only.

Severe Condition (Red) reflects a severe risk of terrorist attacks.

- Increase or redirect personnel to address critical emergency needs.
- Assign emergency response personnel.
- Preposition and mobilize specially trained teams or resources.
- Monitor, redirect, or constrain transportation systems.
- Close public and government facilities.

Explosives Incidents



Approximately 70% of terrorist events involve the use of explosives. Often terrorists employ explosives only, but explosives can be used to disperse other hazardous materials. Therefore, you must view all explosives incidents with suspicion. Do not rule out the possible presence of chemicals, biological agents, or radioactive materials without first examining the outward warning signs and doing appropriate monitoring. Refer to other chapters of this book as needed for additional information.

This chapter provides background information on types of explosions, classification of explosives, the effects of an explosion, and identification of explosive materials. It contains several pages to help you recognize common explosives and devices. Finally, this chapter provides guidelines on what to do upon discovery of an explosive device and after detonation of an explosive.

Background Information

The following pages provide general information to give responders a better understanding of how explosives function.

The Three Basic Types of Explosions

An explosion is broadly defined as the sudden and rapid escape of gases from a confined space, accompanied by high temperatures, violent shock, and loud noise.

- A **mechanical** explosion (or pressure relief explosion) involves a buildup of pressure inside a container, often due to overheating. If the container is not equipped with a safety valve, the internal pressure will eventually exceed the structural capacity of the container, resulting in container failure.
- A **chemical** explosion is caused by an almost instantaneous conversion of a solid or liquid explosive compound into gases that have a much greater volume than the substances from which they are generated. With the exception of nuclear explosives, all manufactured explosives are chemical explosives. Most explosions public safety personnel respond to are caused by chemical explosives.
- A **nuclear** explosion may be induced by either fission (the splitting of the nuclei of atoms) or fusion (the joining of the nuclei of atoms under great force).

Classification of Explosives

Explosives are classified based on their rate of reaction.

- **Low explosives** *deflagrate*; the reaction is defined as very rapid combustion. Consequently, low explosives have a pushing effect rather than the shattering effect associated with high explosives. Low explosives can be initiated by a simple flame or acid/flame reaction. They can also be initiated by shock or friction, but do not require the shock of a blasting cap.
- **High explosives** *detonate*; the reaction is defined as instantaneous combustion, with speeds ranging from 3300 to 29,900 feet (1 to 9.1 km) per second. High explosives have more of a shattering effect rather than the pushing effect associated with low explosives. In general, high explosives must be initiated by the shock of a blasting cap.

Background Information (continued)

Classification of Explosives (continued)

Explosives are also categorized based on their sensitivity to shock, friction, flame, heat, or any combination of these factors.

- **Primary explosives** are extremely sensitive, which makes them very hazardous to handle. Examples include blasting caps and safety fuses filled with black powder. Primary explosives may be referred to as *detonators* or *initiation devices* because they are often used to initiate secondary explosives.
- **Secondary explosives** are much less sensitive, making them less hazardous to handle and use. Because of their relative insensitivity, they must be initiated by a strong explosive wave, such as from a primary explosive. Dynamite is an example of a secondary explosive. Secondary explosives are sometimes referred to as *main charge explosives*.

Explosive Trains

An explosive train is a series of two or more explosions arranged to produce the most effective result. They are classified based on the final material (low explosive or high explosive) in the chain.

- A pipe bomb filled with smokeless or black powder (a low explosive) is an example of a two-step **low-explosive train**. The first step in the train is a safety fuse. When the exposed end of the fuse is ignited, it carries the flame to the powder (the second step) inside the pipe, causing it to explode. The majority of low explosives require only a simple two-step train.
- An electric blasting cap connected to a stick of dynamite is an example of a two-step **high-explosive train**. The explosive inside the blasting cap is initiated by heat from an electric current, resulting in a shock wave that causes the dynamite (a high explosive) to detonate. (A *three*-step explosive train could be set up using a safety fuse to detonate a nonelectric blasting cap, which would in turn detonate the dynamite.)
- **Boosters** are sometimes used to amplify the shock wave from a primary explosive, particularly when the final material in the train is really insensitive. For example, ANFO is insensitive enough that the shock from a blasting cap alone should not cause it to detonate, but it can be detonated by the shock from exploding a smaller amount of another secondary explosive.

Effects of an Explosion

An explosion has three primary effects, as described below.

Blast Pressure Effect

- Expanding gases from an explosion push outward in a spherical pattern like a giant wave smashing and shattering everything in its path. This wave is called the *blast pressure wave*.
- Blast pressure waves have two phases: a *positive-pressure phase* and a *negative-pressure phase*.
- The positive-pressure phase pushes everything in the direction of the blast. The sudden, forceful displacement of air during this phase causes a partial vacuum at the point of origin.
- Once the positive-pressure wave loses energy, the partial vacuum causes the compressed and displaced atmosphere to reverse its movement and rush inward to fill the void near the point of origin. This is the negative-pressure phase.
- The negative-pressure phase is less powerful than the positive-pressure phase, but it lasts three times as long. It causes additional damage, pushing debris back toward the point of detonation. A lot of evidence may be found near the point of origin due to this negative-pressure phase.

Fragmentation Effect

- Shattered fragments from the explosive device are hurled outward at great speeds and can easily puncture many objects. Hot metal fragments can also ignite flammable and combustible materials some distance from the point of origin.
- A person intent on doing further damage might add shrapnel (e.g., nails or staples) to the device, which adds to the fragmentation effect.

Incendiary Thermal Effect

- The incendiary thermal effect is less significant and less damaging than the blast pressure effect or the fragmentation effect. It is usually seen as a bright flash or fireball at the instant of detonation and may or may not result in a subsequent fire.
- When fires start inside a bombed building, they are usually the result of secondary events such as ruptured gas lines or shorted electrical circuits rather than the incendiary thermal effect.

Identification of Explosive Materials

This book contains descriptions and pictures to help you recognize common explosives and initiation devices. Keep in mind, however, that not all explosive materials will be easy to identify. They may be concealed within other items or incorporated into improvised explosive devices (IEDs). They may lack the identification marks that licensed manufacturers are required to use, particularly if manufactured prior to 1971 or if manufactured illegally.

Concealed and Improvised Devices

In both the 1993 World Trade Center bombing and the 1995 Oklahoma City bombing, blasting agents were concealed inside rental trucks. Pipe bombs found at the 1996 Olympic Games in Atlanta were concealed inside an ordinary backpack. Because explosive materials can be easily concealed inside any container, you need to be extremely careful when terrorist events are suspected. That doesn't mean you should be paranoid of every unattended backpack you find. However, it's vital that you not limit your thinking to the explosive materials pictured in this book.

Concealment is not the only concern. There is almost no limit to the improvised explosive devices (IEDs) that can be constructed using materials commonly found in our society. Explosives can be incorporated into almost any object and designed to detonate when the object is disturbed or opened. Mail bombs are a good example of this. (It is beyond the scope of this book to discuss improvised devices in detail. Although the author wants to provide as much information as possible to emergency responders, it is important to avoid giving ideas to the wrong people.)

As recent events have shown us, we must now also think in terms of items not classified as explosives but used as bombs nonetheless (e.g., airplanes or tankers deliberately crashed into buildings). And where suicide bombings were once thought of as acts that occurred only "somewhere else," we need to consider them a realistic threat scenario also. Emergency responders must be vigilant not only in preparing for known threats but also in anticipating the previously unthinkable in areas where we're vulnerable.

Identification of Explosive Materials (continued)

Identification Marks

Licensed manufacturers are required to put identification marks on all explosive items offered for sale or distribution.

- Federal legislation now requires each licensed manufacturer of explosive products in the United States to legibly identify all explosive items that are offered for sale or distribution. This legislation became effective on February 12, 1971. Products produced before that date may not have identifying marks.
- The required marks must identify the manufacturer and the location, date, and shift of manufacture, which can often help law enforcement officials trace the person who purchased the product.
- The marks consist of a series of numbers or a combination of numbers and letters. The format can vary among different manufacturers.
- The identification marks must placed on each cartridge, bag, or other immediate container, as well as on any outside packaging of individual containers.
- If individual units are so small that marks are impractical, as in the case of blasting caps, the manufacturer is required only to mark the packaging material.
- Manufacturers are not required to have different marks for different products, so the same date/shift code may be used on more than one item. If it is necessary to trace an item through these markings, the plant will need to know the brand, type, and exact size of the explosive in addition to the complete identification mark.
- Improvised devices and devices manufactured illegally might not have the normal identification marks, but they might have other markings that can help law enforcement officers trace the bomber.

Common Explosive Devices

The following are common explosive devices responders might encounter.

Mail Bombs

- Mail bombs can come in envelopes or boxes.
- They can be detonated in several ways, including pressure changes (such as when the package is opened), exposure to light, or immersion in water.
- They might have one or more of the following characteristics. Any one characteristic by itself may not mean anything. However, two or more should be viewed suspiciously.
  - Markings such as "Personal," "Confidential," or "Private"
  - Incorrect name, title, or address
  - Misspelled words
  - No return address or fictitious return address
  - Postmark inconsistent with the return address
  - Postmark from a foreign country
  - Distorted handwriting or badly typed address labels
  - Excessive postage (to prevent return or nondelivery)
  - Discolored packaging or oily stains on outer surface (often the most visible indication of a letter bomb)
  - Strange odors, particularly oil smells
  - Protruding wires or aluminum foil
  - Rigid, uneven, or lopsided envelopes or packages
  - Packages with irregular shapes, soft spots, or bulges
  - Unprofessional wrapping on packages
  - Excessive string or tape securing the package
  - Packages stamped with "Fragile: Handle With Care" or "Rush: Do Not Delay"
  - Buzzing or ticking noises coming from the package
  - Pressure or resistance when removing contents
  - Dark or heavily lined envelope (to shield a light-sensitive detonator until the envelope is opened)

Common Explosives Devices (continued)

Pipe Bombs

- Pipe bombs can be made of metal or plastic pipes and caps. They usually contain either black or smokeless powder.
- Many are initiated with safety fuse. Others are initiated by means of a mercury switch that activates when the bomb is disturbed. As with many other devices, pipe bombs can be rigged with multiple initiating devices to fool responders. The photo above shows just one example of what a pipe bomb might look like. You may or may not see different things attached to the outside.
- Pipe bombs might be filled with or wrapped with shrapnel (nails, staples, or other sharp items intended to do more harm).
- Sparks resulting from an attempt to dismantle a pipe bomb can also initiate black powder.

Grenades

- Grenades come in a variety of shapes and sizes. They also come in a variety of colors, but green is the most common.
- The military uses blue grenades as training grenades. However, because grenades can be refilled, it's important to consider grenades of any color to be real and dangerous until proven otherwise.
- A grenade is primed as soon as the pin is pulled, but the firing train doesn't begin until the spoon on the grenade is released.
- Military grenades typically have a 3- to 5-second delay between the time the spoon is released and the time of explosion. The delay on homemade grenades is less predictable.

Common Explosive Devices (continued)

Acid Bombs and Dry Ice Bombs

- Bombs can be made with ordinary plastic soft drink bottles.
- Acid bombs and dry ice bombs function by overpressurization of a closed plastic container.
  - Acid bombs rely on a chemical reaction between muriatic acid (pool acid) and aluminum foil.
  - Dry ice bombs function by a physical reaction as the dry ice warms and expands. Plastic bottle manufacturers modified the cap design years ago to reduce the risk of overpressurization if dry ice is put in their bottles, but a clever bomber could defeat this safeguard.
- Activation time varies between the two bombs:
  - Acid bombs usually function within 30 seconds, although they can be rigged for a delayed action.
  - Dry ice bombs can take between 30 seconds and 30 minutes, depending largely on ambient temperature.
- Acid bombs and dry ice bombs look very similar. However, there are a few distinguishing characteristics:
  - Dry ice bombs may show heavy frosting on the bottles before they explode, whereas acid bombs do not.
  - Because acid bombs function so rapidly, it is far less likely that responders will find an intact one in the field. An intact bottle bomb is more likely (though not guaranteed) to be a dry ice bomb.
  - Acid bombs tend to stretch and warp when they explode, looking as if they have melted.
  - Dry ice bombs usually maintain their shape instead; they appear to have shattered.
- Although both acid bombs and dry ice bombs are dangerous, injuries from an acid bomb will usually be worse because of the chemical exposure. Stay at least 300 feet (91 meters) from an intact device.

Common Explosives

The last three pages focused on explosive devices. The following pages will look at the explosives themselves.

Dynamite

- Dynamite is one of the more common types of explosives used by criminal bombers.
- It is usually found in cylindrical or stick form and is wrapped in buff, white, or red wax paper. Dynamite sticks come in a variety of sizes.
- There are different types of dynamite. Dynamite with a high nitroglycerin content is highly sensitive to shock, friction, and heat. Other forms are less sensitive, but still very dangerous under emergency conditions. (Most dynamite manufactured today contains very little nitroglycerin.)
- Dynamite with a high nitroglycerin content has a heavy, pungent, sweet odor. Dynamite comprised largely of other ingredients may not have a characteristic odor.
- Dynamite can be detonated using either electric or nonelectric blasting caps or detonating cord.
- Dynamite has a limited shelf life. If kept at a constant temperature and rotated periodically, it can last a long time. But if exposed to temperature extremes, it can become unstable relatively quickly. Dynamite that looks like a burrito (old dynamite with leaking nitroglycerin) is extremely dangerous and unstable.
- Depending on the ingredients, leaking dynamite may be light tan to light brown or reddish brown. The texture will also vary, but it is likely to be slightly moist and oily.
- Exposure to nitroglycerin liquid or vapors will usually cause a very persistent and severe headache.

Common Explosives (continued)

TNT (Trinitrotoluene)

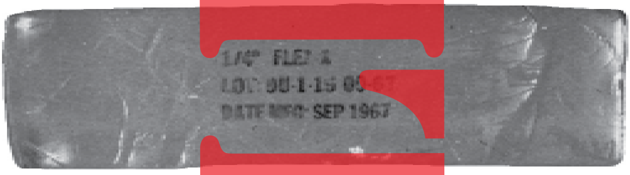
- TNT is widely used as a booster charge, bursting charge, and demolition charge.
- It is relatively insensitive to impact, heat, shock, and friction.
- TNT is most often found in cylindrical or rectangular “blocks” made of cardboard. Each block has metal ends, one of which will have a threaded blasting cap well.
- TNT is usually light yellow to light brown, but it will turn dark brown after several days’ exposure to sunlight. Some TNT might be gray due to the addition of graphite.

Two-Part (Binary) Explosives

- Two-part (binary) explosives consist of two inert compounds that are stored and shipped in separate containers with no special handling required. After the solution is mixed, it becomes cap-sensitive and is considered a high explosive.
- Kinepak, pictured above, is one example of a two-part (binary) explosive. Kinepak is a mixture of ammonium nitrate and nitromethane.
- ANFO (ammonium nitrate mixed with fuel oil) is another example of a two-part (binary) explosive.

Common Explosives (continued)

Sheet Explosives



- Sheet explosive, also known as Flex-X or Detasheet, is a flexible, rubberlike explosive that can be easily cut with a knife. It has a pressure-sensitive adhesive backing that allows it to be quickly applied to irregular or curved surfaces.
- Sheet explosive is commonly packaged in sheets or rolls, though it can be manufactured in a variety of shapes and sizes. Because it is usually very thin, it is often used in letter bombs.
- The military version is dark green. Commercial versions are normally red, but they can be made in almost any color.

Composition C-4

- C-4 is a plastic explosive.
- It is white to light brown and has no odor.
- C-4 comes in block form, usually wrapped in olive drab or clear mylar film bags or glazed paper, depending on type and age of explosive. Older C-4 may be encased in a clear white plastic container with a threaded cap recess in each end.
- C-4 blocks might be labeled "M5A1" or "M112."
- C-4 is relatively insensitive to impact, heat, shock, and friction.
- Unconfined C-4 will burn with an almost invisible flame.

Common Explosives (continued)

Black Powder

- Black powder is a low explosive.
- It is extremely sensitive to friction, heat, impact, and sparks.
- Black powder typically consists of potassium nitrate or sodium nitrate, sulfur, and charcoal.
- Black powder might appear coal black, gray black, or cocoa brown. Its form can vary from a very fine powder to 1/2-inch (1.27 cm) granules.
- Black powder is sold in metal containers ranging from small tin flasks to bulk tin containers or 25-pound (11.35 kg) metal kegs. It can also be found with Civil War souvenir items. Old black powder is just as dangerous as newer powder.
- Black powder is generally safe when wet, but once it dries, it is just as dangerous as it was when it was first manufactured.

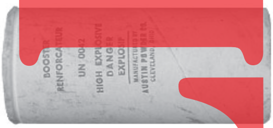
Black Powder *Smokeless Powder*

Smokeless Powder

- Smokeless powder is a low explosive.
- Many smokeless powders are very sensitive to friction.
- Smokeless powder has a nitrocellulose base. Various substances are often added to give different qualities. Variations are distinguished by such terms as “double-base,” “flashless,” and “smokeless,” as well as by trade names or symbols.
- Smokeless powders vary in form and color.
  - The majority of rifle and pistol powders are black and formed into rods, cylindrical strips, round flakes, or irregular grains.
  - Shotgun powders might be orange to green translucent flakes, either round or square, or they might be black irregularly shaped granules.
- Smokeless powders are sold in tin flasks, glass jars, plastic containers and kegs weighing up to 25 pounds (11.35 kg).
- Unconfined powder burns with little or no ash or smoke.

Common Explosives (continued)

Boosters



- High-explosive boosters, also called primers or primer explosives, are used in an explosive train to amplify and strengthen the shock wave from a primary explosive in order to detonate the comparatively insensitive main-charge high explosive.
- Boosters are usually cylindrical, with the explosive encased in a light metal, cardboard, or plastic container.
- There are openings at each end of the booster container. The opening that appears at both ends is for stringing detonation cord through the booster. One end of the booster will have a second opening where the blasting cap is inserted.
- Some boosters are supplied in tin cans with threaded, interlocking ends that allow multiple boosters to be joined.
- Common explosives used in boosters include pentolite, RDX, PETN, and tetryl.

Common Explosives (continued)

Blasting Agents

A blasting agent is a chemical mixture that consists largely of ammonium nitrate and that will detonate when initiated by a high-explosive primer or booster. Blasting agents are relatively insensitive to shock, friction, and impact, but are very dangerous when exposed to fire. The two most common ones are ammonium nitrate and water gels (or blasting slurries).

Ammonium Nitrate

- Ammonium nitrate is one of the least sensitive and most readily available main-charge high explosives. It is also an ingredient of some dynamites and is widely used as a fertilizer.
- Ammonium nitrate ranges in color from white to buff-brown, though colored dyes may be added to facilitate identification. It is usually found in small compressed pellets called "prills."
- When used as an explosive, ammonium nitrate may be sensitized by the addition of fuel oil. This mixture is referred to as ANFO (ammonium nitrate and fuel oil) or as "prills and oil."
- Explosive charges containing ammonium nitrate are usually packaged in waterproof containers.
- Ammonium nitrate is a strong oxidizing agent.
- Brass or bronze nonsparking tools should *not* be used around ammonium nitrate because they will react to form an impact-sensitive explosive.

Water Gels (Blasting Slurries)

- Water gels (or blasting slurries) consist of nitro-carbo-nitrate mixtures, with or without TNT. Some have powdered metals, such as aluminum, added to increase performance.
- Water gels are packaged in polyethylene bags.

Other Primary Explosives

- Lead azide, lead styphnate, and mercury fulminate are three other compounds that might be used in explosive devices.
- All three are extremely sensitive to heat, shock, friction, and static electricity.

Fireworks

Fireworks are not designed as explosives, per se, but they present many of the same dangers to emergency responders.

- All fireworks can be dangerous, but illegal fireworks are far more hazardous than legal ones. They are often very powerful and are made without the quality control standards of legal fireworks. They can be very unpredictable.
- Legal fireworks will contain the name of the manufacturer and a warning label describing necessary safety precautions. Older fireworks will also be marked “Class C Common Fireworks,” whereas newer ones will be marked “Class 1.3 Explosive” or “Class 1.4 Explosive.” If you don’t see these markings, consider the fireworks illegal and dangerous.
- Fireworks that are leaking powder, are damaged in any way, appear to be very old, or appear to have been wet and then dried should be considered more dangerous and unpredictable than normal.

Common Initiation Devices

The following are devices commonly used to initiate explosives.

Safety Fuse

- Safety fuse can be used to detonate explosives nonelectrically. Its purpose is to transmit a flame at a continuous, uniform rate to a nonelectric blasting cap, but it can also be used to initiate a low explosive main charge directly.
- Safety fuse is approximately 0.2 inches (0.5 cm) in diameter (about the size of a lead pencil). Commercial brands normally have an orange or white outer covering to provide high visibility. Military brands are normally dark green. Both kinds might have colored markings that contrast with the background color.
- Safety fuse contains a black powder core that provides a burning rate of approximately 40 seconds per foot (0.3 meters), slow enough to allow a bomber time to leave the scene safely.
- Safety fuse gives off smoke and a characteristic acrid odor when burning, which may provide sufficient warning for others to escape.
- A portion of the spent fuse will usually survive an explosion and may be located close to the point of detonation.

Safety Fuse

Detonating (Det) Cord

Detonating (Det) Cord

- Detonating (det) cord looks similar to safety fuse. Detonating cord is usually yellow, with a plastic-like outer jacket, but it can come with a variety of colored outer sheaths. The biggest distinguishing feature, however, is its white or pink powder core. (Light gray or pale green powder is less common.)
- The explosive in detonating cord is generally RDX, HMX, or PETN, which react at far quicker rates—in excess of 22,000 feet (6.7 km) per second—than does the black powder in safety fuse.

Common Initiation Devices (continued)

Blasting Caps

- Blasting caps contain a small amount of a primary explosive.
- They are sensitive to shock, heat, and impact and should be handled carefully at all times.
- There are two primary types of blasting caps: electric and nonelectric.
- Electric blasting caps can be recognized by two lead wires protruding from one end. The wires are usually insulated and normally have a short-circuiting shunt on exposed ends to guard against static electricity and to prevent accidental firing.
- Nonelectric blasting caps look like small metal tubes or shells. One end is closed. The other end is open to allow insertion of a safety fuse.
- Blasting caps vary in size from slightly over one inch to several inches in length.
- **Electric blasting caps can be set off by radio signals**, so it's vital to avoid using radios anywhere near electric blasting caps. Radios should be kept *at least* 330 feet (100 meters) away.

Fuse Igniters and Improvised Igniters

- A variety of other devices, both commercial and improvised, can be used to apply sparks or flame to a safety fuse.
- Igniting a safety fuse does not require any fancy equipment. It can be accomplished with an ordinary match.
- Several types of military and commercial igniters might be used to provide a more reliable method of igniting a safety fuse, particularly in adverse weather conditions. Percussion type igniters and friction type igniters, for example, are small tubes made of plastic or cardboard with a pull ring or handle at one end and an opening to insert the safety fuse at the other. The igniter is activated when the ring or handle is pulled.

Upon Discovery of an Explosive

The following are general instructions that apply to any situation involving explosive devices. Remember that explosive devices might not look like bombs and can be concealed inside other objects. Be suspicious of things that look out of place, and use available resources, as appropriate, to help determine whether or not the object in question might be a bomb. For example, a package delivered by a legitimate shipping company should have a tracking number on it. If you can't tell who sent the package, you can ask the shipper to identify the sender through the tracking number. If necessary, you can call the sender to confirm the legitimacy of the shipment. This is an easy way to rule out a parcel bomb.

Do

- Remain calm.
- Isolate the area, and deny entry to unauthorized personnel.
- Evacuate the area to a distance of at least 900 feet (0.27 km) in all directions, including above and below the object. Move people away from the device rather than move the device. (Greater distances might be prudent, especially if there's any possibility that emergency responders could be targeted. Terrorists who gain access to our training materials might build or plant devices to harm us at what we believe to be safe distances.) (See also the Vehicle Bomb Evacuation Distance Table on page 8-22.)
- *If safe to do so*, open doors and windows as you evacuate to minimize damage from the blast. The shock wave will do more damage in an enclosed area than in an open one.
- Take cover behind buildings if possible. If you can't stay behind a building, use other available cover.
- Call for assistance from a specially trained and equipped bomb squad. Call for additional resources (e.g., fire department) and make other notifications (e.g., FBI and ATF) as appropriate.
- Be alert for secondary devices. Search the area if appropriate.
- Recognize that a device might activate in some manner other than the obvious. For example, a timer might count up instead of down, and you would have no way of knowing when it was set to detonate under those conditions. The device could even be activated by remote control by a terrorist who is waiting for emergency responders to get close.

(continued next page)

Upon Discovery of an Explosive Device (continued)

Do (continued)

- Treat all devices as dangerous until proven otherwise. For example, a hand grenade normally used for training purposes (typically blue in color) can be reloaded. Even something that appears to be a toy weapon can be a real device.
- Observe for evidence of chemical, biological, or radiological materials that might have been planted with the explosive.
- Pay attention to circumstances surrounding the incident. Note suspicious people or activities. Relay any information to the appropriate officials, regardless of how unimportant it may seem to you at the time.
- Look at the big picture. Maintain situational awareness.
- Try to minimize the logistical and financial impact of shutting down a business. However, do not be pressured into compromising life safety.
- Assign a public information officer to address the media. This will minimize the spread of rumors.
- Follow department SOPs.

Don't

- Do not panic.
- Do not touch, shake, or disturb the device.
- Do not open a container that you suspect contains a bomb.
- Do not attempt to move the device to another location. Evacuate the area instead.
- Do not immerse the device in water. Doing so may cause the device to detonate.
- Do not put the device in a confined space, such as a desk drawer or filing cabinet. Confinement will cause more harm if the bomb does detonate.
- Do not attempt to cover the object, particularly with metal, glass, or other materials that could become a fragmentation hazard if the device explodes.
- Do not turn lights or equipment on or off. Leave everything as you find it.
- Do not operate radios within 330 feet (100 meters) unless you are certain the device can't be activated by radio transmissions.
- Do not block access to the device. Do not block doors.
- Do not smoke in the vicinity.
- Do not attempt to disarm the device.

Upon Discovery of an Explosive Device (continued)

Vehicle Bomb Evacuation Distances

The chart below was adapted from information in both the *Emergency Response Guidebook* and the Vehicle Bomb Explosion Hazard and Evacuation Distance Table produced by the Bureau of Alcohol, Tobacco and Firearms (ATF).

- The distance provided is the *minimum* evacuation distance to prevent life-threatening injury from blast or fragmentation hazards. However, greater distances may be appropriate to prevent non-life-threatening injury or temporary hearing loss.
- Hazard ranges are based on open, level terrain.
- Minimum evacuation distance may be less when explosion is confined within a structure.
- An explosion confined within a structure may cause structural collapse or building debris hazards.
- Additional hazards include vehicle debris.

Vehicle Bomb Evacuation Distance Table

Vehicle Silhouette	Vehicle Description	Minimum Evacuation Distance to Prevent Life-Threatening Injuries
	Passenger Vehicle	0.5 mile (0.8 km)
	Small Van	1 mile (1.6 km)
	Large Truck	1.5 miles (2.4 km)

After Detonation of an Explosive

The following are general instructions that apply anytime a device has been detonated.

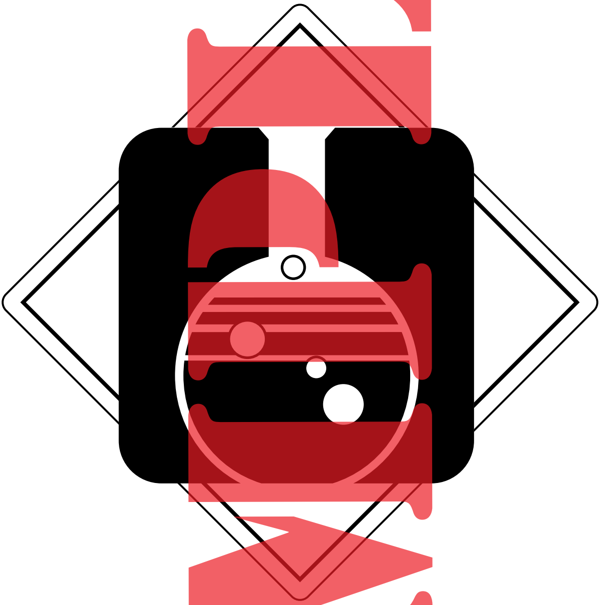
Do

- Remain calm.
- Isolate the area and deny entry to unauthorized personnel. If entry is necessary, keep the number of people to a minimum.
- Call for assistance from a specially trained and equipped bomb squad. Make other notifications as appropriate.
- Be alert for secondary devices. Search the area if appropriate.
- Observe for evidence (e.g., unusual odors or unusual patient symptoms) that might indicate the explosive was used to disperse other hazardous materials. Conduct atmospheric monitoring as appropriate.
- Look at the big picture. Maintain situational awareness.
- Spend as little time in the blast area as possible. If you need to rescue patients, load and go. Treatment can wait until you are in a safe area.
- When treating patients, avoid cutting through areas of clothing that contain evidence (e.g., holes made by bomb fragments).
- If possible, determine the seat of the blast (point of origin).
- Pay attention to circumstances surrounding the incident. Note suspicious people or activities. Relay any information to the appropriate officials, regardless of how unimportant it may seem to you at the time.
- Preserve evidence as much as possible. Don't touch anything you don't have to. Use photos, video tape, and sketches to help preserve the scene, particularly if anything must be moved.
- Assign a public information officer to address the media. This will minimize the spreading of rumors.
- Follow department SOPs.

Don't

- Do not panic.
- Do not turn lights or equipment on or off. Leave everything as you find it.
- Do not disturb evidence any more than is necessary to save lives or control immediate hazards. If you must disturb evidence, pay attention to conditions so you can reconstruct them for investigators later. Make note of anything you moved and any actions you took.

Chemical Warfare Agents



Although almost any chemical can be used for a terrorist attack, emergency responder training usually focuses on a handful of chemicals that have been specifically developed for warfare, used in military or civilian attacks before, or sought after by terrorists.

This chapter begins with general information that applies to any incident involving chemical warfare agents, which is helpful if you don't yet know what you are dealing with. It then provides more detailed information on nerve agents, blister agents, blood agents, choking agents, and riot control agents.

For additional assistance in dealing with chemical warfare agents, contact the Chemical and Biological Hotline staffed by the National Response Center (NRC). (See page 14-46.)

General Information About Chemical Agents

There are numerous hazardous materials that could be used as chemical weapons, but only a handful that are considered chemical warfare agents.

These first few pages provide general information that applies to any incident involving chemical agents. This is a good place to start if you don't know what specific agent you are dealing with or if the agent is not one of those listed later in this chapter.

Types of Chemical Agents

Although almost any chemical can be used for a terrorist attack, terrorism training usually focuses on the ones identified below, because these chemicals have been specifically developed for warfare, used in military or civilian attacks before, or sought after by terrorists.

- **Nerve agents** are organophosphate compounds that attack primarily the nervous system, causing uncontrolled muscular contractions. They are considered to be the most dangerous of the chemical warfare agents. The common ones are tabun (GA), sarin (GB), soman (GD), and V agent (VX).
- **Blister agents** (also known as mustard agents or vesicants) are extremely toxic chemicals that produce characteristic blisters on exposed skin. The common ones are mustard (H), distilled mustard (HD), nitrogen mustard (HN), Lewisite (L), and phosgene oxime (CX).
- **Blood agents** are those that interfere with the body's ability to use oxygen. Hydrogen cyanide (AC) and cyanogen chloride (CK) are the most common.
- **Choking agents** are those that attack primarily the respiratory tract (the nose, the throat, and particularly the lungs). The two that fit this category, chlorine (CL) and phosgene (CG), are common industrial chemicals.
- **Riot control agents** (also known as irritants) cause respiratory distress and copious tearing that quickly incapacitate a person. The common ones include tear gas, mace, pepper spray (OC), and adamsite (DM). (Depending on chemical composition, tear gas can be CS, CR, or CN, and mace can be CN or PS. See page 9-28 for more information.)

General Information (continued)

Health Effects

Initial signs and symptoms associated with chemical agents usually manifest themselves within minutes of exposure. Sometimes, depending on the agent and route of exposure, initial effects are delayed for several hours, but *most* chemical warfare agents act very quickly. The general health effects listed below can help point you toward a particular class of agent, particularly when combined with other clues (e.g., odors). More detailed descriptions are provided later in this chapter where the specific agents are discussed by type.

- **Nerve agents**: The most significant indicators of nerve agent poisoning are rapid onset of pinpoint pupils and muscular twitching. Other key indicators are runny nose, salivation, sweating, nausea and vomiting, difficulty breathing, and convulsions.
- **Blister agents:** Most blister agents produce immediate irritation to eyes, skin, and mucous membranes. With mustard, however, pain and irritation may be delayed by as much as 24 hours. (Mustard is the only chemical warfare agent that does not produce symptoms within minutes of exposure.) Irritation to the respiratory system causes shortness of breath. Blisters are the most distinguishing characteristic of blister agents.
- **Blood agents**: Cyanide exposure causes rapid onset of respiratory stimulation, dizziness, nausea, vomiting, and headache. High concentrations cause convulsions and respiratory arrest. (Both nerve agents and cyanide cause convulsions, but cyanide does not produce pinpoint pupils, excessive secretions, and fine tremors in the muscles under the skin.)
- **Choking agents**: These gases quickly cause irritation to the eyes, nose, and throat; respiratory distress; nausea and vomiting; burning of exposed skin; and tightness in the chest. Pulmonary edema can develop within 24 hours.
- **Riot control agents**: These agents cause rapid onset of respiratory distress, eye irritation, and tearing. Effects seldom persist more than a few minutes once patients are moved to fresh air.

General Information (continued)

Routes of Exposure / Dissemination

- Inhalation is the primary route of entry for most chemical agents.
- Absorption through the skin or eyes is also a major route of entry for many of the chemical agents.
- Accidental ingestion is unlikely unless responders fail to thoroughly wash their hands before eating, drinking, or smoking.
- The worst terrorist scenarios involve disseminating the agents in a manner that creates a large gas or vapor cloud (e.g., opening a gas cylinder, using spray devices, or dispersing the agent with an explosive device) because it's harder to protect against a gas or vapor than against a liquid or solid.
- Other possible scenarios include contaminating surfaces that people are likely to contact or contaminating food or water supplies. However, these scenarios are less effective and thus considered less of a risk.

Patient Decontamination

Follow the patient decon guidelines on pages 6-11 to 6-15, as well as the general decon guidelines on pages 2-57 and 2-58. The following are a few generalizations to help you. For more specific recommendations, contact your poison control center.

- It's safe to use *plain* water with *any* of the chemical agents.
- It's safe to use *soapy* water with *most* of the chemical agents.
- Although some sources recommend using a 0.5% hypochlorite solution on nerve agents, mustard, and Lewisite, hypochlorite can cause further harm to patients. (See page 6-13 for details.)

If you have an appropriate chemical agent monitor, you can use it to check for residual contamination on the patient.

Treatment

Follow the general treatment protocols for all chemical exposures (pages 6-26 to 6-29). A few of these chemical agents have specific antidotes; they are identified throughout this chapter where the agents are covered by type. However, treatment for most chemical agents consists largely of providing supportive care for presenting signs and symptoms.

General Information (continued)

Two Properties That Affect Risk

Chemical agents are often discussed in terms of **volatility** and **persistency**. Volatility and persistency are relative terms used to express how rapidly an agent will evaporate, or dissipate. They are directly related to *vapor pressure* (defined on page 5-41).

Unfortunately, these relative terms often mislead responders. For example, the G agents are considered *volatile*. The word *volatile* might create the impression that G agents will jump out and attack responders from a distance. They won't. The vapors remain close to the surface of the liquid. Sarin, the most volatile of the G agents, has a vapor pressure of 2.1 mmHg at 68˚F/20˚C (or 2.9 mmHg at 77˚F/25˚C). It evaporates at a slower rate than does water (with a vapor pressure of 17.5 mmHg at 68˚F/20˚C). Certainly, it's more volatile than VX (0.0007 mmHg), but far less so than hydrogen cyanide (630 mmHg) or chlorine (6.8 atm).

Agents that evaporate within a matter of hours are considered *nonpersistent*, whereas those that take several days or weeks are considered *persistent*. Again, the G agents will evaporate at a slightly slower rate than water does; they are nonpersistent. VX, on the other hand, evaporates about as quickly as motor oil does; it is a persistent agent. Several agents can be made more persistent by the addition of thickeners. Other properties (e.g., vapor density) and external factors (e.g., weather conditions) also affect how quickly or slowly an agent evaporates.

The more volatile the agent (the greater the vapor pressure), the greater the risk to responders. Truly volatile materials might require a higher level of personal protective equipment and greater isolation distances. (Obviously, you must also evaluate risk in terms of toxicity, flammability, etc.) On the other hand, the more volatile and nonpersistent the agent, the easier decon becomes. There will be less agent on the body or equipment to be decontaminated because some of it has already evaporated.

It is beyond the scope of this book to list chemical and physical properties of hazardous materials. However, this chapter does provide vapor pressure and vapor density for the chemical agents to help you understand the risks associated with them. (As much as possible, the vapor pressure was provided at 68˚F/20˚C.)

Personal Protective Equipment (PPE)

Performance requirements for protective ensembles used at CBRN terrorism incidents can be found in two NFPA standards:

- *NFPA 1991: Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies* includes the former requirements for Class 1 CBRN ensembles—those providing the highest level of protection.
- *NFPA 1994: Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents* covers the remaining ensembles, designed to protect emergency responders at terrorism incidents as follows:

Class	Hazards	Conc.	Min. Resp. Prot.
2	chem (vapor or liquid)	≥ IDLH	CBRN* SCBA
3	chem (vapor or liquid)	< IDLH	CBRN* APR/PAPR
4	bio or rad particulate	< IDLH	APR/PAPR

* NIOSH CBRN certification

The following are general guidelines only and must not be used as a substitute for department SOPs or for obtaining more specific information from appropriate reference sources. See also pages 2-47 to 2-54 for general information on PPE.

Hot Zone Operations / Rescue

- In general, entry into a hot zone should be done only by hazmat personnel in chemical protective clothing.
  - Level A is recommended for entry into an area suspected of nerve agent or blister agent contamination.
  - Level B may be used with nerve agents once it's determined that a vapor hazard no longer exists.
  - Choking agents may require Level A or B, depending on assignment.
  - Level B is usually sufficient with blood agents.
- Structural firefighting clothing and SCBA are sufficient for riot control agents.
- If police officers must enter the scene where riot control agents are present, they should wear department-issued respiratory protection and cover exposed skin.

(continued next page)

General Information (continued)

Personal Protective Equipment (continued)

Hot Zone Operations / Rescue (continued)

- It *may* be possible to effect a rescue of *known live victims* from a chemical agent atmosphere using structural firefighting clothing and SCBA. However, this decision requires a careful risk-versus-gain analysis. (See pages 2-38 to 2-40 for information about a study conducted by the U.S. Army SBCCOM Domestic Preparedness Chemical Team on this subject.)

Warm Zone Operations / Patient Decon

- Structural firefighting clothing and SCBA are often sufficient for decon, particularly if covered by a chemical-resistant apron. However, inexpensive disposable chemical protective clothing may be preferable, since it's difficult to adequately decontaminate structural firefighting clothing.
- Chemical protective clothing (Level B or Level A) should be worn if patients or responders are grossly contaminated with a blister agent or thickened nerve agent.
- For healthcare facilities receiving contaminated patients, OSHA recommends *minimum* PPE of a powered air-purifying respirator (PAPR) with a protection factor of 1000, a chemical-resistant garment, a head covering (if not part of the respirator), a double layer of protective gloves, and chemical protective boots. (See the January 2005 document titled *OSHA Best Practices for Hospital-Based First Receivers of Victims from Mass Casualty Incidents Involving the Release of Hazardous Substances* for complete details and prerequisites.) Healthcare facilities that are not adequately prepared to handle contaminated patients may have to rely more heavily on assistance from firefighters and hazmat teams, which requires cooperative planning between all parties, with contingencies for different scenarios.

Cold Zone Operations / Patient Care

- No special protective gear is required when caring for patients who have been thoroughly decontaminated or who have been exposed only to chlorine or phosgene gas. (See also pages 6-4 to 6-7 for concerns about possible secondary contamination in the patient's blood other body fluids.)

Detection

Appearance

Of all the chemical agents covered in this chapter, the only one with a distinctive appearance is chlorine; it is clear to amber-colored in liquid form and greenish-yellow in gas form. Other agents are described later in this chapter, but none are so distinctive that they would be recognized by sight, and most won't even produce a visible cloud when dispersed. However, there may be other visual indicators, such as abandoned spray devices or explosions that disperse liquids, mists, or gases. See pages 7-6 and 7-7 for other examples.

Odor

Be cautious when using odors to identify chemicals. Besides the obvious concern that getting close enough to smell a chemical can result in injury, you need to keep in mind that witness descriptions may or may not be reliable. For example, most people would recognize the odor of chlorine, but how many would know what bitter almonds smell like? If people are insensitive to particular odors, if the odor threshold is too high, or if exposure causes olfactory fatigue, it may be impossible to get a good description.

- **Nerve agents**: Pure nerve agents are odorless. Impure G agents may have a slight fruity odor, and VX may have a slight sulfur odor. However, odors can vary with impurities, so these descriptions may be of limited value
- **Blister agents**: Depending on purity and concentration, mustards may be odorless or may smell like mustard, onion, or garlic. Lewisite smells like geraniums. Phosgene oxime has an intense, irritating odor.
- **Blood agents**: Cyanide has an odor of bitter almonds or peach kernels, although at least 25% the population is genetically unable to smell the odor.
- **Choking agents**: Chlorine smells like bleach. Phosgene smells like freshly cut grass or newly mown hay.
- **Riot control agents**: Tear gas and pepper spray smell like peppers. Mace has a fragrant odor, like that of apple blossoms. Adamsite is odorless.

General Information (continued)

Detection (continued)

Detection Devices / Monitors

The following is a general overview of detection devices that can identify chemical warfare agents.

- Colorimetric tubes are available for almost all of the agents except riot control agents.
- The M8 and M9 chemical agent detector papers can identify the liquid form of nerve agents and blister agents.
- The M18A2 and M256A1 Chemical Agent Detector Kits can be used for nerve agents, blister agents, and blood agents.
- The M272 Chemical Agent Water Testing Kit can be used to detect water contaminated with nerve agents or cyanide.
- Various chemical agent monitors can detect one or more types of chemical warfare agents.
- Gas chromatography and mass spectrometry (GC/MS) equipment can identify nerve agents, blister agents, and many toxic industrial chemicals.

It's beyond the scope of this book to go into more detail on detection equipment. One important recommendation, however, is to be familiar with how to get access to the latest and greatest detection equipment when you need it. National Guard WMD Civil Support Teams (CST), for example, have some of the best equipment and most highly trained personnel available. If you suspect a terrorist event, consider requesting Civil Support Team assistance through your state notification center or office of emergency services. See page 14-48 for more information.

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Detection (continued)

Detection Devices / Monitors (continued)

If you do have chemical warfare agent detectors available to you, be familiar with the capabilities and limitations identified by the manufacturer and reliable third-party studies. The following are some limitations to be aware of:

- Some detectors respond only to liquids, while others respond only to vapors.
- Some detectors won't detect an agent in water.
- Some detectors can detect multiple agents or types of agents. Others are more limited in their capabilities.
- Some detectors are less sensitive than others and might not detect tiny concentrations.
- Many detectors are prone to false positives.
- Some detectors rely on technologies that have limited shelf lives (e.g., colorimetric tubes).
- Temperature and humidity can affect the performance of some detectors.
- Some detectors take several minutes to provide a reading.
- Detectors that rely on batteries might not provide accurate readings if the batteries aren't fully charged.
- Some detectors require more calibration and maintenance than others and might not provide accurate results if neglected.
- The more complex the equipment, the greater the potential for human error.
- The most accurate detection equipment (e.g., gas chromatography and mass spectrometry [GC/MS]) is very expensive, requires greater training to operate, and can take several hours to provide results.

(continued next page)

General Information (continued)

Detection (continued)

Detection Devices / Monitors (continued)

Develop a detection strategy that incorporates the equipment available to you, but that also emphasizes common sense, evaluation of on-site indicators, and assistance from appropriate resources. Make sure that strategy stays within your training and department SOPs.

- Evaluate sensory clues, such as appearance and odor. (See page 9-9 for more information.) Remember: Do not expose yourself to the material. Use binoculars and question witnesses about appearance and odor while maintaining a safe distance.
- Look for other indicators that might point to a terrorist attack rather than an accidental event. (See pages 7-4 and 7-5.)
- Determine if patient signs and symptoms are consistent with those produced by chemical warfare agents. (Page 9-4 provides an overview of those signs and symptoms, but more details can be found throughout this chapter.)
- Survey the scene with conventional detection equipment. (See pages 5-48 to 5-50.) Check for radioactive materials, flammable gases or vapors, oxygen-deficient or oxygen-enriched environments, and corrosive gases or vapors as you would in any other unknown atmosphere. Don't overlook the more common and likely scenarios, the possibility of multiple chemical hazards, or the opportunity to rule out chemical warfare agents.
- Use available chemical agent detectors as appropriate. The limitations listed on the previous page should make it clear that some equipment won't be effective because it's not designed to detect the suspected agent or not designed to detect the material in the form present. So choose the appropriate detectors. Confirm readings with a combination of equipment for more reliable results.
- If appropriate, obtain a sample for laboratory analysis.
- Request assistance early in the incident from other resources that can assist you either by bringing advanced detection equipment to the scene or by helping to assess the situation over the phone. (See chapter 14 for information about resource agencies.)

Nerve Agents

Nerve agents are similar to organophosphate pesticides, but they are 100 to 500 times more potent. Nerve agents attack primarily the nervous system, causing uncontrolled muscular contractions. They are considered the most dangerous of the chemical agents. Exposure to even minute quantities may be rapidly fatal. The common nerve agents are listed below.

Agent	UN#	Class	ERG Guide	NFPA 704*
Tabun (GA)	2810	6.1	153	4-2-1
Sarin (GB)	2810	6.1	153	4-1-1
Soman (GD)	2810	6.1	153	4-1-1
V Agent (VX)	2810	6.1	153	4-1-1

* NFPA 704 ratings represent health, flammability, and reactivity hazards. See pages 3-23 to 3-28 for more information.

Description

Nerve agents are clear, colorless liquids at ambient temperatures. (The term *nerve gas* is a misnomer.) Pure nerve agents are odorless. Impure G agents may have a slight fruity odor, and VX may have a slight sulfur odor. However, odors and colors can vary with impurities, so these descriptions may be of limited value.

G agents are considered volatile and nonpersistent. (However, to put it in perspective, they are less volatile than water, which has a vapor pressure of 17.5 mmHg at 68˚F). These agents can be made more persistent by adding various thickeners. VX is a persistent, oily liquid with little volatility; it evaporates about as quickly as motor oil. The vapors of all four agents are heavier than air.

Agent	Vapor Pressure (mmHg)	Vapor Density
Tabun (GA)	0.037 at 68˚F/20˚C	5.6
Sarin (GB)	2.1 at 68˚F/20˚C	4.86
Soman (GD)	0.4 at 77˚F/25˚C	6.3
V Agent (VX)	0.0007 at 68˚F/20˚C	9.2

Under ambient conditions, nerve agent vapors will not travel far; thus the size of the endangered area may be relatively small. However, the vapor hazard is increased significantly when the product is exposed to high temperatures, spread over a large area, or aerosolized.

Nerve Agents (Continued)

Health Effects

Nerve agents attack primarily the nervous system by inhibiting the normal function of acetylcholinesterase, an enzyme required for nerve transmission.

The primary **route of entry** is inhalation of the vapors. However, nerve agents are also toxic by eye absorption, skin absorption, or ingestion. **Onset** of signs and symptoms is very rapid (seconds to minutes) for inhalation and eye exposure. Onset is slower (several minutes to several hours) with skin absorption, although nerve agents do penetrate the skin rapidly and effectively. Speed of onset also varies with amount of exposure.

The **most significant indicators** of nerve agent poisoning are rapid onset of pinpoint pupils and muscular twitching. (Pinpoint pupils are characteristic of eye and inhalation exposure and are best observed when patients are *not* in bright sunlight. Pupils may be normal after skin absorption.) Symptoms can appear almost immediately following inhalation exposure.

Small exposures are usually indicated by pinpoint pupils, difficulty breathing, and runny nose. **Larger exposures** will also produce loss of consciousness, convulsions, respiratory failure, and flaccid paralysis.

Detailed signs and symptoms are listed below. However, not all of these indicators will be present in every patient.

- **Eyes**: miosis (pinpoint pupils), redness, blurred or dim vision, and eye pain that is aggravated by bright light
- **Skin**: excessive sweating and fasciculations (fine tremors in the muscles under the skin)
- **Respiratory system**: runny nose, nasal congestion, coughing, difficulty breathing, tightness in the chest, and respiratory failure
- **Muscular system**: muscular twitching and convulsions, after which the patient will become flaccid and limp
- **Nervous system**: headache, drowsiness, giddiness, anxiety, difficulty thinking, difficulty sleeping, nightmares, and coma
- **Gastrointestinal system**: salivation, nausea, vomiting, abdominal cramps, diarrhea, and involuntary urination and defecation

Nerve Agents (Continued)

Patient Decontamination

If exposure was to vapor only, removing outer clothing may be sufficient. However, if there is a possibility of liquid contamination, patients must be decontaminated.

Follow the patient decon guidelines on pages 6-10 to 6-15. Decontaminate patients with plain water or soap and water. (If thickening agents are added to nerve agents, it decreases their water solubility, making plain water less effective than it would be otherwise.) Refer to pages 6-12 and 6-13 for more information on patient decon solutions.

Treatment

Follow the general treatment protocols for all chemical exposures (pages 6-26 to 6-29). Specific treatment for nerve agents may include administration of *atropine*, *2-PAM Chloride*, and *diazepam*. Antidotes must be given as soon as possible if patients are already symptomatic. Required dosages and frequency of administration will vary depending on several factors, including how the antidote is administered (via IV or autoinjector), whether the patient is an adult or a child, the level of exposure, and severity of symptoms. Follow your local protocols, and seek advice from a qualified medical expert.

Many agencies are supplying emergency personnel with the MARK 1 Nerve Agent Autoinjector so that responders have life-saving antidotes at their immediate disposal. The kit contains two injectors. The first contains two milligrams of atropine; the second, 600 milligrams of pralidoxime chloride (2-PAM Chloride).

The MARK 1 kit is administered by injection into a large muscle area, usually over the outer thigh midway between the hip and knee. Start with the atropine (#1). The injector is armed as soon as it is removed from the kit. Hold the injector over the injection site, applying firm even pressure until it pushes the needle into the thigh. Hold it in place for a full ten seconds. Repeat the same process with the 2-PAM Chloride injector (#2). Secure exposed needles to prevent needle stick injuries, then massage the injection site to help circulate the antidotes.

(continued next page)

Nerve Agents (Continued)

Treatment (continued)

For moderate or severe symptoms, additional MARK 1 kits can be administered at five- to ten-minute intervals. However, do not administer more than three kits without seeking further medical attention. More than three doses of 2-PAM Chloride can cause uncontrolled hypertension (increased blood pressure) and an increased risk of heat exhaustion or heat stress. If you are experiencing rapid heartbeat and dry mouth, do not repeat injections.

Patients experiencing convulsions/seizures should be given CANA (20 milligrams of Valium/diazepam) injectors following the same procedures as for the MARK 1 kits.

Note: Antidotes will not be effective if any agent remains on the skin or on clothing touching the skin. Therefore, thorough decontamination in addition to antidote therapy is essential.

Detection

Nerve agents are difficult to identify by sight or smell. Outward warning signs will generally be the best clue. Look for general indications of a terrorist event, such as abandoned spray devices or explosions that disperse liquids, mists, or gases. (See pages 7-6 and 7-7 for other examples.) Look, also, for rapid onset of the signs and symptoms identified on the previous page. Pinpoint pupils and muscular twitching are the best indicators.

The following detection devices can be used for nerve agents. (Consult with the individual manufacturers for information on the capabilities and limitations of each device.)

- Colorimetric tubes
- M8 and M9 chemical agent detector papers (liquids only)
- The M18A2 Chemical Agent Detector Kit
- The M256A1 Chemical Agent Detector Kit
- The M272 Chemical Agent Water Testing Kit
- Various chemical agent monitors

Refer to pages 9-10 to 9-12 for more information.

Blister Agents (Vesicants)

Blister agents (also known as mustard agents or vesicants) are extremely toxic chemicals that produce characteristic blisters on exposed skin. The common ones are listed below:

Product	UN#	DOT Class	ERG Guide	NFPA 704*
Mustard (H)	2810	6.1	153	4-1-1
Distilled mustard (HD)	2810	6.1	153	4-1-1
Nitrogen mustard (HN)	2810	6.1	153	**
Lewisite (L)	2810	6.1	153	4-1-1
Phosgene Oxime (CX)	2811	6.1	154	**

* NFPA 704 ratings represent health, flammability, and reactivity hazards. See pages 3-23 to 3-28 for more information.

** Data not available.

Description

Mustards and **Lewisite** are oily liquids that have been described as anything from colorless to pale yellow to dark brown, depending on purity. Depending on purity and concentration, mustards may be odorless or may smell like mustard, onion, or garlic. Lewisite smells like geraniums.

Pure **phosgene oxime** is a colorless crystalline solid, but phosgene oxime can also be found as a yellowish-brown liquid. It has an intense, irritating odor.

All of the blister agents are relatively persistent.

Agent	Vapor Pressure (mmHg)	Vapor Density
Mustard (H)	depends on purity	5.5
Distilled mustard (HD)	0.072 at 68˚F/20˚C	5.4
Nitrogen mustard (HN) *	0.0109-0.29 at 68˚F/20˚C	5.4-7.1
Lewisite (L)	0.39 at 68˚F/20˚C	7.1
Phosgene Oxime (CX) **	11.2 at 77˚F/25˚C	3.9

* There are three forms of nitrogen mustard: HN1, HN2, and HN3. Each has slightly different properties.

** The liquid form of phosgene oxime has a vapor pressure of 13 mmHg at 140˚F/40˚C.

Blister Agents (Continued)

General Health Effects

Blister agents are extremely toxic. The primary **routes of entry** are inhalation and absorption. Blister agents easily penetrate clothing and are quickly absorbed through the skin. Only a few drops on the skin can cause severe injury, and 3 grams absorbed through the skin can be fatal.

Common signs and symptoms are irritation and burns to the skin, eyes, and respiratory tract. If a large area of the skin is involved, significant amounts of the agent can be absorbed into the bloodstream, causing severe systemic poisoning.

Mustard

Mustard causes tissue damage almost immediately after exposure, but the clinical effects are delayed from 2 to 24 hours, with 4 to 8 hours being the most common. (It is the only chemical warfare agent that does not produce symptoms within minutes of exposure.) This delay can make it difficult for responders to identify everyone who has been exposed. However, the slower the onset, the less severe the injuries are likely to be. Detailed signs and symptoms include the following:

- **Eyes**: Mild exposure results in tearing, itching, burning, reddening, and a gritty feeling in the eyes. In more severe cases, there can be marked swelling of the eyelids, severe pain that is aggravated by bright light, and possible corneal damage.
- **Skin**: Initially the skin becomes red (like a sunburn), with itching, burning, and tenderness in the affected area. Patients may later develop large fluid-filled blisters, with the warm and moist groin and armpit areas being particularly susceptible. Skin damage from vapor exposure usually resembles a first- or second-degree burn, while liquid exposure can produce damage comparable to a third-degree burn.
- **Respiratory System**: Effects often include sinus pain, runny nose, sneezing, sore throat, and a hacking cough. Patients might have nosebleeds, hoarseness, or even loss of voice. More severe exposures result in a productive cough and difficulty breathing.
- **Digestive System**: Patients may have nausea and vomiting.

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Blister Agents (Continued)

General Health Effects (continued)

Lewisite and Phosgene Oxime

Lewisite produces clinical effects similar to those produced by mustard. (See previous page.) There are two major differences, however. First, Lewisite causes pain or irritation within seconds to minutes after exposure. Second, because onset of symptoms is so rapid, people exposed to Lewisite are likely to leave the immediate area and decon early, thus limiting their exposures.

Phosgene oxime produces many effects similar to those of mustard and Lewisite. (See previous page.) It causes immediate pain or irritation to the skin, eyes, and lungs. What distinguishes phosgene oxime from other blister agents, however, is that the skin lesions look more like gray wheals (hives) than blisters. Phosgene oxime causes more severe tissue damage than other blister agents do.

With both **Lewisite** and **phosgene oxime**, the irritation to eyes, skin, and mucous membranes might initially resemble the effects of riot control agents. However, the pain is more severe and will not decrease upon moving the patient to fresh air, as would be the case with riot control agents.

Patient Decontamination

If exposure was to vapor only, removing outer clothing might be sufficient. However, if there is a possibility of liquid contamination, patients must be decontaminated.

With **Lewisite** and **phosgene oxime**, decon must be performed immediately to prevent further tissue damage.

With **mustard**, decon should ideally be performed within 1 to 2 minutes. However, patients may not know they've been exposed until several hours later, when symptoms finally develop. By that time, most of the mustard will have already been absorbed by the tissue or evaporated. Nonetheless, patients should be decontaminated to ensure that any agent trapped against the body will not cause further harm to patients or EMS personnel.

(continued next page)

Blister Agents (continued)

Patient Decontamination (continued)

Because mustard reacts rapidly with body tissues to form different chemical compounds, there is no mustard present in blister fluid. Studies have also concluded that there is no mustard present in other tissues and body fluids within a few minutes after exposure. However, because *thickened* mustard reacts more slowly with body tissues and can persist in open wounds for longer periods, it might be prudent to flush open wounds with water or saline.

Follow patient decon guidelines on pages 6-10 to 6-15. You can use plain water to decon any of the blister agents. Some reference sources also recommend using soap and water or a 0.5% hypochlorite solution for any of the blister agents, whereas other sources get more specific. For example, the U.S. Army textbook *Medical Aspects of Chemical and Biological Warfare* lists dilute hypochlorite as an option for mustard and Lewisite, but not for phosgene oxime. It lists soap and water for distilled mustard (HD) only and the M258A1 and M291 military decon kits for mustard and Lewisite. (Pages 6-12 and 6-13 in this book identify the advantages and disadvantages of various decon solutions. Hypochlorite, in particular, can cause further harm to patients.)

Treatment

Follow the general treatment protocols on pages 6-26 to 6-29. Care for skin lesions as you would second-degree burns. Cover the lesions with dry, sterile dressings, separating fingers and toes if affected. Never attempt to break or drain lesions. Be careful not to overhydrate patients if you administer IVs. Fluid loss from blister agent burns is less than from thermal burns.

Mustard or **phosgene oxime**: There is no specific antidote. Early decontamination (within 1 to 2 minutes of exposure) is the most effective treatment. Analgesics may be administered to control pain. Commercially available eye drops can be used to relieve eye irritation and conjunctivitis.

Lewisite: British Anti-Lewisite (also known as BAL or dimercaprol) administered intramuscularly will reduce the severity of systemic effects. Early decontamination (within seconds or minutes of exposure) is also vital.

Blister Agents (continued)

Detection

Blister agents are relatively difficult to detect by sight or smell, though they do have a characteristic mustard-, onion-, or garlic-like odor when impure.

Outward warning signs will generally be the best clue. Lewisite and phosgene oxime produce immediate noticeable effects (moderate to severe burning or pain to eyes, skin, and mucous membranes). However, mustard will not produce noticeable effects in the early stages; signs and symptoms are delayed for several hours. Look, also, for general indications of a terrorist event, such as abandoned spray devices or explosions that disperse liquids, mists or gases. (See pages 7-6 and 7-7 for other examples.)

The following detection devices can be used for blister agents. (Consult with the individual manufacturers for information on the capabilities and limitations of each device.)

- Colorimetric tubes
- M8 and M9 chemical agent detector papers (liquids only)
- The M18A2 Chemical Agent Detector Kit
- The M256A1 Chemical Agent Detector Kit
- Various chemical agent monitors

Refer to pages 9-10 to 9-12 for more information.

Blood Agents

Blood agents interfere with the body's ability to use oxygen. Some agents prevent red blood cells from carrying oxygen to other cells in the body. Others inhibit the ability of cells to use oxygen for producing the energy required for metabolism. The most common blood agents are listed below:

Product	UN#	DOT Class	ERG Guide	NFPA 704*
Hydrogen Cyanide (AC)	1051	6.1	117	4-4-2
Cyanogen Chloride (CK)	1589	2.3	125	3-0-2

* NFPA 704 ratings represent health, flammability, and reactivity hazards. See pages 3-23 to 3-28 for more information.

Description

Hydrogen cyanide and cyanogen chloride are very volatile, nonpersistent, colorless liquids under pressure, although at higher temperatures, hydrogen cyanide is a colorless gas. Both produce an odor of bitter almonds or peach kernels, but at least 25% of the population is genetically unable to smell the odor. Hydrogen cyanide is also flammable.

Agent	Vapor Pressure (68˚F/20˚C)	Vapor Density
Hydrogen Cyanide (AC)	630 mmHg	0.94
Cyanogen Chloride (CK)	1010 mmHg	2.1

Blood Agents (continued)

General Health Effects

Cyanide causes cell death by poisoning the mechanism that uses oxygen. Oxygen carried by the blood is prevented from entering other cells in the body, causing them to suffocate. The primary route of entry is inhalation, but cyanide can also be absorbed through skin or eyes. Onset of signs and symptoms is very rapid.

- Low concentrations produce an increase in the rate and depth of respiration, dizziness, nausea, vomiting, and headache.
- High concentrations initially stimulate the respiratory system, sometimes to the point where the patients cannot voluntarily hold their breath. Violent convulsions occur within 30 seconds, followed shortly thereafter by respiratory arrest, then cardiac arrest. Death occurs within a few minutes of exposure.
- Cyanogen chloride also irritates the eyes, nose, and mucous membranes, much as riot control agents do.

Exposure to both nerve agents and cyanide will produce convulsions. However, cyanide exposure does *not* produce pinpoint pupils, excessive secretions, and fine tremors in the muscles under the skin, all of which are common with nerve agents. Another distinguishing characteristic sometimes seen with cyanide is abnormally red skin. The skin may look redder because oxygen in the blood isn't being picked up and used by other cells.

Patient Decontamination

If exposure was to vapor only, removing outer clothing may be sufficient. However, if there is a possibility of liquid contamination, patients must be decontaminated.

Follow the patient decon guidelines on pages 6-10 to 6-15, and decontaminate the skin with plain water or soap and water.

Blood Agents (continued)

Treatment

Follow the general treatment protocols for all chemical exposures (pages 6-26 to 6-29).

Specific treatment for hydrogen cyanide and cyanogen chloride includes amyl nitrite and sodium nitrite to draw the cyanide out of cells in the body and sodium thiosulfate to detoxify the cyanide and help remove it from the body. The three compounds (amyl nitrite, sodium nitrite, and sodium thiosulfate) are packaged together in cyanide antidote kits.

If patients ingested cyanide-containing compounds, avoid contact with gastric contents.

Detection

Suspect cyanide if patients describe peach blossom or bitter almond odors. Beyond that, cyanide can be detected with the following equipment. (Consult with the individual manufacturers for information on the capabilities and limitations of each device.)

- Colorimetric tubes
- The M18A2 Chemical Agent Detector Kit
- The M256A1 Chemical Agent Detector Kit
- The M272 Chemical Agent Water Testing Kit

Refer to pages 9-10 to 9-12 for more information.

Choking Agents

The choking agents are common industrial chemicals that attack primarily the respiratory tract (the nose, the throat, and particularly the lungs).

Product	UN#	DOT Class	ERG Guide	NFPA 704*
Chlorine (CL)	1017	2.3	124	3-0-0
Phosgene (CG)	1076	2.3	125	4-0-0

* NFPA 704 ratings represent health, flammability, and reactivity hazards. See pages 3-23 to 3-28 for more information.

Description

Chlorine and phosgene are gases in their normal states, but they are usually stored as liquids in cylinders, ton containers, or tank cars. Chlorine is clear to amber-colored in liquid form; it is greenish-yellow in gas form. Phosgene is colorless in both forms.

Both gases have strong, irritating chemical odors, although olfactory fatigue can occur with chlorine. Chlorine smells like bleach. Phosgene smells like freshly cut grass or newly mown hay. Both gases are extremely volatile and nonpersistent. They are heavier than air and can remain for long periods in low-lying areas.

Agent	Vapor Pressure (68˚F/20˚C)	Vapor Density
Chlorine	6.8 atm (approx. 5168 mmHg)	2.47
Phosgene	1.6 atm (approx. 1218 mmHg)	3.48

Chlorine is nonflammable, but it is a strong oxidizing agent. It can react explosively or form explosive compounds with many common substances, including acetylene, ether, turpentine, ammonia, fuel gas, hydrogen, and finely divided metals.

Phosgene is nonflammable. However, it reacts with moisture to form hydrochloric acid and carbon dioxide.

Choking Agents (continued)

General Health Effects

Inhalation is the primary **route of exposure** for choking agents. Health effects vary depending on the particular choking agent and the amount and duration of exposure. Some health effects are immediate; others can be delayed by up to 24 hours.

General health effects often resemble those associated with riot control agents and can include:

- Irritation to eyes, nose, and throat (coughing and choking)
- Respiratory distress
- Nausea and vomiting
- Burning of exposed skin
- Tightness in the chest

Severe exposure results in pulmonary edema (fluid buildup in the lungs), which prevents oxygen from diffusing across the lungs and into the bloodstream. Patients essentially drown in their own fluids. Severe pulmonary edema can be fatal.

Onset of pulmonary edema can take 2 to 24 hours to develop. The more quickly it develops, the worse the patient's condition. The first symptom is usually shortness of breath upon exertion. Later, respiratory distress can be severe even when the patient is at rest. Other signs and symptoms include:

- Dyspnea (difficulty breathing)
- Rapid, shallow breathing
- Noisy respirations (wheezing, rales, rhonchi)
- Coughing
- Frothy pink sputum (in severe cases)
- Cyanosis (bluish color of the skin and mucous membranes)
- Pale, clammy skin
- Rapid, weak pulse
- Low blood pressure
- Restless and anxiety
- Nausea and vomiting

Contact with liquefied compressed gas causes frostbite injury.

Choking Agents (continued)

Patient Decontamination

Asymptomatic patients exposed to the gas form of chlorine or phosgene do not need decontamination. However, decon is needed for patients experiencing skin or eye irritation, as well as for any patients who have been contaminated by choking agents in liquid form, whether they are symptomatic or not.

Follow the patient decon guidelines on pages 6-10 to 6-15, and decontaminate the skin with water or soap and water.

Treatment

There are no antidotes for chlorine or phosgene. Treatment consists of supportive measures for presenting signs and symptoms. Follow the general treatment protocols for all chemical exposures (pages 6-26 to 6-29).

Patients exposed to chlorine who have minor or transient irritation of the eyes or throat may be discharged from the scene after their names, addresses, and phone numbers are recorded and they are advised to promptly seek medical care if symptoms develop or recur. Patients experiencing more severe irritation after exposure to chlorine and all patients exposed to phosgene should be transported to a medical facility for evaluation. Exposure to chlorine or phosgene can cause pulmonary edema, so patients should be kept under observation for at least 6 hours, preferably 24 hours. Meanwhile, patients should rest and avoid any exertion since exertion will increase the severity of pulmonary damage.

Detection

Both chlorine and phosgene can be recognized by their characteristically strong, irritating odors. The discovery of lecture bottles or gas cylinders is another good clue.

Both chlorine and phosgene can be detected with colorimetric tubes.

Refer to pages 9-10 to 9-12 for more information.

Riot Control Agents (Irritants)

Riot control agents cause temporary incapacitation by irritating the eyes and respiratory system. They are also known as irritants, irritating agents, or harassing agents. The common ones are listed below.

Product	UN#	DOT Class	ERG Guide
Tear Gas (CS)	1693	6.1	159
Tear Gas (CR)	1693	6.1	159
Tear Gas, Mace (CN)	1697	6.1	153
Pepper Spray (OC)	—	2.2 (6.1)*	159
Mace (PS)	1580	6.1	154
Adamsite (DM)	1698	6.1	154

* The hazard class can be 2.2 or 6.1, depending on how the pepper spray is packaged.

The following are the chemical names for these agents:

- Chlorobenzylidenemalononitrile (CS) is currently the most widely used tear gas.
- Dibenzoxazephine (CR) is a British agent.
- Chloracetophenone (CN) can be used in tear gas and mace.
- Oleoresin capsicum (OC) is used in pepper spray.
- Chloropicrin (PS) is used in mace.
- Diphenylaminearsine chloride is Adamsite (DM).

Description

Riot control agents are dispersed as aerosols or powders. Some are sold in small containers as personal defense devices. These devices may contain a single agent or a mixture. Some devices also contain a dye to visually mark a sprayed assailant.

Agent	Odor
Tear Gas (CS)	Pepper
Tear Gas (CR)	Pepper
Tear Gas, Mace (CN)	Fragrant (like apple blossoms)
Pepper Spray (OC)	Pepper
Mace (PS)	Intense
Adamsite (DM)	Odorless

Riot Control Agents (continued)

General Health Effects

Riot control agents cause respiratory distress and copious tearing that quickly incapacitate a person. They are rarely lethal, but can act as asphyxiants under some conditions.

The primary **route of entry** is inhalation, though these agents can also be absorbed through the skin and eyes. **Onset** of signs and symptoms usually occurs within seconds. Effects seldom persist more than a few minutes once patients are removed to fresh air and decontaminated, although they can last several hours, depending on the dose and duration of exposure.

Common signs and symptoms include the following:

- **Eyes**: burning, irritation, tearing, difficulty keeping eyes open, and eye pain that is aggravated by bright light
- **Skin**: burning, irritation, and redness
- **Respiratory system**: sneezing, coughing, runny nose, irritation, burning of mucous membranes, and tightness in the chest
- **Gastrointestinal system**: nausea and vomiting (more common with adamsite [DM] than with other riot control agents)

Less commonly, exposure to riot control agents can cause blisters (usually with high concentrations in high temperature and humidity) or allergic contact dermatitis in sensitive individuals. Exposure to riot control agents can also trigger asthma attacks or other secondary problems in some individuals.

Patient Decontamination

It is often sufficient to remove patients to fresh air and to brush the powder from skin and clothing. If additional decon is needed for symptomatic patients, follow the patient decon guidelines on pages 6-10 to 6-15. Flush the skin with plain water, soap and water, or a weak solution of sodium bicarbonate (baking soda). (Using water or soap and water on the skin may cause a temporary worsening of the burning sensation, but will not cause additional damage. Hypochlorite will further irritate the skin.)

Riot Control Agents (continued)

Treatment

Follow the general treatment protocols for all chemical exposures (pages 6-26 to 6-29). More specific treatment is generally not required since the signs and symptoms generally subside on their own once patients are moved to fresh air.

Detection

Currently, one device (the APD2000) will detect pepper spray or mace if the capsaicin levels are high enough. However, odors, signs and symptoms, and dissemination devices are generally the best indicators of riot control agents.

Biological Agents

Because onset of health effects is delayed with most biological agents, a covert terrorist attack will likely manifest as an unusual outbreak of disease, impacting public health authorities more so than first responders. First responders will have more of a supporting role. On the other hand, when a citizen calls 911 to report that he or she just opened an envelope containing something labeled "Anthrax," first responders will be on the front line. So this chapter has been included to give first responders a brief overview of biological agents. However, it's important to coordinate closely with public health authorities who have access to more thorough information on infectious disease. Additional assistance may be obtained through the Chemical and Biological Hotline staffed by the National Response Center (NRC). (See page 14-46.)

This chapter starts with general information that applies to any incident involving biological agents, which is helpful if you don't yet know what you're dealing with. It then provides more detailed information on specific agents that either have been weaponized in the past or have been sought after by terrorists.

General Information About Biological Agents

Many organisms can potentially be used as biological agents, but only a few have been weaponized in the past or have been sought after by terrorists. This book focuses on the most likely candidates. Biological agents are primarily Division 6.2 materials (infectious substances). Some mycotoxins are classed as Division 6.1 (poisonous materials) instead.

These first few pages provide general information that applies to any incident involving biological agents. This is a good place to start if you don't know what specific agent you are dealing with or if the agent is not one of those listed later in this chapter.

Types of Biological Agents

The biological agents most likely to be used as weapons of mass destruction are generally divided into four groups:

- **Bacteria** are single-celled living organisms capable of independent growth; they don't require a living host in which to replicate. Many can be cultured in a lab. Some, like anthrax, form spores that can survive for long periods in conditions that would otherwise kill the bacteria. Bacteria can also produce extremely potent toxins inside the body. Examples of bacteria include anthrax, brucellosis, cholera, plague, and tularemia.
- **Viruses** are also living organisms, but they are much smaller than most bacteria. Unlike bacteria, viruses are incapable of the basic metabolic functions necessary for independent growth. They require living cells in which to replicate. Examples of viruses include smallpox, Venezuelan equine encephalitis (VEE), and viral hemorrhagic fever (VHF).
- **Rickettsiae** are microorganisms that have many of the characteristics of bacteria. However, like viruses, they grow only within living cells. Q fever is an example of a rickettsia.
- **Toxins** are nonliving chemical compounds—potent poisons produced by a variety of living organisms, including bacteria, plants, and animals. They produce effects similar to those caused by chemical agents. Biological toxins are far more toxic than most industrial chemicals. Examples of toxins are botulinum toxin (botulism), ricin, saxitoxin, staphylococcal enterotoxin B, and trichothecene mycotoxins.

General Information (continued)

CDC Bioterrorism Agent Categories

The CDC separates bioterrorism agents into three categories, depending on how easily they can be spread and the severity of their health effects.

Category A Agents

Category A agents include organisms that pose the highest risk to the public and national security because they:

- Can be easily spread or transmitted from person to person
- Result in high death rates and have the potential for major public health impact
- Might cause public panic and social disruption
- Require special action for public health preparedness

Category A agents include:

- Anthrax (*Bacillus anthracis*)
- Botulism (*Clostridium botulinum* toxin)
- Plague (*Yersinia pestis*)
- Smallpox (variola major)
- Tularemia (*Francisella tularensis*)
- Viral hemorrhagic fevers:
  - Filoviruses (e.g., Ebola, Marburg)
  - Arenaviruses (e.g., Lassa, Machupo)

Category B Agents

Category B agents are the second highest priority because they:

- Are moderately easy to spread
- Result in moderate illness rates and low death rates
- Require specific enhancements of the CDC's laboratory capacity and enhanced disease monitoring

(continued next page)

General Information (continued)

CDC Bioterrorism Agent Categories (continued)

Category B Agents (continued)

Category B agents include:

- Brucellosis (*Brucella* species)
- Epsilon toxin of *Clostridium perfringens*
- Food safety threats (e.g., *Salmonella* species, *Escherichia coli* O157:H7, *Shigella*)
- Glanders (*Burkholderia mallei*)
- Melioidosis (*Burkholderia pseudomallei*)
- Psittacosis (*Chlamydia psittaci*)
- Q fever (*Coxiella burnetii*)
- Ricin toxin from *Ricinus communis* (castor beans)
- Staphylococcal enterotoxin B
- Typhus fever (*Rickettsia prowazekii*)
- Viral encephalitis (alphaviruses) (e.g., Venezuelan equine encephalitis, eastern equine encephalitis, western equine encephalitis)
- Water safety threats (e.g., *Vibrio cholerae, Cryptosporidium parvum*)

Category C Agents

Category C agents are the third highest priority. They include emerging pathogens that could be engineered for mass spread in the future because they:

- Are easily available
- Are easily produced and spread
- Have potential for high morbidity and mortality rates and major health impact

Category C agents include:

- Nipah virus
- Hantavirus

General Information (continued)

Routes of Exposure / Dissemination

Inhalation

- The most likely terrorist scenarios for biological agents involve inhalation as the route of exposure. Many biological agents can be disseminated by aerosolization (mixing the agent with a liquid and dispersing it with a spray device) or dispersed as dry powders (possible with spores, toxins, and freeze-dried bacteria and viruses).
- *Airborne transmission* of an infectious disease occurs by dissemination of either dust particles containing an infectious agent or airborne droplet nuclei (small-particle residue of evaporated droplets containing microorganisms that remain suspended in air for long periods of time). Microorganisms that spread by airborne transmission can be dispersed widely by air currents and can easily be inhaled by other people at a distance from the patient; hence, special air handling and ventilation is required in addition to basic respiratory protection. (These precautions are beyond the scope of this book.) Fortunately, not many diseases are spread by airborne transmission. Those that are include tuberculosis, measles, and chickenpox.

Skin or Eye Contact

- Most biological agents do not penetrate healthy, unbroken skin. (The exceptions are trichothecene mycotoxins.) Thus, it is unlikely terrorists would have much success attempting to infect people through this route of entry. However, some of the diseases caused by these agents can be transmitted from one person to another through contact with blood and other body fluids (*contact transmission*). Skin and eye protection is required when caring for patients with these diseases.
- *Droplet transmission* can occur when droplets containing a microorganism are generated from an infected person during coughing, sneezing, and talking, or during certain procedures, such as suctioning. Droplets are propelled a short distance in air (usually 3 feet [1 meter] or less) and can be deposited on another person's conjunctiva, nasal mucosa, or mouth. A mask and eye protection are required, but because the droplets do not remain suspended in air, special air handling and ventilation are *not* needed.

General Information (continued)

Routes of Exposure / Dissemination (continued)

Ingestion

- Pathogens can be ingested by eating contaminated food or by eating food after it's been handled by someone whose hands are contaminated. Both scenarios are examples of ordinary food poisoning.
- Terrorists might attempt to contaminate food and water supplies with a biological agent, though doing so would generally result in fewer casualties than would inhalation exposures.
- It is unlikely that terrorists could successfully contaminate municipal water supplies because dilution and chlorination would either kill the agent or greatly reduce its effectiveness. However, smaller water supplies may be vulnerable.

Injection

- Terrorists might inject an agent directly into an intended victim.
- Biological agents can also be transmitted through needle sticks or puncture wounds from other sharp objects used in caring for infected patients.

Vector

- Many diseases are naturally transmitted by bites from mosquitoes, fleas, ticks, etc. It is conceivable that terrorists might use vectors as a means to transmit some biological agents, although this scenario is far less likely than the others.

Rate of Action (Incubation Period)

- Time lapse between contamination and onset of symptoms varies with the type of agent, the dose received, the duration of exposure, the route of entry, and individual susceptibility.
- With bacteria and viruses, onset is usually hours to days after exposure.
- With toxins, onset is usually minutes to hours after exposure. This rapid onset may cause responders to mistakenly assume they are dealing with a chemical agent. Careful evaluation of both symptoms and circumstances of the illness is essential.

General Information (continued)

Health Effects

The health effects identified in this chapter give first responders an overview of common signs and symptoms associated with terrorist use of biological agents. It is beyond the scope of this book to address the sometimes different health effects of naturally occurring diseases; the full range of signs and symptoms patients may experience; or differential diagnosis based on chest x-rays, blood tests, lab cultures, etc. It is assumed that medical professionals will have this information at their disposal or will be able to obtain it from their local or state health departments.

- By weight, biological agents are generally more toxic than chemical agents are.
- The initial effects of many bacteria and viruses resemble those of a common cold or flu. Therefore, many people may delay seeking treatment until they are very ill, and medical professionals may not realize they are dealing with a biological agent until they get more specific clues.
- The effects of some toxins resemble those of some of the chemical agents. Thus it's possible to mistakenly assume one is dealing with a chemical agent, especially if onset of symptoms occurs within minutes of exposure. Careful evaluation of both symptoms and circumstances of the illness is essential.
- Some bacteria and viruses are contagious, but many are not. The biological warfare agents covered in this book that require more than universal precautions are pneumonic plague, smallpox, and viral hemorrhagic fevers.
- The infectious dose—the number of organisms needed to cause disease—varies based on many host, agent, and environmental factors.
- Toxins are not contagious.

"Contagious" Versus "Infectious"

While often used interchangeably, the terms *contagious* and *infectious* are usually distinguished in technical medical use. *Contagious* means "communicable by contact" and refers to a very easily transmitted disease, such as a cold or flu. *Infectious* refers to disease caused by exposure to a harmful microorganism that can be transmitted from one person to another only by a *specific* kind of contact, such as sexually transmitted diseases. Not all infectious diseases are contagious.

General Information (continued)

Personal Protective Equipment

Performance requirements for protective ensembles used at CBRN terrorism incidents can be found in two NFPA standards:

- *NFPA 1991: Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies* includes the former requirements for Class 1 CBRN ensembles—those providing the highest level of protection.
- *NFPA 1994: Standard on Protective Ensembles for Chemical/Biological Terrorism Incidents* covers the remaining ensembles, designed to protect emergency responders at terrorism incidents as follows:

Class	Hazards	Conc.	Min. Resp. Prot.
2	chem (vapor or liquid)	≥ IDLH	CBRN* SCBA
3	chem (vapor or liquid)	< IDLH	CBRN* APR/PAPR
4	bio or rad particulate	< IDLH	APR/PAPR

* NIOSH CBRN certification

The following are general guidelines only and must not be used as a substitute for department SOPs or for obtaining more specific information from appropriate reference sources. See also pages 2-47 to 2-54 for general information on PPE.

Hot Zone Operations / Rescue

Currently, the best guidance for selecting PPE for incidents involving biological agents may be the interim recommendations issued by the CDC in 2001, some of which are reproduced below. (These recommendations can be found on the CDC's web site.)

- Responders should use NIOSH-approved SCBA with a Level A suit for a suspected biological incident where any of the following information is unknown or the event is uncontrolled:
  - The type(s) of airborne agent(s)
  - The dissemination method
  - If dissemination via an aerosol-generating device is still occurring or it has stopped but there is no information on the duration of dissemination or what the exposure concentration might be

(continued next page)

General Information (continued)

Personal Protective Equipment (continued)

Hot Zone Operations / Rescue (continued)

- Responders may use a Level B protective suit with exposed or enclosed NIOSH-approved SCBA if:
  - The suspected aerosol is no longer being generated
  - Other conditions may present a splash hazard
- Responders may use a full face piece respirator (APR) with a P100 filter or powered air purifying respirator (PAPR) with high efficiency particulate air (HEPA) filters when:
  - An aerosol-generating device was not used to create high airborne concentration
  - Dissemination was by a letter or package that can be easily bagged

The CDC's interim recommendations further state that NIOSH recommends *against* wearing standard firefighter turnout gear into areas potentially contaminated with biological agents.

Warm Zone Operations / Decon

For decon operations in the warm zone, it is generally sufficient to wear protective clothing one level below that which is worn in the hot zone. When the agent is unknown or particularly hazardous, it may be appropriate to wear the same level of protective clothing worn for hot zone operations.

For healthcare facilities receiving contaminated patients, OSHA recommends *minimum* PPE of a powered air-purifying respirator (PAPR) with a protection factor of 1000, a chemical-resistant garment, a head covering (if not part of the respirator), a double layer of protective gloves, and chemical protective boots. (See the January 2005 document titled *OSHA Best Practices for Hospital-Based First Receivers of Victims from Mass Casualty Incidents Involving the Release of Hazardous Substances* for complete details and prerequisites.) Healthcare facilities that are not adequately prepared to handle contaminated patients may have to rely more heavily on assistance from firefighters and hazmat teams, which requires cooperative planning between all parties, with contingencies for different scenarios.

(continued next page)

General Information (continued)

Personal Protective Equipment (continued)

Cold Zone Operations / Patient Care

- Use standard universal precautions when caring for patients who have been thoroughly decontaminated. No special protective gear is required.
- When caring for patients who are already sick versus those newly exposed to an infectious agent, if you know or suspect the disease to be contagious, follow the body substance isolation procedures identified on page 6-8.

Patient and Equipment Decontamination

Very seldom is decon needed for biological agents because of the delay between exposure and onset of disease (discovery). However, decon may be required when exposure is discovered soon after the event (e.g., shortly after a terrorist attack).

- Remove contaminated clothing.
- Decon patients as needed, following the guidelines on pages 6-10 to 6-15. Careful washing with soap and water is effective for removing most biological agents. (Although some sources recommend using a 0.5% hypochlorite solution on biological agents, it can cause further harm. See page 6-13.)
- Since it is sometimes difficult to adequately decon medical equipment, use disposable supplies for patient care whenever possible, and properly dispose of the supplies after use.
- Unless otherwise indicated for a specific biological agent, disinfect contaminated equipment with a 5% hypochlorite solution or other decon solutions according to department SOPs. (See page 2-59 for more information.)

General Information (continued)

Patient Treatment

It is beyond the scope of this book to recommend specific antibiotics or other drugs, since treatment will vary depending on the specific biological agents, their resistance to drugs, progression of the disease, possible side effects, patient allergies, etc. Plus, because incidents involving biological agents usually manifest as an unusual outbreak of disease, it's unlikely that EMS personnel will administer antidotes or antibiotics in the field. Finally, drug therapy may change over the life of this book. For current information, contact the CDC or other appropriate resources.

- Provide supportive therapy based on signs and symptoms.
- Notify your local health department. Notification is mandatory with some diseases (e.g., smallpox) and vitally important for any suspected terrorist attack involving biological agents.
- Determine, if possible, the site where the biological agent was dispersed so that access can be restricted until health officials assure you that the site no longer poses a threat.

Detection

Biological agents can't be seen, smelled, tasted, or felt. Nor can they be detected by standard field detection equipment. We often have to rely on outward warning signs:

- The first indication of a biological agent attack may be widespread outbreak of disease. However, early symptoms may mimic those of a common cold or flu, so recognition can take time. Positive identification may require laboratory testing of blood, body fluids, or tissue samples from infected patients.
- Terrorist attack should be considered if there are outbreaks of disease not known to affect that part of the country or if there are symptoms not consistent with natural transmission of the disease (e.g., symptoms are associated with inhalation exposure, but the normal mode of transmission is ingestion).
- Other indicators may include unscheduled and unusual spray being disseminated (especially if done outdoors during periods of darkness), abandoned spray devices, and threats of a terrorist attack involving a biological agent.

(continued next page)

General Information (continued)

Detection (continued)

Positive identification of biological agents usually requires laboratory analysis by trained personnel using infrared (IR) spectrometry, gas chromatography and mass spectrometry (GC/MS), or cell culture analysis. There's currently little in the way of field detectors, and most of what does exist is costly.

Detection kits/papers available for some agents have important limitations you should be familiar with. The following are examples of limitations that *may* apply, but you must refer to manufacturers' instructions and reliable third-party studies for specifics:

- Limited shelf life.
- Potential for false positives or false negatives. (For example, if a kit functions by detecting proteins—all biological materials and many toxins contain protein— it will read positive with many safe substances, like yeast and whole wheat flour, too.)
- Cross-sensitivity to other substances.
- Insensitivity to small test samples.
- Inability to identify a *full range* of possible agents.
- Potential to rule *out* a specific agent, but inability to identify a mystery substance that might still be hazardous. (For example, a kit designed to test for only one agent reveals nothing about the presence of others.)
- Potential for human error in the sampling process or interpretation of test results.

Detection kits/papers should be considered simply a tool to help assess credibility, not a tool to provide definitive answers. If there appears to be a credible threat and detection kits/papers provide a positive response, it warrants greater consideration than an incident with no credible threat and a negative response.

It's beyond the scope of this book to go into greater detail on detection equipment. One important recommendation, however, is to be familiar with how to get access to the latest and greatest detection equipment when you need it. National Guard WMD Civil Support Teams (CST), for example, have some of the best portable equipment and most highly trained personnel available. If you suspect a terrorist event, consider requesting Civil Support Team assistance through your state notification center or office of emergency services. See page 14-48 for more information.

White Powder Calls

The anthrax attacks of 2001 caused a huge spike in "white powder calls" for emergency responders. Many agencies published guidelines for handling such incidents. The following is a compilation of guidelines from several sources and includes information that applies to both the general public and emergency responders. Remember, however, that your own agency's standard operating procedures (SOPs) and local protocols take precedence over these general guidelines.

Note: These pages stress white powder calls associated with suspicious mail. However, many of the same principles apply to unidentified powders found anywhere else.

Characteristics of Suspicious Mail

Suspicious mail may have one or more of the following characteristics. Any one characteristic by itself may not mean anything. However, two or more should be considered suspect, especially when the mail is sent to someone likely to be a target for terrorism. (Many of these characteristics are also red flags of a possible mail bomb. More information on mail bombs can be found on page 8-8.)

- Warnings or threats such as "Anthrax"
- Markings such as "Personal," "Confidential," or "Private"
- Incorrect name, title, or address
- Misspelled words
- No return address or fictitious return address
- Postmark inconsistent with the return address
- Postmark from a foreign country
- Distorted handwriting or badly typed address labels
- Excessive postage (to prevent return or nondelivery)
- Discolored packaging or oily stains on outer surface
- Strange odors
- An unknown substance leaking from envelopes or packages
- Rigid, uneven, or lopsided envelopes or packages
- Packages with irregular shapes, soft spots, or bulges
- Unprofessional wrapping on packages
- Excessive string or tape to secure packages
- Packages stamped with "Fragile: Handle With Care" or "Rush: Do Not Delay"

White Powder Calls (continued)

General Guidelines: Handling and Opening Mail

The chance of encountering mail contaminated with anthrax or other biological agents is remote. Nonetheless, health professionals, the FBI, and emergency services agencies have developed common sense guidelines for handling mail, particularly for people who handle large volumes of mail.

- Wash your hands with warm water and soap before and after handling mail.
- Do not eat, drink, or smoke around mail.
- Consider wearing disposable plastic or rubber gloves if you have open cuts or skin lesions on your hands.

Surgical masks, eye protection, and gowns are not needed.

Recipient Guidelines: Handling Suspicious Mail

If the mail contains powder or a written threat or if it has other characteristics listed on the previous page, the following guidelines should be relayed to the people who discover it.

- Do not shake or empty the envelope or package.
- Leave the envelope or package alone. Don't move or discard it.
- Do not sniff, touch, taste, or closely examine the envelope, package, or any contents that may have spilled.
- Alert others, and isolate the area so no one disturbs the envelope or package. Evacuating the entire workplace is usually not required at this point.
- If possible, shut off the ventilation system.
- Make appropriate notifications. (For most recipients, this means calling 911 and allowing responders to notify other authorities if appropriate.) Indicate whether the envelope or package contains any visible powder or other unknown substance, whether the substance was released, and what you have done with the envelope or package.
- Wash hands with warm water and soap for one minute.
- Direct people to remain on scene until evaluated by emergency responders and questioned by law enforcement. If anyone insists on leaving before responders arrive, get names and contact information.
- Do not panic.

White Powder Calls (continued)

Threat Credibility Assessment

The anthrax attacks of 2001 generated such a huge volume of white powder calls nationwide that many response agencies were forced to develop different protocols based on whether or not the threat was perceived as credible. Emergency call takers, dispatchers, and first responders alike had to take on greater responsibility for assessing the threat credibility so that the more highly trained hazmat teams could be channeled where they were needed most. The following are some good questions to include in a threat assessment.

- Did the envelope or package contain an explicit threat?
- Has there been a recent exposure to any suspicious substance? If so, get a thorough description of the substance.
- What does the powder look like? Weaponized anthrax is generally an off-white to yellowish powder, similar in texture to talcum powder. However, don't necessarily rule out a terrorist event simply because it doesn't look like anthrax. What's to say a terrorist didn't disguise it to fool responders? Or that a terrorist didn't use something other than anthrax? Consider the other questions on this page, and use your common sense.
- Does the envelope or package have other characteristics of suspicious mail listed on page 10-14?
- Has there been a recent onset of flu-like symptoms? If so, how long have symptoms lasted? Does this fit the profile of anthrax or other diseases?
- Could there be another logical explanation for the powder? Could it be, for example, sheet rock dust from construction in the area or a sweetener someone spilled while preparing coffee? Could it be narcotics? Are there wrappers present or other clues to substantiate this?
- Have there been other similar events, as there were with the anthrax attacks of 2001?
- Is there reason to suspect that the recipient (either an individual or a business) might be targeted? Has the recipient received other threats or suspicious packages? Has the recipient been the target of other crimes? Is there anyone who might want to harm the recipient (an angry spouse, a disgruntled employee, an unhappy customer, etc.)?

White Powder Calls (continued)

Responder Guidelines: Handling Suspicious Mail with No Credible Threat

If you've assessed the threat credibility and can determine that there's no reasonable threat of anthrax and/or anthrax exposure (or any other "weapon du jour"), bring closure to the incident while still on scene.

- Reassure people that there's no threat and no need for you to take samples for testing.
- Advise people that there's no need to take a shower, go to the emergency room, or contact their doctors. Trying to make them feel better by suggesting these actions only increases their anxiety and creates problems for other healthcare workers.
- Give people documentation from the CDC, health department, or other reliable sources to educate them on appropriate safety measures and signs and symptoms of exposure.
- Thank the individuals for calling 911, and reassure them that they did the right thing. It's important that we not discourage anyone from doing their part to protect themselves and homeland security, even when most of these calls turn out to be false alarms.
- Give people an incident number for later follow-up if needed.

White Powder Calls (continued)

Responder Guidelines: Handling Suspicious Mail with Credible Threat

The guidelines below include recommendations from an FBI, DHS, and HHS/CDC coordinated document called *Guidance on Initial Responses to a Suspicious Letter / Container With Potential Biological Threat* dated November 2, 2004.

The extent to which you follow these guidelines and the order in which you perform them will depend, in part, on the scenario you are faced with. Is there a visible powder or other unknown substance? (Bear in mind that trace amounts may not be visible to the eye but can still represent a health risk or provide critical forensic evidence.) Is there an articulated threat (e.g., a threatening letter)? Are recipients ill?

- Implement the Incident Command System.
- Isolate the area and deny access to unauthorized personnel. Move everyone a safe distance away.
- Do not touch, move, or open any suspicious mail until an initial threat assessment is complete.
- Treat this as a crime scene until proven otherwise.
- Notify the proper authorities. Not all of the agencies listed below need to be notified immediately, but if the incident escalates, you may need to call in additional resources.
  - A trained hazmat team will be needed to conduct risk assessments, field safety screening, sample/evidence collection, and perhaps decon and other mitigation measures.
  - A bomb technician may be needed to assess suspicious packages with characteristics suggesting a parcel bomb.
  - Law enforcement (local, state, FBI and/or postal inspectors) should be notified when a potential threat is identified. An articulated threat (with or without the presence of a suspicious substance) is a federal crime and may also violate state and local laws.
  - If there is a threat of public health exposure or environmental contamination, other agencies that should be notified include the local and state public health departments, the CDC/HHS, and the Department of Homeland Security.

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Responder Guidelines: Handling Suspicious Mail with Credible Threat (continued)

- Advise people who were in the area to thoroughly wash face and hands with warm water and soap. Advise them to also blow and wipe their noses.
- Implement patient decon procedures for anyone who may have been contaminated. (See pages 6-10 to 6-15.) Collect and contain clothing and personal items in plastic bags, and label the bags for easy identification.
- Use appropriate PPE in the hot or warm zones. (See pages 10-9 to 10-11.) Consider using disposable chemical protective clothing versus garments that are harder to decon (e.g., structural firefighting clothing).
- Conduct a threat assessment. (The FBI has the lead role in WMD threat assessment, but the process may involve several agencies.)
- Conduct field screening as appropriate to rule out explosive devices, radiological materials, corrosive materials, and volatile organic compounds. (Field detection capabilities for biological warfare agents is still very limited. If you have the resources to screen for biological warfare agents, use them. But understand the limitations. See page 10-13 for more information.)
- Photograph the evidence.
- Properly package the evidence, consistent with local protocols and chain-of-custody requirements. Generally, this means double-bagging the item in clear sealed bags, but this may vary depending on the circumstances. (Separate samples may be needed for laboratory analysis and forensic examination.)
- Clearly document all relevant information. Include a proper chain-of-custody form.
- Ensure the evidence is delivered to an appropriate Laboratory Response Network (LRN) laboratory for testing and analysis. Follow the laboratory's sample submission guidelines.
- Advise potentially exposed people to seek medical attention if they experience flu-like symptoms in the next few days.
- Document the names and contact information of anyone who may have been exposed to the suspicious substance so that public health officials can follow up with them as appropriate.
- Arrange for the building/area to be tested and cleared by the appropriate health agency before allowing the public to return.

Anthrax

Anthrax *bacteria* may be found in cattle, sheep, horses, and other hoofed animals, whereas anthrax *spores* may be found in the soil. Anthrax spores are very stable. They can survive in sunlight for several days and can remain viable in soil or water for years if conditions are right, causing disease a long time beyond the initial dissemination. There are three forms of anthrax, categorized by how anthrax enters the body:

- **Cutaneous anthrax**: Spores can enter the body when handling contaminated animal parts without wearing gloves to protect broken skin. The anthrax attacks of 2001 demonstrated that the cutaneous form of the disease can also be contracted by handling artificially contaminated objects, like mail. The vast majority of anthrax cases result from cutaneous exposures.
- **Inhalation anthrax**: Inhalation of anthrax spores causes a very severe form of the disease. Dissemination of the spores as a dust that can be inhaled is the most likely terrorist scenario.
- **Gastrointestinal anthrax**: The least common form of anthrax is contracted by eating contaminated meat.

The anthrax vaccine is currently recommended only for high-risk populations. It's primarily given to military personnel deployed to areas with high-risk exposure. However, antibiotics used in post-exposure prophylaxis are very effective in preventing anthrax disease after an exposure. Contact the CDC for more information.

The incubation period is 1 to 7 days. Anthrax is not contagious.

Health Effects - Cutaneous Anthrax

- The first sign is an itchy bump resembling an insect bite.
- A day or two later, the bump becomes a round, fluid-filled ulcer 1/2 inch (1.3 cm) to just over 1 inch (2.5 cm) in diameter. A depressed, painless black scab that subsequently forms in the middle of the ulcer is a characteristic sign of cutaneous anthrax. The scab falls off within a week or two.
- There may also be severe swelling around the ulcer and painful swollen lymph nodes in the area.
- The mortality rate is roughly 20% in untreated patients, but with proper treatment, most patients will survive.

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Anthrax (continued)

Health Effects - Inhalation Anthrax

- Onset of disease is gradual and begins with flu-like symptoms: fever, chills, malaise, fatigue, nausea, vomiting, headache, and muscle pain, sometimes accompanied by a nonproductive cough and mild chest discomfort.
- Sometimes there is a short period of improvement. However, initial symptoms are followed in 2 to 4 days by abrupt and severe respiratory distress with cyanosis, profuse sweating, and high fever.
- Shock and death usually occur within 24 to 36 hours after onset of severe symptoms.
- The mortality rate is 80% to 90% in untreated patients. The disease is also usually fatal if treatment is begun after patients are symptomatic. However, prompt treatment with appropriate antibiotics can reduce the mortality rate to perhaps 30%.

Health Effects - Gastrointestinal Anthrax

- The most common form of gastrointestinal anthrax resembles severe food poisoning, with initial symptoms of nausea, vomiting, loss of appetite, and fever. Soon, patients experience abdominal pain, vomiting of blood, and severe diarrhea.
- Another, though less common, form of gastrointestinal anthrax produces sore throat, fever, trouble swallowing, and sometimes ulcers in the mouth or back of the throat. Patients may also have very tender swollen lymph nodes in the neck.
- Left untreated, about 50% of patients will die.

EMS Response

- Decon patients if contaminated.
- Provide antibiotics and supportive therapy as needed. (Antibiotics may be successful in treating the disease if administered before patients are significantly symptomatic.)
- Use universal precautions.
- Disinfect contaminated equipment with a sporicidal agent or hypochlorite solution.
- Notify your local or state health department.

Botulism

Botulism is a muscle-paralyzing disease caused by the botulinum toxin produced by the bacteria Clostridium botulinum. The bacteria are harmless, but the toxin they produce is perhaps the most lethal substance that exists. It is 15,000 times more toxic than VX (the most toxic of the nerve agents) and 100,000 times more toxic than sarin. The botulinum toxin is not contagious.

Under natural conditions, humans can acquire the botulinum toxin by ingesting improperly canned or undercooked foods containing the bacteria. The result is food poisoning (botulism).

The most likely terrorist scenarios are dissemination by aerosol or contamination of food or water supplies.

Although research is being done to create a vaccine for botulism, there's currently nothing that has been tested and proven safe for the public. Contact the CDC for more information.

Health Effects

- Symptoms usually appear in 12 to 36 hours, but may take several days, particularly with inhalation exposure.
- Early signs and symptoms include generalized weakness, dizziness, dry mouth and throat, slurred speech, difficulty swallowing, and blurred or double vision.
- Subsequent signs include flaccid paralysis of the muscles, starting at the shoulders and moving down the body. Paralysis of breathing muscles leads to respiratory failure and death.
- In untreated patients, the fatality rate can be 60% or higher. Even with prompt treatment, it can be as high as 20%.

EMS Response

- Decon patients if contaminated.
- Provide respiratory therapy and other supportive therapy as needed. (There is an antitoxin maintained by the CDC.)
- Use universal precautions.
- Once botulism is confirmed, attempt to identify whether others have shared a common food. Initial suspicion should be directed toward home-cooked or home-preserved foods, but commercially preserved foods should not be overlooked either.
- Disinfect contaminated equipment with a hypochlorite solution.

Brucellosis

Brucellosis, also known as undulant fever, can be acquired under natural conditions by contact (via breaks in the skin) with blood, bodily fluids, and other tissues of infected animals or by ingestion of raw (unpasteurized) milk and dairy products from infected animals.

Terrorists are most likely to disseminate brucellosis by aerosol or by sabotaging a food supply. There is no vaccine available for brucellosis.

Health Effects

- The incubation period normally ranges from 3 to 4 weeks, but may be as short as 1 week or as long as several months.
- Initial symptoms usually consist of intermittent fever, headache, chills, profuse sweating, profound weakness and fatigue, and pain in the joints, muscles, and lumbar region. Cough occurs in 15% to 25% of the cases.
- Systemic symptoms can persist for prolonged periods.
- Untreated disease can persist for months to years, and patients may experience relapses and remissions.
- Fatalities are uncommon, even in untreated cases.

EMS Response

- Decon patients if contaminated.
- Provide antibiotics and supportive therapy as needed.
- Use universal precautions.
- Disinfect contaminated equipment with a hypochlorite solution.

Cholera

Under natural conditions, humans can acquire cholera by consuming food or water contaminated by the cholera bacteria. Cholera spreads rapidly in areas where proper treatment and sewage precautions are not practiced or not available.

The most likely terrorist scenario is contamination of food or water supplies. Dissemination by aerosol is unlikely.

Currently, the manufacture and sale of the only licensed cholera vaccine in the U.S. has been discontinued. Two recently developed vaccines are licensed and available in other countries. They appear to provide somewhat better immunity and fewer side effects than the previously available vaccine. However, they are not available in the U.S. Contact the CDC for more information.

Health Effects

- The incubation period ranges from a few hours to 5 days, with the average being 2 to 3 days.
- Cholera is characterized by sudden onset of profuse watery diarrhea, with fluid loss exceeding 5 to 10 liters per day.
- Other signs and symptoms can include nausea, vomiting, intestinal cramping, and headache.
- Without treatment, death may result from severe dehydration, hypovolemia, and shock. The mortality rate can be as high as 50% in untreated cases.

EMS Response

- Decon patients if contaminated.
- Provide fluid replacement, electrolyte replacement, antibiotics, and supportive therapy as needed.
- Use universal precautions, paying particular attention to thorough hand-washing and avoiding contact with body fluids, especially feces and vomitus.
- Disinfect contaminated equipment with a hypochlorite solution.

E. coli

Escherichia coli (E. coli) are a large group of bacteria, only some strains of which are harmful. Most E. coli infection outbreaks involve bacteria known as "Shiga toxin-producing" E. coli (or STEC). The most common STEC in North America is E. coli O157:H7 (or E. coli O157).

The STEC bacteria live in the guts of ruminant animals, including cattle (the major source for human illness), goats, sheep, deer, and elk. Infections result from swallowing tiny amounts of human or animal feces, often because of people who fail to thoroughly wash their hands after using the bathroom or changing diapers and before preparing or eating food. People who don't thoroughly wash their hands after contact with animals and their environments also risk spreading the disease. E. coli infections can also result from consuming undercooked meat, raw milk, unpasteurized dairy products or juices (such as raw apple cider), or other contaminated food and water. The most likely terrorist scenario is contamination of food supplies.

Health Effects

- The incubation period is usually 3 to 4 days, but it can be as short as 1 day or as long as 10 days.
- Patients often experience slow onset of mild belly pain or diarrhea that worsens over several days.
- Some patients may have vomiting and bloody diarrhea.
- If a fever develops, it's usually mild (less than 101˚F/38.5˚C).
- Between 5% and 10% of patients develop a potentially life-threatening complication known as hemolytic uremic syndrome (HUS) Roughly 7 days after onset of initial symptoms (and just as the diarrhea is improving) patients feel very tired, urinate less frequently, and lose color in their cheeks and inside the lower eyelids. These patients should be hospitalized due to the risk of kidney failure and other serious conditions.

EMS Response

- Decon patients if contaminated.
- Provide fluid replacement and supportive therapy as needed.
- Use universal precautions (especially thorough hand-washing).
- Use soap and water or a mild hypochlorite solution to clean contaminated equipment.

Glanders

Glanders is uncommon in humans; it's a disease primarily affecting animals such as horses, donkeys, and mules, though rarely in the United States. However, it takes very few of the *Burkholderia mallei* bacteria to cause disease, making the organism a consideration for bioterrorism.

Glanders is most often transmitted by direct contact with infected animals, with the bacteria entering the body through mucous membranes or broken skin. Human-to-human transmission can occur, but it's far less common. There is no vaccine for glanders.

Health Effects

- General symptoms of glanders include fever, muscle aches and tightness, chest pain, and headache.
- Other symptoms may include excessive tearing of the eyes, light sensitivity, and diarrhea.
- Where the bacteria enters the body through a break in the skin, a **localized infection** with ulceration will develop within 1 to 5 days. Patients may also have swollen lymph nodes.
- If the bacteria entered through **mucus membranes**, patients will have increased mucus production from the affected sites.
- If patients develop **pulmonary infections**, they can have pneumonia, pulmonary abscesses, and pulmonary effusion.
- Glanders can develop into a **chronic infection** with multiple abscesses within the muscles of the arms and legs or in the spleen or liver.
- Mortality rate can range from 40% if treated to 95% if untreated, with some variation depending on the type of infection.

EMS Response

- Decon patients if contaminated.
- Provide antibiotics and supportive therapy as needed.
- Use universal precautions.
- Use soap and water or a mild hypochlorite solution to clean contaminated equipment.

Melioidosis

Melioidosis, also known as Whitmore's disease, occurs primarily in tropical climates, especially in Southeast Asia. The bacterium that causes it, *Burkholderia pseudomallei*, is found in contaminated soil and water. Routes of entry include inhalation of dust, ingestion of contaminated water, and contact with contaminated soil, especially through broken skin. Person-to-person transmission is rare, but has happened.

The bacteria are sturdy, easily available in the tropics, and fairly easy to cultivate, making it a potential warfare agent for dissemination in aerosolized form. There is no vaccine for melioidosis.

Health Effects

- The incubation period for natural exposures can range from 2 days to many years. With an aerosol attack, it can be from 10 to 14 days.
- An **acute localized infection** produces a nodule where the bacteria entered through a break in the skin. Symptoms may include fever and general muscle aches. The infection can spread to the bloodstream.
- **Pulmonary infection** commonly presents with chest pain and cough (either productive or nonproductive) with normal sputum. Other symptoms may include high fever, headache, loss of appetite, and general muscle soreness.
- Symptoms of **acute bloodstream infection** generally include respiratory distress, severe headache, fever, diarrhea, pus-filled lesions on the skin, muscle tenderness, and disorientation. Infection is typically short-lived.
- It's possible for melioidosis to develop into a chronic infection involving body organs, including the joints, viscera, lymph nodes, skin, brain, liver, lung, bones and spleen.
- If bloodstream infection develops, mortality can range from 40% if treated with antibiotics to 90% if untreated.

EMS Response

- Decon patients if contaminated.
- Provide antibiotics and supportive therapy as needed.
- Use universal precautions.
- Use soap and water or a mild hypochlorite solution to clean contaminated equipment.

Plague

There are two primary types of plague: bubonic and pneumonic. A third type, septicemic plague, is a generalized, often fatal infection that can result if bubonic or pneumonic plague spread beyond its initial target organ, progressing to the bloodstream, central nervous system, etc.

Bubonic plague is transmitted from rodents to humans by the bite of an infected flea. Pneumonic plague can result from the septicemic form or from inhalation of the bacteria. Pneumonic plague is directly communicable from one person to another; bubonic and septicemic plague are not. There's no vaccine available in the U.S., but antibiotics taken within seven days after exposure to an infected person can greatly reduce the chances of getting sick.

A terrorist is most likely to disseminate *bubonic* plague via contaminated fleas and *pneumonic* plague via aerosol.

Health Effects - Bubonic Plague

- The incubation period is 2 to 10 days.
- Bubonic plague targets the lymph system, causing malaise, high fever, and tender, swollen lymph nodes (particularly in the groin and legs). Onset is often sudden and intense.
- In untreated patients, the mortality rate can be as high as 50%.

Health Effects - Pneumonic Plague

- The incubation period is 2 to 3 days.
- Pneumonic plague targets the lungs, causing high fever, chills, headache, muscle pain, cough with bloody sputum, difficulty breathing, and cyanosis. Onset is often sudden and intense.
- In untreated patients, the mortality rate is 90% to 100%.

EMS Response (Both Types)

- Decon patients if contaminated.
- Provide antibiotics and supportive therapy as appropriate.
- Use universal precautions.
- Wear a NIOSH-certified HEPA filter respirator (or equivalent) when caring for patients with pneumonic plague. (If possible, place masks on these patients as well.)
- Disinfect contaminated equipment with a hypochlorite solution.

Q Fever

Q fever is caused by the Coxiella burnetii rickettsia found most often in sheep, cattle, and goats. Humans can acquire the disease by ingesting contaminated milk or by inhaling dust contaminated with feces or tissues from infected animals. Although it's less common, humans can also acquire Q fever through tick bites. Q fever is not contagious.

The most likely terrorist scenario is dissemination by aerosol. The rickettsia that causes Q fever is highly infectious when inhaled.

A vaccine has been developed and has successfully protected humans in occupational settings in Australia, but it's not commercially available in the U.S. Contact the CDC for more information.

(Note: Q Fever is one of many rickettsial illnesses that can result from tick, mite, or flea bites. Common early symptoms of rickettsial illnesses are generally nonspecific and include fever, headache, and malaise. Other symptoms can include nausea, vomiting, chills, rashes, and dark scabs around the bite. The EMS response is the same as for Q fever.)

Health Effects

- The incubation period usually ranges from 10 to 20 days.
- Onset of disease begins with flu-like symptoms, including sudden onset of fever, headache, chills, weakness, and profuse sweating. Many patients have pneumonia. Some also have a nonproductive cough and pain in the chest upon respirations.
- The disease is incapacitating, but is not usually fatal. In rare cases, however, complications can include endocarditis (infection of the valves or the lining of the heart) and death.
- The illness usually lasts between 2 days and 2 weeks.
- Patients usually recover uneventfully, even without treatment.

EMS Response

- Decon patients if contaminated.
- Provide antibiotics and supportive therapy as appropriate.
- Use universal precautions.
- Use soap and water or a mild hypochlorite solution to clean contaminated equipment.

Ricin

Ricin is a toxin made from castor beans. Possible terrorist scenarios include dissemination through aerosolization, contamination of food or water supplies, or direct injection into an intended victim. The toxin is not contagious, but there are currently no antidotes or vaccines for ricin.

Health Effects

- Onset of symptoms typically occurs in 8 to 24 hours, but may occur as early as 3 hours or as late as 72 hours after exposure, depending on dose and route of exposure.
- Early symptoms of **inhalation** exposure include fever, cough, tightness of the chest, difficulty breathing, nausea, weakness, and muscle aches. Patients subsequently experience severe respiratory distress from pulmonary edema. Death occurs within 36 to 72 hours.
- **Ingestion** of ricin will cause nausea and vomiting; gastrointestinal bleeding; failure of the liver, spleen, and kidneys; and death from cardiovascular collapse.
- **Injection** of ricin will destroy tissues, including muscle and lymph nodes, near the injection site. Death will result from cardiovascular collapse and/or failure of major body organs.

EMS Response

- Decon patients if contaminated.
- Provide airway management, fluid replacement, and other supportive therapy as needed.
- Use universal precautions.
- Disinfect contaminated equipment with soap and water or a hypochlorite solution.

Salmonellosis

Salmonellosis is a diarrheal illness caused by a variety of Salmonella bacteria usually transmitted to people by eating foods contaminated with animal or human feces. People can also become sick by consuming raw or undercooked eggs, meat, or poultry or raw or unpasteurized milk or other dairy products. The most likely terrorist scenario is contamination of food supplies. There is no vaccine for salmonellosis.

Health Effects

- The incubation period is 12 to 72 hours.
- Patients develop diarrhea, fever, and abdominal cramps that usually last 4 to 7 days. Most recover without treatment.
- Some patients develop diarrhea severe enough to require hospitalization and rehydration, often with intravenous fluids.
- In the most severe cases, where the bacteria spread from the intestine to the bloodstream and other parts of the body, salmonellosis can be fatal if not treated promptly with antibiotics.

EMS Response

- Decon patients if contaminated.
- Provide antibiotics, fluid replacement, and other supportive therapy as needed.
- Use universal precautions (especially thorough hand-washing).
- Use soap and water or a mild hypochlorite solution to clean contaminated equipment.

Saxitoxin

Saxitoxin is a potent neurotoxin found in shellfish, such as mussels, clams, and scallops. The most likely terrorist scenario is dissemination by aerosolization.

Health Effects

- Symptoms typically appear within 10 to 60 minutes, but onset can vary based on route of exposure. *Inhalation* of a lethal dose can kill within minutes, whereas symptoms of saxitoxin *ingestion* may be delayed by several hours, depending on the dose and individual susceptibility.
- Early symptoms include numbness or tingling of the lips, tongue, and fingertips, followed by numbness of the neck and extremities and general loss of muscular coordination.
- Other symptoms may include nausea and vomiting, a feeling of lightheadedness or floating, dizziness, weakness, difficulty speaking, incoherence, visual disturbances, memory loss, and headache.
- The terminal stages, characterized by respiratory distress and flaccid muscle paralysis, can occur 2 to 12 hours after exposure. Death results from respiratory paralysis.
- Patients who survive will usually begin to recover within 12 to 24 hours. Complete recovery may require 7 to 14 days.

EMS Response

- Decon patients if contaminated.
- Provide respiratory therapy and other supportive therapy as needed.
- If the saxitoxin was ingested, treat the patient with standard poison ingestion procedures.
- Use universal precautions.
- Disinfect contaminated equipment with soap and water or a hypochlorite solution.

Smallpox

In the aftermath of September 11 and the subsequent anthrax attacks, there has been increased concern about smallpox as a possible weapon of mass destruction. While the mortality rate for smallpox is considerably lower than for some of the other biological warfare agents, smallpox is highly contagious and is a horrible and frightening disease.

Smallpox was eradicated worldwide by 1980, thanks to an aggressive vaccination program. However, because several countries experimented with the smallpox virus for biological warfare, the virus still exists. The CDC in the United States and Vector in Russia are known to have deposits of the smallpox virus, but there may be other sources that we don't know about.

There is a vaccine for smallpox, but it's currently unavailable to the general public. It's being offered only to persons at greatest risk of exposure (e.g., military personnel, healthcare providers, and emergency responders). Nonetheless, the U.S. has a big enough stockpile of smallpox vaccine to vaccinate everyone in the country who might need it in the event of an emergency.

Monitoring of smallpox vaccinations in late 2002 and early 2003 suggested that the vaccine may cause heart problems, among other known side effects. This prompted the CDC, the Advisory Committee on Immunization Practices (ACIP), and other agencies to recommend a list of conditions under which people should not be vaccinated. However, this does not mean that people who aren't vaccinated are unprotected if exposed to smallpox. According to the CDC, vaccination within 3 days of exposure will completely prevent or significantly modify smallpox in the vast majority of persons. Vaccination 4 to 7 days after exposure likely offers some protection from disease or may modify the severity of disease. Contact the CDC for more information.

The most likely terrorist scenario is dissemination by aerosol. However, the smallpox virus is a fragile one. Based on laboratory experiments, it's estimated that 90% of an aerosolized release will die or dissipate in about 24 hours.

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Smallpox (continued)

Health Effects

- The average incubation period is 12 to 14 days, but it can range from 7 to 17 days. People generally feel fine during this time and do not have symptoms. They are not contagious yet.
- Early symptoms include malaise, head and body aches, and sometimes vomiting. Patients also have a high fever (101˚F/38.3˚C to 104˚F/40˚C). Patients are sometimes contagious at this point.
- Within 2 to 4 days, a rash emerges with small red spots on the tongue and in the mouth. These spots then develop into open sores that spread the virus. Patients are most contagious during this phase.
- As the mouth sores break down, a rash appears on the rest of the body, but it's most abundant on the face and extremities. Within a few days, the rash progresses to raised bumps filled with a thick, opaque fluid. The bumps become pustules that are firm to the touch, feeling like there are small round objects embedded under the skin.
- The pustules scab over usually about two weeks after the rash appears. The scabs fall off roughly a week later, leaving many survivors with permanent scars.
- Smallpox is generally spread through the respiratory system by direct and fairly prolonged face-to-face contact. However, it can also be spread through direct contact with infected bodily fluids or contaminated objects (e.g., bedding and clothing.) Patients are contagious until the last smallpox scab falls off.
- The mortality rate can be up to 30% in unvaccinated patients.

EMS Response

- Decon patients if contaminated.
- Provide supportive therapy (e.g., IV fluids and medicine to control fever or pain) and antibiotics for any secondary bacterial infections.
- Use universal precautions.
- Wear a NIOSH-certified HEPA filter respirator (or equivalent) when caring for patients with smallpox, because the disease is easily transmitted from person to person. (If possible, place masks on these patients as well.)
- Isolate anything contaminated with blood or body fluids.
- Quarantine infected patients for at least 16 to 17 days.
- Notify the CDC immediately.

Staphylococcal Enterotoxin B (SEB)

Staphylococcal enterotoxin B (SEB) is a common cause of accidental food poisoning. Possible terrorist scenarios are dissemination by aerosolization or contamination of food or water sources.

The toxin is not contagious, and there is currently no vaccine for Staphylococcal enterotoxin B.

Health Effects

- Symptoms generally appear within 3 to 12 hours.
- Inhalation exposure generally results in more dramatic and more serious symptoms than does ingestion.
- Symptoms of **inhalation** exposure are sudden onset of fever, chills, headache, muscle aches, and a nonproductive cough. The fever may last 2 to 5 days. The cough may persist for up to 4 weeks. Some patients experience shortness of breath and chest pain. Many patients, especially those with gastrointestinal exposure, also experience nausea, vomiting, and diarrhea.
- **Ingestion** of the toxin typically causes vomiting, abdominal cramps, and diarrhea.
- The mortality rate is relatively low for SEB acquired through accidental food poisoning. However, higher exposures, such as might occur with a deliberate attack, can lead to septic shock and death.

EMS Response

- Decon patients if contaminated.
- Provide airway management, fluid management, and supportive therapy as needed. (There is no antidote for this toxin.)
- Use universal precautions.
- Once SEB is identified in a patient, attempt to identify whether others have shared a common food. Initial suspicion should be directed toward home-cooked or home-preserved foods, but commercially preserved foods should not be overlooked either.
- Disinfect contaminated equipment with a hypochlorite solution.

Trichothecene Mycotoxins

Trichothecene mycotoxins are naturally produced by fungi. There are many types, all of which are generally addressed as a group, although the T-2 mycotoxin is the one that usually raises the greatest concern. These toxins can enter the body through all routes of entry, including absorption through intact skin. There is no vaccine or antidote for trichothecene mycotoxins.

The most likely terrorist scenario is dissemination by aerosol. Trichothecene mycotoxins should be suspected if there has been an aerosol attack in the form of "yellow rain," leaving droplets of yellow fluid on contaminated surfaces.

Health Effects

- Symptoms occur within minutes or hours after exposure and will vary somewhat depending on the route of entry.
- General early symptoms include burning, itching, red skin; burning of the eyes, nose, and throat; sneezing; and conjunctivitis.
- Other respiratory symptoms may include nasal discharge, itching and sneezing, cough, dyspnea, wheezing, chest pain, and hemoptysis (coughing up blood or bloody mucous).
- Gastrointestinal symptoms may include nausea, vomiting, diarrhea, and abdominal pain.
- As patients worsen, skin irritation turns to blisters, necrosis (tissue death), and sloughing of epidermis.
- Severe poisoning results in prostration (extreme physical exhaustion), weakness, ataxia (loss of muscle coordination, particularly in the extremities), collapse, shock, and death.

EMS Response

- Decon patients if contaminated.
- If the toxin was ingested, give patients activated charcoal.
- Provide supportive therapy as needed.
- Use complete skin and respiratory protection if the toxin is in the atmosphere. Otherwise, use universal precautions.
- Clean contaminated equipment with sodium hydroxide or sodium hypochlorite.

Tularemia

There are several forms of tularemia, also known as rabbit fever or deer fly fever. The two we are most concerned with are ulceroglandular tularemia and typhoidal tularemia.

Ulceroglandular tularemia is acquired under natural conditions through bites from infected deer flies, mosquitoes, or ticks. The bacteria can also be transmitted from contaminated animals through mucous membranes or breaks in the skin. Typhoidal tularemia can be acquired by inhalation of contaminated dust or by ingestion of contaminated food or water. Neither form is directly transmitted from person to person.

The most likely terrorist scenario is dissemination by aerosolization, but tularemia can be used to contaminate food and water supplies.

A vaccine is under review by the Food and Drug Administration, but not currently available in the U.S. Contact the CDC for more information.

Health Effects

- The incubation period is usually 1 to 14 days, depending on the form of tularemia, with 3 to 5 days being average.
- Ulceroglandular tularemia is characterized by a local ulcer, swollen lymph nodes, fever, chills, headache, and malaise.
- Typhoidal tularemia is characterized by fever, headache, substernal discomfort, prostration (fatigue or extreme tiredness), weight loss, and a nonproductive cough.
- Pneumonia is common with typhoidal tularemia, although it may occur with any form. Pneumonia can be fatal if untreated.

EMS Response

- Decon patients if contaminated.
- Provide antibiotics and supportive therapy as needed.
- Use universal precautions.
- Clean contaminated equipment with a hypochlorite solution.

Venezuelan Equine Encephalitis (VEE)

The Venezuelan Equine Encephalitis (VEE) virus can be found in horses, mules, and donkeys in Central and South America, Mexico, and limited parts of the United States. It is transmitted to humans through mosquitoes. The most likely terrorist scenario is dissemination by aerosol.

A vaccine is available as an investigational new drug. Contact the CDC for more information.

Health Effects

- The incubation period is 1 to 6 days.
- Early symptoms include sudden onset of general weakness, spiking fever, severe headache, chills, stiffness and rigidity, numbness of the legs, and photophobia (abnormal sensitivity to light).
- Additional symptoms may include nausea, vomiting, diarrhea, cough, and sore throat.
- The acute phase lasts 24 to 72 hours, but complete recovery may take 1 to 2 weeks.
- In severe cases, patients may experience central nervous system infection, characterized by seizures, coma, and paralysis. This is more common in children than in adults, although the incidence is still low.
- Fatalities are uncommon, although there is a higher risk of death for patients with central nervous system infection.

EMS Response

- Decon patients if contaminated.
- Provide supportive therapy as needed.
- Use universal precautions.
- Clean contaminated equipment with a hypochlorite solution.

Viral Hemorrhagic Fevers (VHF)

Several illnesses fall under the general grouping of viral hemorrhagic fevers, including Ebola, Marburg, lassa fever, Argentine fever, Bolivian fever, hantavirus, Congo-crimean hemorrhagic fever, yellow fever, dengue fever, and Rift Valley fever. Although each is slightly different, they all have common characteristics.

Most of these diseases are transmitted to humans by mosquitoes. Some are transmitted by contact with infected animals or body excretions from infected rodents. Several are highly contagious, transmitted from person to person by contact with blood and other body fluids.

The only vaccines available are for yellow fever and Argentine hemorrhagic fever. Contact the CDC for more information.

The most likely terrorist scenarios are dissemination by aerosolization or by contamination of food supplies.

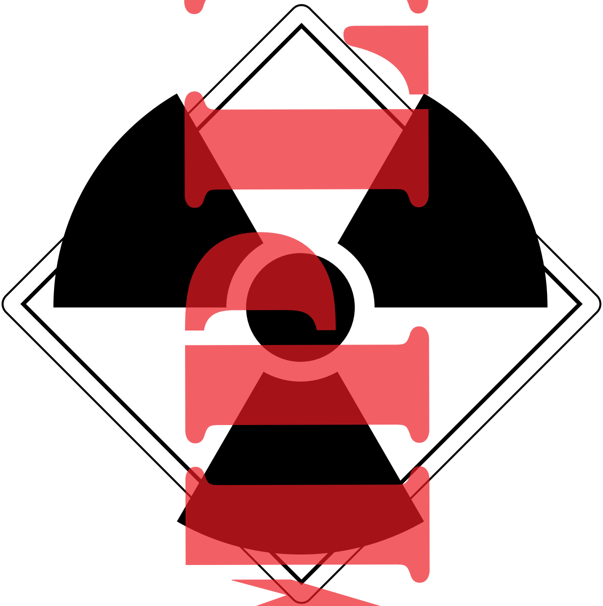
Health Effects

- Onset of symptoms varies depending on the specific virus. For most, it occurs within 3 to 7 days. Some take a little longer.
- Early symptoms include fever, headache, muscle pain, fatigue, dizziness, loss of strength, flushing of the face and chest, edema, and blotches on the skin from subcutaneous bleeding.
- Some viral hemorrhagic fevers produce vomiting and diarrhea.
- The most distinguishing symptoms are internal and external bleeding and shock.
- The mortality rate varies with the different viruses. Ebola is one of the deadliest, with a mortality rate that ranges from 50% to 90%.

EMS Response

- Decon patients if contaminated.
- Provide antiviral therapy and supportive therapy as needed.
- Use universal precautions and body substance isolation procedures. (See page 6-8.) Strict adherence to infection control procedures is essential to protect healthcare workers.
- Wear a NIOSH-certified HEPA filter respirator (or equivalent).
- Notify the CDC and your local or state health department.

Nuclear Events



Most of the information in this chapter applies to any incident (intentional or accidental) involving radioactive materials. It includes basic radiation concepts, radiation exposure limits, responder protection guidelines, health effects, patient care, and radiation monitoring. The level of detail provided in this chapter is designed to help dispel some of the myths and concerns that make radiation incidents frightening to so many people.

Note: This book uses the English units of measure (roentgen, rad, and rem) because they are more common in the United States and responders are more familiar with them. Most of the rest of the developed world uses the international (SI) units (gray and sievert). These terms are explained in this chapter but are not emphasized.

11-2

Basic Radiation Concepts

Radiation is a form of energy. Radiation from both natural and manmade sources is around us daily. The potential for harm varies with the type of radiation.

Nonionizing Radiation

We're generally not concerned with nonionizing radiation, such as that produced by microwaves, radio frequencies, heat, and light. The electromagnetic waves produced by nonionizing radiation emit less energy than those produced by gamma rays and x-rays (two forms of ionizing radiation). The energy from nonionizing radiation can move atoms, creating heat, light, sound, etc. But the energy isn't sufficient to change atoms structurally, as happens with ionizing radiation.

Ionizing Radiation

Ionizing radiation produces enough energy to change the structure of atoms struck by that energy.

Radioactive elements are unstable atoms. When atoms give off radioactivity, they are throwing off excess energy and/or particles to become stable. This process is called *radioactive decay* or *disintegration*.

Each atom has a nucleus filled with protons and neutrons. Electrons orbit the nucleus much the way planets orbit the sun. Protons and electrons are electrically charged (protons positively and electrons negatively). Atoms must have an equal number of protons and electrons to be electrically neutral. However, when struck by energy from ionizing radiation, an atom will lose electrons and no longer be neutral. It is now *ionized*. This effect is called *ionization*.

There are five types of ionizing (damaging) radiation. All five are defined on the following page, but this book focuses primarily on the first three—the three that responders are most likely to encounter at a hazmat incident. All radioactive materials give off at least one type of radiation. Most give off two or three.

(continued next page)

Basic Radiation Concepts (continued)

Ionizing Radiation (continued)

Alpha particles are subatomic particles made of two protons and two neutrons released from the nucleus of an atom. They are relatively large particles that can travel only a couple inches in air. Alpha particles contain a lot of energy but have very low penetrating power. They are stopped by shielding as light as a sheet of paper and cannot penetrate intact skin. Alpha particles are not a serious external hazard, but if alpha emitters (radioactive materials that emit alpha particles) enter the body through inhalation, ingestion, or contamination of an open wound, they will deposit their ionizing energy in the adjacent tissues.

An excess neutron in the nucleus can transform into a proton and electron. The electron is then ejected as a **beta particle**. These relatively small particles can travel several feet to several yards in air. They vary in energy level. Those with the highest energy level can penetrate about a half-inch through intact skin. External exposure to beta particles can produce burns to the skin. But the greatest danger is from internal exposure to beta emitters that enter the body. It takes heavier shielding (e.g., aluminum, wood, or plastic) to stop beta radiation.

Gamma rays are high-energy electromagnetic waves generated in the nucleus of an atom. Gamma rays travel at the speed of light and have strong penetrating power, able to travel considerable distances and through skin, PPE, and other objects. Although gamma emitters can be inhaled, ingested, or absorbed through open wounds, most exposures to gamma rays are from external sources. Dense shielding (e.g., lead or concrete) is required to stop gamma radiation.

X-rays originate in the electron shells. They are similar to gamma rays, but they're less energetic and less penetrating. Most x-rays are produced by x-ray machines. Once the machine is turned off, it no longer emits radiation.

Neutron particles (neutrons) are larger than beta particles, but smaller than alpha particles. Neutron radiation has very strong penetrating power and often causes more damage to body tissues than do other forms of radiation. However, neutron radiation is rare; it's primarily associated with nuclear power plants.

Basic Radiation Concepts (continued)

Other Classifications of Radioactive Materials

Special form materials typically contain radioisotopes that emit a high level of radioactivity. However, they are encapsulated in durable containers of such high integrity that a breach is unlikely. The only way to open the containers is to destroy them.

Low specific activity (LSA) materials are those with a low level of activity (rate of decay) or those in which the radioactivity is uniformly distributed throughout an inactive material (e.g., earth, concrete, rubble, or other debris). Closely related are **surface contaminated objects (SCO)**—nonradioactive materials externally contaminated with a low-level radioactive substance. Both present minimal risk to responders.

Nuclear power plants, hospitals, universities, and other industries that use radioactive materials generate contaminated waste. **Low-level waste** (e.g., lab supplies, discarded PPE, cleaning rags, and filters) emit only small amounts of radiation.

Transuranic waste (TRU) is material (e.g., protective clothing, tools, and equipment) contaminated with radioisotopes heavier than uranium (beyond uranium on the periodic table). Most transuranic waste is no more radioactive than low-level waste, but it remains radioactive far longer.

Fuel rods (tubes filled with ceramic pellets created from uranium) are a key component of the nuclear power cycle. Those that have not yet been in a reactor emit very little radioactivity. The **spent fuel** (used fuel rods removed from a reactor) *is* highly radioactive. Spent fuel and waste materials from operations where spent fuel is reprocessed both constitute **high-level radioactive waste**.

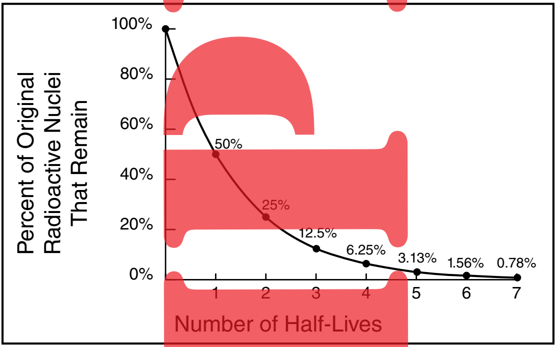
Fissile materials (uranium-233, uranium-235, plutonium-239, and plutonium-241), also known as **special nuclear materials**, are of particular concern because they can be used to create an atomic bomb. Tight restrictions govern the production and use of fissile materials.

Uranium mill tailings are radioactive rock and soil by-products that result from mining uranium. When the naturally occurring radium in these tailings decay, it emits radon gas (the second leading cause of lung cancer in the United States today).

Basic Radiation Concepts (continued)

Half-Life

Half-life is the measure of how long it takes for one half of a radioactive material's atoms to decay. Half-life is reflected by a 50% drop in energy level (for example, from 10 mR/hr to 5 mR/hr on a survey meter). Half-lives of different radioisotopes can vary from less than a second to thousands or millions of years. However, the half-life of each radioisotope is constant and independent of sample size. As a rule of thumb, a radioactive isotope decreases to less than 1% of its original energy level after 7 half-lives.



A Radioactive Isotope Decreases to Less Than 1% of Its Original Energy Level After 7 Half-Lives

Half-life is significant in determining how long an area must be sealed off and whether the incident can be allowed to self-mitigate. If a material's half-life is only a few hours or days, it may be best to simply seal off the site until the hazard is no longer present. Conversely, if the half-life is several years, it will probably be necessary to bring in a cleanup company to mitigate the hazard.

Other Hazards of Radioactive Materials

Many radioactive materials have multiple hazards. For example, they may be flammable, toxic, or corrosive in addition to being radioactive. These hazards must also be considered when planning a response.

Units of Radiation Measurement

English units of radiation measure are used most often in the U.S., but the International System (SI) of Units is used on labels and shipping papers and in most places internationally.

Measuring Dose Rate and Dose

Roentgen (R) is the unit of measure that identifies the amount of radiation (energy) produced by gamma rays and x-rays. It is a measure of the *exposure (dose) rate*—the ionization in air. Detectors commonly measure gamma radiation in roentgens, milliroentgens, or microroentgens per hour (R/hr, mR/hr, or μR/hr). (The prefixes are explained on the next page.) What this means is that a person would have to be in that environment for 60 minutes to be exposed to the amount of radiation displayed on the detector.

Rad (radiation absorbed dose) describes radiation energy absorbed by exposed matter (living or not). The international equivalent is **gray (Gy)**. However, 1 gray equals 100 rads.

Rem (roentgen equivalent man) is used to measure energy absorbed by living tissue (the dose received). It reflects the biological damage done by an absorbed dose of radiation. The international equivalent for rem is **sievert (Sv)**. However, 1 sievert equals 100 rems.

The following equation shows the approximate relation between the five units of measure above.

100 roentgens = 100 rads (1 gray) = 100 rems (1 sievert)

In reality, the effective biological damage (measured in rems or sieverts) is determined by multiplying the number of rads or grays by a *quality factor* that varies with the type of radiation. This is because some types of radiation are more harmful than others. So the equation above is not precisely accurate, but it is close enough for first responders. However, if you see exposure levels cited in terms of rads/grays instead of rems/sieverts, recognize that it's raw data that subject matter experts may fine-tune to reflect biological damage based on type of radiation and how easily different body organs absorb and are damaged by radiation.

Units of Radiation Measurement (continued)

Measuring Dose Rate and Dose (continued)

The following are some of the prefixes commonly seen with these units of radiation measure.

Unit	Symbol	Power	Equivalent	Numeric Representation
Tera	T	10^{12}	trillion	1,000,000,000,000
Giga	G	10^{9}	billion	1,000,000,000
Mega	M	10^{6}	million	1,000,000
kilo	k	10^{3}	thousand	1,000
—	—	1	one	1
milli	m	10^{-3}	thousandth	1/1,000
micro	µ	10^{-6}	millionth	1/1,000,000
nano	n	10^{-9}	billionth	1/1,000,000,000
pico	p	10^{-12}	trillionth	1/1,000,000,000,000

Prefixes Commonly Used with Units

Measuring Activity (Rate of Decay)

Curie (Ci) is the unit of measure that reflects activity (rate of decay). One curie is the quantity of radioactive isotope that produces 37 billion disintegrations per second (dps). For regulatory purposes, the DOT defines a radioactive material as any material having a specific activity greater than 0.002 microcuries (0.002 µCi) per gram. (A microcurie is one millionth of a curie.) The international **Becquerel (Bq)** is similar. However, 1 becquerel equals one disintegration per second. Thus 1 curie equals 37 billion becquerels (37 GBq).

When comparing radioactive sources, the higher the number or curies or becquerels, the more hazardous the isotope. However, curies and becquerels don't tell the first responder about human exposure. So roentgen, rad (gray), and rem (sievert) are the units of measure most important to emergency responders.

Radiation Exposure Limits

Average Annual Doses

We all receive a small amount of ionizing radiation (average 360 mrem) every year, roughly 82% from natural sources and 18% from manmade sources. The National Council on Radiation Protection and Measurement estimates the sources of radiation exposure to break down as shown below.

%	Source of Average Annual Dose of Ionizing Radiation
55%	Radon (from radioactive decay of uranium-238 in rock and soil)
11%	X-rays and other medical and dental procedures
11%	Internal (materials such as potassium and carbon in food and air)
8%	Terrestrial (other radioactive materials in the Earth's crust)
8%	Cosmic radiation
4%	Nuclear (power plant emissions, fallout from weapons testing)
3%	Consumer products (e.g., cigarettes, smoke detectors, color TVs)
1%	Other

Radiation Exposure Limits

Radiation exposures should always be kept *as low as reasonably achievable*. (This is known as the *ALARA principle*.) The U.S. EPA has published recommended dose limits for workers performing emergency services. Doses for all workers during emergencies should, to the extent practicable, be limited to 5 rem. The chart below shows situations for which higher doses may be justified if the benefits outweigh the risks. Exceeding the 25-rem limit to save lives should be considered only on a voluntary basis and only with a full awareness of the risks involved, including the health effects at anticipated doses. Further, the EPA recommends that doses to workers performing emergency services be treated as a once-in-a-lifetime exposure. (See page 11-7 for information on units of radiation measurement.)

Dose Limit	Activity	Condition
5 rem	all	
10 rem	protecting valuable property	lower dose not practicable
25 rem	life saving or protecting large populations	
> 25 rem		voluntary basis, fully aware of risks

The EPA limits still leave a safety margin. Although there may be mild symptoms with doses as low as 30 rems, most people won't develop radiation sickness at less than 70 to 100 rems.

Radiation Exposure Limits (continued)

Incident Stay Time

If you need to enter the hot zone at a radiation incident and you know the dose rate present, you can use the Incident Stay Time Table below to determine how long you can be in the area without exceeding the EPA limits (which are based on hour-long exposures). For example, if you needed to rescue someone who was hurt or trapped in a 50-R/hr atmosphere, you could stay up to 30 minutes without going over the 25-rem limit to save a life. Or you could use multiple teams, limiting each to 12 minutes to keep everyone's exposure at or below 10 rems.

	Time to Receive Maximum Dose		
Dose Rate	**5 rem**	**10 rem**	**25 rem**
2 mR/hr	104 days	208 days	520 days
5 mR/hr	41.6 days	83.3 days	208 days
10 mR/hr	20.8 days	41.6 days	104 days
25 mR/hr	8.3 days	16.6 days	41.6 days
50 mR/hr	4.1 days	8.3 days	20.8 days
0.5 R/hr	10 hours	20 hours	50 hours
1 R/hr	5 hours	10 hours	25 hours
20 R/hr	15 minutes	30 minutes	75 minutes
50 R/hr	6 minutes	12 minutes	30 minutes
100 R/hr	3 minutes	6 minutes	15 minutes

Incident Stay Time Table

You can also calculate stay time with any of the equations below. To understand where the "constant" comes from, multiply 60 (as in minutes) by the appropriate EPA exposure limit. For example, for lifesaving operations (25-rem limit), you can spend 60 minutes in a 25-R/hr atmosphere (60 x 25 = 1500). Exposure rate and time may vary, but the number 1500 is a constant. For protecting valuable property (10-rem limit), the constant is 600 (60 x 10 = 600). For anything else (5-rem limit), the constant is 300 (60 x 5 = 300).

EPA Limit	**Constant**	**Meter Reading**	**Stay Time**
25 rems ...	1500 ÷	___ R/hr	= ___ Minutes
10 rems ...	600 ÷	___ R/hr	= ___ Minutes
5 rems ...	300 ÷	___ R/hr	= ___ Minutes

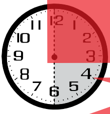
Time, Distance, and Shielding

The same principles of time, distance, and shielding that protect responders from radiation apply to *any* incident. Therefore, those basic concepts were covered on pages 2-45 and 2-46. However, the following are some other points specific to radiation.

These principles are designed to protect you from internal and external radiation. However, if you've had an internal exposure, your body remains exposed until that radionuclide is eliminated from the body or decays to a stable isotope. Alpha and beta emitters are the most hazardous because alpha and beta particles can transfer ionizing energy to surrounding tissue.

Time

The correlation between *dose* (exposure) and *dose rate* (radiation present in the atmosphere) is directly related to time. *Dose rate* is expressed in roentgens *per hour* (R/hr), so the *dose* must be calculated by the hours, or fraction thereof, that one is exposed.

Dose Rate: 50 R/hr	Dose Rate: 50 R/hr
	
Exposure: 25 rems	Exposure: 10 rems

The Relation Between Dose Rate and Dose

- Keep your exposure time to a minimum.
- Establish clear objectives before entering the hot zone.
- Plan your activities carefully so they can be completed as quickly and safely as possible.
- If you know the dose rate present in the atmosphere, use the incident stay time table or the equation provided on page 11-10 to calculate mission duration.
- If you don't know the dose rate, be expeditious, but not so hasty that you cause harm. For instance, you can take time to safely extricate a patient, but don't linger in the hot zone afterwards.
- If operations in the hot zone will be extended, rotate personnel through the area to limit individual exposure.

(continued next page)

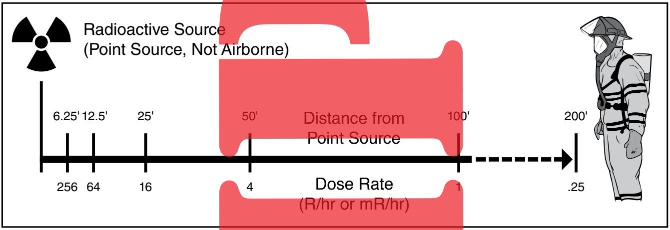
Time, Distance, and Shielding (continued)

Time (continued)

- Assign a timekeeper to track personnel in the hot zone.
- Limit patient care in the hot zone to maintaining an airway, controlling severe bleeding, and immobilizing the spine.

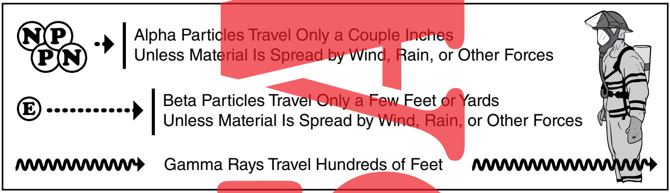
Distance

Distance is a more important factor than time is in controlling exposure. Whereas cutting exposure time in half cuts the dose in half, doubling your distance from the radioactive source reduces the exposure by 75%. This is known as the *Inverse Square Law*. Note: This applies to a point source, not an airborne source.



Doubling Your Distance Reduces Your Exposure by 75%.

Distance is also effective in reducing the type of exposure. Alpha particles travel only a couple inches in air. Beta particles travel several feet to several yards. Unless you have the contaminant on you or the material is being spread by wind, rain, or other forces, once you back out of the area, you are no longer at risk from alpha and beta particles; you need worry only about gamma radiation.



Distance Helps Control Type of Exposure Too

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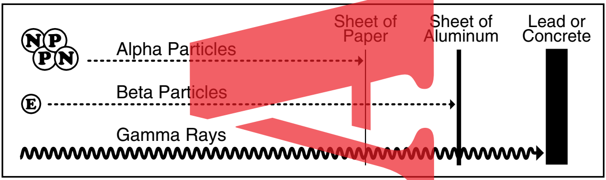
Distance (continued)

- Stay upwind, uphill, and upstream to protect against airborne particles.
- Use remote devices whenever possible. For example, use unmanned monitors instead of hand lines to fight a fire.
- Use the current edition of the ERG to determine appropriate isolation and evacuation distances. Guides 161 through 165 in the ERG2008 recommend 75 feet (25 meters) for initial isolation, 330 feet (100 meters) for downwind evacuation on a large spill, and 1000 feet (300 meters) for initial evacuation when a large quantity of radioactive material is involved in a major fire.
- Confirm safe distances by monitoring the atmosphere.
- Use common sense when establishing isolation zones. It's appropriate to err on the side of safety if you are unsure of the risks. However, incidents involving dangerous levels of radiation are rare, and releases are uncommon, even under accident conditions, due to the sturdy packaging. So, seldom is it necessary, for example, to shut down a freeway in both directions, severely impacting the entire community.

Shielding

Appropriate shielding will help reduce your exposure. Alpha particles are stopped by shielding as thin as a sheet of paper. It takes heavier shielding, such as a thick piece of aluminum or an inch of wood, to stop beta radiation. Gamma radiation is so penetrating that far denser shielding, such as several inches of lead or concrete, is required.



The Effect of Shielding on Alpha, Beta, and Gamma Radiation

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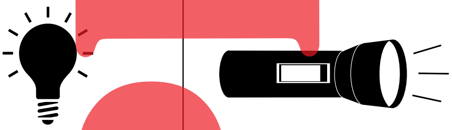
Time, Distance, and Shielding (continued)

Shielding (continued)

Radiation can be directional, like the beam of a flashlight. If a package is breached, but the radioactive source is still contained within the package, radiation will be projected in the direction of the breach. Any radiation detected in another direction should be within normal limits of what is permissible at the surface of the package and from 1 meter (3 feet) away.



Unshielded, radiation radiates in all directions (like light from a light bulb).

Properly shielded, radiation becomes directional (like the beam of a flashlight).

The Effect of Shielding on Radiation Direction

Radioactive materials and wastes are placed in different types of packages based on level of radioactivity. (See page 4-15.) The packages not only provide shielding but also allow you to make a quick estimate about the degree of risk posed by the radioisotope and the likelihood of a breach based on severity of impact in an accident. Type B and C packages are the only ones that contain potentially life-endangering amounts of radioactive materials. (Package type should be identified on the container and on shipping papers.)

- Wear proper PPE. (See next page.)
- Use any other available shielding. Lead is the best shield against gamma rays and x-rays, but it's generally not practical for emergency operations. However, you can position yourself behind fire engines, buildings, or hills when not directly involved in hot zone operations.
- Even when working in the hot zone, you can use available shielding, such as approaching from behind vehicles versus moving in direct line of sight.
- If appropriate, minimize dispersal of radioactive materials (e.g., by wind and rain) by covering them with a tarp, a plastic sheet, or even dirt.

Time, Distance, and Shielding (continued)

Protective Clothing As Shielding

Personal protective equipment (PPE) also provides some shielding. Firefighters should wear structural firefighting clothing and SCBA to enter the hot zone. This provides full protection from alpha particles. It also protects against inhalation or ingestion of beta particles. Although some beta radiation may penetrate protective clothing, the clothing does reduce the exposure potential. (Again, one can use the flashlight analogy. Light from a flashlight will penetrate clothing, but it will be less strong on the other side.) Structural firefighting clothing will not protect against penetrating radiation such as gamma rays and neutron particles.

EMS personnel do not need special protective clothing if patients have been thoroughly decontaminated. However, if that is not the case, EMS personnel should, if possible, wear a long-sleeve uniform, gloves, hood or hair cover, eye protection, shoe covers, and a face mask (e.g., an N-95 HEPA filter mask or equivalent). The clothing will protect against inhalation, ingestion, and secondary contamination (skin contact) with alpha and beta emitters. It will not protect against radiation penetration. The best protection for that is to ensure that contaminated patients are thoroughly decontaminated once more serious injuries are cared for.

Police officers and other personnel who don't enter the hot zone also need no special protective clothing. However, anyone who must handle contaminated people or evidence should wear a long-sleeve uniform, gloves, hood or hair cover, eye protection, shoe covers, and a face mask (e.g., an N-95 HEPA filter mask or equivalent). The clothing will protect against inhalation, ingestion, and secondary contamination (skin contact) with alpha and beta emitters. It will not protect against radiation penetration.

As soon as practical, responders should remove outer garments that might have become contaminated. They should then be monitored to determine if further clothing removal or decon is needed.

Health Effects

Exposure Versus Contamination

A person can be exposed to radiation without being contaminated (e.g., when receiving a medical x-ray). Exposure to radiation can cause tissue damage, but it won't make an exposed person radioactive. That person poses no threat to others.

However, a person who has a radioactive substance on his or her body is externally contaminated. He or she acts as a radioactive source and can both expose and contaminate other people. It's safest to assume that victims are contaminated until proven otherwise.

People can become internally contaminated if radioactive materials enter the body through inhalation, ingestion, or contamination of an open wound. They can subsequently expose others nearby. The body fluids (blood, sweat, and urine) of internally contaminated people may contain radioactive materials that can contaminate and/or expose others. Standard universal precautions (gloves, handwashing, etc.) will help protect emergency personnel from contact with these fluids.

Radiation Sickness Versus Other Effects

The speed with which initial signs and symptoms appear increases with exposure levels. Onset of nausea and vomiting—the earliest clinical signs of acute radiation sickness—usually takes several hours. So when health effects are observed right after an incident, one should first suspect other causes, such as traumatic injuries, exposure to other hazardous materials, or other hazardous properties (e.g., corrosivity or toxicity) of the radioactive material. Even anxiety over a presumed exposure can cause nausea and vomiting. However, if nausea and vomiting occur shortly after exposure, one must also consider the possibility that patients received a high absorbed dose of radiation.

Health Effects (continued)

Effects of Whole Body Exposure

The effects of radiation sickness will vary depending on the type of radiation, how much of the body was exposed, the depth of penetration, the dosage received, and whether the exposure is from a single event or multiple events. (Multiple exposures increase the risk of cancer and tax the body's ability to repair itself.) Health effects also vary based in individual factors, such as age and state of health. The following health effects apply to acute whole body exposures:

- There may be mild symptoms with doses as low as 30 rems (0.3 Sv), but most people won't develop what is considered "radiation sickness" at less than 70 to 100 rems (0.7 to 1.0 Sv).
- Whole body exposures above 70 to 100 rems (0.7 to 1.0 Sv) may cause nausea and vomiting for 1 to 2 days and a temporary drop in the production of new blood cells.
- As the exposure increases, so do the signs and symptoms of radiation sickness. Initial effects can include nausea, vomiting, diarrhea, dizziness, fatigue, headache, and loss of appetite. Higher doses can also cause fever, sweating, and difficulty breathing.
- Above 350 rems (3.5 Sv), the initial effects will be followed by a period of apparent wellness. But usually within 2 to 3 weeks, patients will become sick again and experience infection, electrolyte imbalance, diarrhea, bleeding, cardiovascular problems, and sometimes lapses in consciousness. Medical care is required.
- The experts don't agree on a precise number, but a whole body exposure in the range of 250 to 500 rems (2.5 to 5.0 Sv) is considered the LD_{50}/60 days, meaning that 50% of patients exposed to this level of radiation will die within 60 days if untreated. However, all can survive with proper medical attention.
- Above 1000 rems (10 Sv), the chances of survival drop significantly, even with aggressive treatment.
- Patients exposed to 5000 rems (50 Sv) will die within 48 hours. There is no effective treatment for such acute exposures. Treatment is limited to making patients as comfortable as possible.

(continued next page)

Health Effects (continued)

Effects of Whole Body Exposure (continued)

Some experts use rads/grays instead of rems/sieverts when describing health effects. At the first responder level, there's very little difference. However, rads/grays is raw data, whereas rems/sieverts is fine-tuned to reflect effective biological damage.

Aside from the radiation sickness described on the previous page, ionizing radiation can disrupt normal cell growth and repair processes, resulting in an increased risk of cancer—often considered the primary health effect. Or radiation can cause changes in DNA—mutagens that affect a developing fetus (teratogenic effects) or that can be passed from parent to child (mutagenic effects).

Other health effects include damage to the blood-forming organs, sterility, or other damage to the reproductive system.

Effects of Partial Body Exposure

Partial body exposure results in radiation burns that develop slowly, although patients might also experience the early nausea and vomiting typical of whole body exposures.

- Roughly 2 to 3 weeks after partial body exposures of 300 to 1000 rems (3 to 10 Sv), effects can resemble a first-degree sunburn.
- Higher exposures—up to 2500 rems (25 Sv)—will produce blisters within 1 to 2 weeks.
- Partial body exposures exceeding 3000 rems (30 Sv) can cause slow-healing ulcers or gangrene.
- Extremely high exposures manifest with tingling, pain, redness, and swelling very soon after the exposure.

Decon and Patient Care

Patient Decontamination

Serious medical problems take priority over radiation concerns, such as monitoring and decon, because radiation injuries are not immediately life-threatening, whereas other injuries can be. Nonetheless, use common sense. If patients are grossly contaminated, you can reduce the risk of secondary contamination to yourself and other EMS providers by quickly removing the patients' outer clothing and doing emergency decon. However, remember that serious medical concerns always take precedence.

- Assume patients are contaminated until proven otherwise.
- Follow the general patient decon guidelines on pages 6-10 to 6-15. (Exception: With radiation incidents, it's usually unnecessary to flush the body. If contamination is minimal, cleansing with a mister or wet towel may be preferable.)
- Isolate contaminated clothing and other personal items in double plastic bags labeled with each patient's name and clearly marked "Radioactive. Do Not Discard."
- Treat contaminated clothing as a potential radioactive source until proven otherwise.
- Use radiation detectors to ensure that patients are adequately decontaminated. (See page 11-27)
- If you need to transport contaminated patients, protect the ambulance. (See page 6-9.) Don't put personnel or ambulances back in service until they have been checked for contamination and are decontaminated as needed.

Patient Treatment

- Follow the general treatment protocols for all chemical exposures (pages 6-26 to 6-29).
- Treat life-threatening injuries first.
- Provide supportive therapy as needed.
- Transport patients to a medical facility capable of handling radiation accident patients. Any hospital should be able to provide initial care. However, hospitals vary in their ability to provide continued care for acute radiation sickness. They also vary in how well equipped they are to handle patients who have not been fully decontaminated. Coordinate with the facility before transporting patients so that medical personnel can prepare.

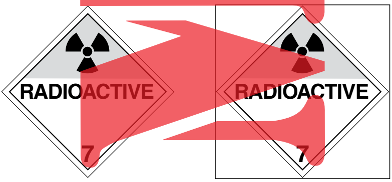
Radioactive Labels and Placards

The labels below reflect the maximum potential radiation exposure a person could receive per hour in close proximity to an intact package. This is the maximum exposure rate one should detect *above normal background levels*. (Color versions of the labels and placards are shown on page 3-16).

Maximum Allowable Radiation Level

Label	at package surface	at 1 meter from package
I	0.5 mR/hr	none
II	50 mR/hr	1 mR/hr
III	200 mR/hr	10 mR/hr

Placards are required on vehicles transporting Radioactive III materials (those that emit the highest level of radiation) and vehicles with exclusive use shipments. Thus the presence or absence of placards also provides a clue as to the degree of risk.

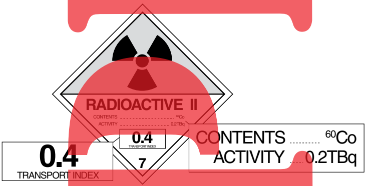


A placard on a square background means the vehicle contains a *highway route controlled quantity (HRCQ)*—a high-level radioactive material, such as spent fuel, shipped along designated routes. These designated routes (known as *preferred routes*) consist of interstate highways and bypass roads around cities. They may include alternative routes selected by a state or tribal authority in cooperation with affected state and local agencies. Preferred routes are chosen based on an evaluation of risk factors such as accident rate, transit time, population density, activities/occupancies along the route, time of day, and day of the week.

Radioactive Labels and Placards (continued)

Labels normally identify the **contents** by name, but they might use authorized symbols instead (e.g., ^{60}Co versus Cobalt-60). Low-specific activity (LSA-I) materials may be identified with the term LSA-I instead of the actual radionuclide.

Activity (rate of decay) is expressed in SI units (becquerels). English units of measure (curies) may be included in parentheses following the SI units. (In some cases, the weight of fissile materials may be used in place of SI units.)

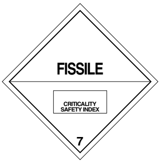


Transportation Index, Contents, and Specific Activity

The Radioactive II and Radioactive III labels contain a **transportation index (TI)**. (The transportation index is also indicated on shipping papers.) This number identifies the maximum radiation level (measured in mR/hr) allowed at 1 meter (3 feet) from an undamaged package.

For example, if the transportation index is 0.4 (as in the illustration above), the radiation intensity at 1 meter should be no more than 0.4 mR/hr above normal background levels. If your survey meter is reading something higher, you should suspect that the package has been breached.

Fissile Labels



Fissile labels may be affixed to packages containing fissile materials, depending on how they fall into the requirements or exceptions under Title 49. Fissile labels contain a **criticality safety index (CSI)**, which is not a radiation measurement; rather, it's a number used to help shippers limit the accumulation of fissile materials—materials that could be used to create an atomic bomb. Fissile materials are those whose atoms are capable of being split (nuclear fission).

Monitoring Essentials

We cannot detect radiation through our senses. It can be sensed or measured only by special monitoring equipment. The following pages provide general information. For specific instructions on how to use your radiation detectors, refer to user manuals that came with them.

Types of Radiation Meters

Most radiation meters used by emergency responders fall into one of two categories. **Survey meters** measure radiation present (dose rate) when the measurement is taken. **Personal dosimeters** measure accumulated exposure received by personnel working around radiation. (Newer electronic dosimeters can also measure dose rate—the amount of radiation present.)

To provide an analogy, the survey meter is like a car speedometer that identifies how fast you are driving at a given point in time. A dosimeter is like a trip odometer that tells you how far you have traveled since the journey began. (Electronic dosimeters capable of monitoring both accumulated dose and dose rate are like a combination odometer and speedometer.) Both types of meters provide vital information needed by responders at a radiation incident.

Personal Dosimeters

There are two main types of dosimeters. The first is a **badge type**, the predominant technologies being thermoluminescent dosimeters (TLD) and film badges. These dosimeters are used to create official exposure records for radiological workers. They may or may not be provided to emergency responders at a radiation incident. However, these dosimeters cannot be read by the wearer; they must be processed by a TLD or film badge laboratory (preferably the one from where they were obtained).

(continued next page)

Monitoring Essentials (continued)

Personal Dosimeters (continued)

Direct reading (self-reading) dosimeters allow response personnel to monitor their own accumulated exposure during an incident rather than have to wait for lab results or to calculate approximate exposures based on survey meter readings and length of exposure. Dosimeters measure accumulated exposure to gamma and x-ray radiation. Pocket optical dosimeters and their required chargers are older technology. Electronic dosimeters are a more recent development.

Pocket optical dosimeters measure accumulated exposure in roentgens (R) or milliroentgens (mR). Exposure is indicated by a vertical hairline that moves across a fixed horizontal scale. The indicator can be viewed through a lens at one end of the dosimeter when pointing it toward a light source (other than the sun). Pocket optical dosimeters can be very difficult to read when wearing full-face respiratory protection. They can be shock-sensitive, which affects the accuracy of any reading. And they lack any alarm mechanism to alert users when defined set points have been exceeded.

Electronic dosimeters measure accumulated exposure in roentgens or milliroentgens. Some measure in microroentgens (μR)—usually reflecting background levels. With the digital display, these dosimeters are more accurate and easier to read than pocket optical dosimeters are. Some measure both dose (accumulated exposure) and dose rate (R/hr). They have the added advantage of programmable alarms that can alert the wearer when a specified dose or dose rate is reached and alarm again at a higher action level.

Dosimeters are designed to be used by a single individual. Badge type dosimeters must not be traded with other responders under any circumstances. A direct reading dosimeter may be handed off to another responder once your mission is complete and the dosimeter reading has been recorded.

(continued next page)

Monitoring Essentials (continued)

Personal Dosimeters (continued)

Each dosimeter is different, so it's essential to be familiar with your specific unit and the manufacturer's instructions. The following are only general reminders.

- Be sure the dosimeter has been properly calibrated and is fully charged or has fresh batteries.
- Zero the dosimeter (unless you are monitoring your accumulated exposure over multiple shifts or missions).
- Clip the dosimeter to outer clothing as directed by the manufacturer (usually to the upper torso).
- Periodically read the dosimeter to monitor your exposure when working in a radiation environment.

An electronic dosimeter capable of measuring dose rate (R/hr) has added value for emergency responders. When worn as part of the daily uniform, it can alert the user to higher-than-normal radiation levels at any incident, whether one suspects radiation or not. It works continuously and doesn't require the user to operate a meter the way one has to deploy a survey meter. The programmable alarms can be set to any level deemed appropriate. For instance, one could set the dosimeter to alarm at 2 mR/hr, the point at which we would normally establish an initial perimeter.

Some electronic dosimeters can do double duty as a survey meter. They can be used to verify readings on a survey meter (described on the following pages), so responders aren't relying on a single instrument. If the incident extends over a large area, as might happen in a "dirty bomb" scenario, electronic dosimeters can supplement available survey meters, allowing responders to monitor more areas simultaneously. Procedures vary nationwide, but some experts consider it acceptable—in the initial response phase, when available equipment is limited—to use electronic dosimeters to monitor dose rate in the hot zone while keeping survey meters with contamination detection capability in the decon area to frisk patients and responders exiting the hot zone.

Monitoring Essentials (continued)

Survey Meters

The most sophisticated (and expensive) survey instruments are capable of identifying specific radioisotopes. Most agencies won't have this equipment or the training required to operate it properly, but it can be brought to the scene by county or state radiological officers or by personnel from the EPA, the DOE Radiological Assistance Program, the National Guard Civil Support Teams, or similar resources.

Although most survey meters can't identify specific radioisotopes, they will confirm that radiation is present and, subject to some of the limitations identified in this chapter, will also indicate *how much* radiation is present. **Measurement devices** are used to establish control zone boundaries, control personnel exposure, assess package integrity, and locate sources of radiation. **Contamination detection devices** are used to locate contamination on personnel and equipment and to determine the effectiveness of decon.

Know the limitations of your meters. No meter can detect all types of radiation effectively. Many are also limited in the levels they can detect. For example, the CD (Civil Defense) V-715 survey meter measures high-level (>50 mR/hr) gamma radiation only, whereas the CD V-700 measures low-level (<50 mR/hr) gamma and beta radiation. (Note: Some experts consider civil defense meters less precise than meters based on newer technology. But if properly calibrated—an annual requirement for all radiation detectors—they're still a useful tool for responders.)

Understand how to adjust the equipment based on type of radiation. For example, the meter may have a probe that detects both gamma and beta radiation with the shield open and gamma only with the shield closed. Other detectors may have two probes: a gamma scintillator for area monitoring and an alpha beta gamma pancake probe for frisking (checking patients and responders for contamination).

(continued next page)

Monitoring Essentials (continued)

Survey Meters (continued)

Understand the units of measure, and read the meter correctly. One of the most common mistakes people make is misinterpreting the reading. If you fail to read your meter correctly, you might either turn a minor problem into a major incident or inadvertently overexpose yourself and other responders. Remember: One roentgen (R/hr) equals 1000 milliroentgens (mR/hr) or 1,000,000 microroentgens (μR/hr).

Know what scale you are reading. If your meter is set to the x1 (times 1) scale, the exposure rate is what you see on the meter. However, if the selector switch is set to x0.1, x10, x100, or x1000, the meter readings must be multiplied by 0.1, 10, 100, or 1000 respectively. For example, if your meter is reading 1.5 mR/hr, but the selector switch is set to x1000, the true exposure rate is 1500 mR/hr (or 1.5 R/hr). Relay readings to responders up-range, who are generally in a better position to record and interpret results.

Many survey meters display results in counts per minute (cpm). It takes a subject matter expert to convert counts per minute into more familiar units of measure. So for practical purposes, consider counts per minute a reference unit to identify whether or not contamination is present. Some response from the meter is normal due to background radiation. Noticeable increases (more than two to three times background) should be considered a positive indication of contamination.

Because of the limitations inherent in the equipment, it might be necessary to use more than one detector. Ideally, you should have the capability to monitor for alpha, beta, and gamma radiation. You must also be able to monitor both high and low levels of gamma radiation. A high-range meter is critical for detecting dangerous levels of radiation. In that environment, a low-range detector may become saturated above its top limit and give false low readings or become nonoperational. Conversely, a high-range detector might not be sensitive enough to pick up low levels of radiation, resulting in exposures that could otherwise be avoided.

(continued next page)

Monitoring Essentials (continued)

Survey Meters (continued)

Each survey meter is different, so it's essential to be familiar with your specific unit and the manufacturer's instructions. The following are only general reminders:

- Attach and adjust the probe (if applicable).
- Be sure the meter has been properly calibrated and that it has fresh batteries.
- Verify that the meter is on, the range selector switch is set to the lowest (most sensitive) scale, the audio can be heard (if applicable), and a visual response registers on the meter.
- Zero the meter (if applicable).
- Perform preoperational checks per the instruction manual.
- Allow adequate warmup time.
- Establish the background radiation in a nonaffected area.
- If the meter is not intrinsically safe, monitor for flammable atmospheres before taking the survey meter into the hot zone.
- When using measurement equipment (e.g., to assess the scene), start from a safe distance and slowly move closer if appropriate.
- Relay readings to responders up-range who can record and interpret the results.

When using radiation (contamination detection) equipment to monitor patients and responders, systematically survey from head to toe on all sides. Hold the probe one-half inch from the body. Alpha particles, in particular, can't be detected if you don't hold the probe close enough. Be careful, however, not to touch the probe to any contaminated surface. If you contaminate the probe itself, you will "detect" radiation every place you monitor until you decontaminate the probe.

Move the probe slowly (no more than two inches per second), or you might miss something. Pay particular attention to areas where contamination is most likely and areas that provide a route of entry into the body. These include the head, face, hands, feet, open wounds, and areas visibly contaminated. Also pay attention to skin folds and other areas where contamination could be shielded from detection. (Note: Blood, water, and other fluids can shield alpha particles from detection.)

An increase in the instrument chirping and/or the digital readout are indicative of contamination.

Monitoring Essentials (continued)

Background Radiation

Recognize that some background radiation is normal. It's typically less than 0.05 mR/hr, but that can vary with elevation, geology, etc. Knowing the normal background radiation levels in your area can help you quickly determine the likelihood of a problem. If meter readings exceed two or three times the normal background level, suspect that radioactive materials are present and respond accordingly.

Before entering a potential hot zone, you must establish the background radiation level in a nonimpacted area. Subsequent meter readings are evaluated relative to this background level. Decisions are often made based on specific numbers (e.g., establishing an initial perimeter where radiation levels are at or below 2 mR/hr above background). However, it may be appropriate to think in multiples (e.g., to decon people or surfaces if readings exceed two or three times background). Consult with your subject matter experts to develop preestablished action levels.

Potential Terrorist Scenarios

This final section briefly looks at potential terrorist scenarios:

- Using a hoax or threat, with no actual event
- Planting a radioactive source near intended targets
- Disseminating radioactive materials with a spray device
- Contaminating food and water supplies
- Bombing a nuclear facility or transportation vehicle
- Using an improvised nuclear device (IND)
- Using a radiological dispersal device (RDD)—a “dirty bomb” (the most likely scenario)

Keep in mind that most of the radioactive sources a terrorist might gain access to do *not* emit life-endangering amounts of radiation. High-level radioactive sources are too tightly regulated and controlled in many countries to make them easily accessible. That doesn’t mean that terrorists couldn’t obtain high-level sources. However, if terrorists can create almost as much panic with more easily obtainable low-level radioactive materials (and less risk of getting caught), most will take the path of least resistance.

The guidelines provided throughout this chapter and others will help you handle almost *any* incident involving nuclear materials, including the terrorist scenarios that follow. (It’s beyond the scope of this book to address anything on the scale of nuclear weapons from Iran, North Korea, or other nations.)

A Hoax or Threat

So many people are afraid of radiation that a simple hoax might be enough to terrorize a portion of the population. For example, a damaged box with a radiation label left in plain view in a public place could generate significant concern until emergency responders with radiation detectors determined there was no threat. It’s a scenario that’s quickly defused by well-trained responders with the right equipment, yet one that has the potential to disrupt normal operations and raise questions about our ability to protect against real incidents involving radioactive materials.

Likewise, the mere threat of a terrorist attack involving radioactive materials can cause fear and disruption. Responders must be able to quickly determine if the threat is credible, how to protect against it if it is, and how to calm public fears if it isn’t.

Potential Terrorist Scenarios (continued)

Concealed Radioactive Sources Placed Near Intended Targets

Radioactive materials concealed near intended targets could cause victims to develop radiation sickness. The source would irradiate (but not contaminate) exposed persons until the radioactive material was discovered or until the victims developed recognizable symptoms and someone unraveled the mystery of why. It's a scenario that lacks the immediacy and impact associated with the others, but one that might be employed on a small scale by someone intending to hurt specific individuals.

Dissemination by Spray Device

Dissemination of radioactive materials with a spray device is another low-tech method that lacks the immediate, dramatic results some of the other scenarios would produce. However, it contains the frustrating complications of delayed discovery similar to those in a biological agent attack. There's also a much greater danger of secondary contamination as victims unknowingly spread the radioactive materials. Protection from this scenario is highly dependent on vigilance from all citizens. People must be willing to question unusual spraying and to alert authorities. And emergency responders must be able to monitor for radioactive materials and other contaminants.

Contamination of Food and Water Supplies

Contamination of food and water supplies isn't a scenario that most experts talk about. But if a religious cult can contaminate salad bars with Salmonella (Oregon, 1984), why can't someone sprinkle a radioactive dust or powder on foods instead? The relative difficulty of obtaining radioactive materials, combined with the inability to produce immediate, dramatic results, makes the scenario unlikely, but not impossible. Protection from this scenario requires the same kind of vigilance from citizens as does protecting food and water supplies from contamination with chemical and biological warfare agents.

Potential Terrorist Scenarios (continued)

Bombing of Nuclear Facilities / Transporters

A terrorist might use ordinary explosives to damage a nuclear facility or a vehicle transporting nuclear materials. In general, nuclear facilities are at less risk because they store high-level radioactive materials in well-protected, heavily shielded areas. Transportation vehicles are more vulnerable to attack. However, other safeguards are used to protect high-level radioactive materials in transit (e.g., heavy-duty packaging, escorts accompanying the shipment, devices that can immobilize the vehicle in a hijack attempt, and continuous satellite monitoring of the transport vehicle).

Use of an Improvised Nuclear Device

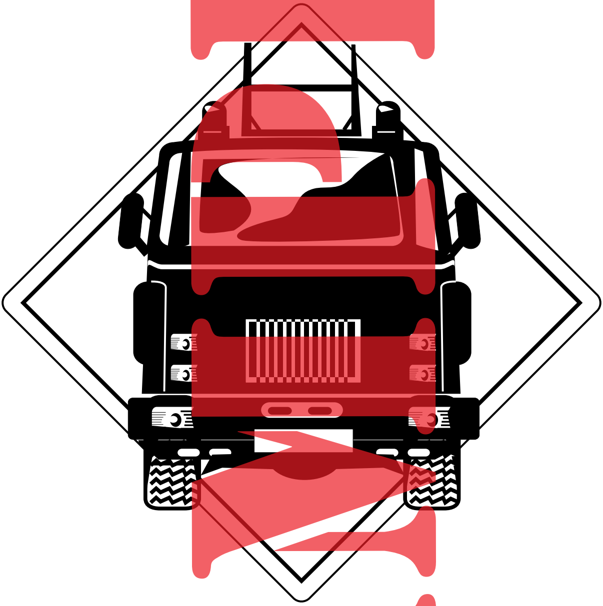
Use of an improvised nuclear device (IND)—be it a nuclear weapon obtained from a nuclear State or a weapon fabricated by terrorists with illegally obtained fissile materials—would cause catastrophic loss of life and spread high levels of contamination over a large area. IND scenarios have long been considered unlikely because of the extreme difficulty of acquiring a functional nuclear weapon. However, the escalation of terrorism worldwide makes it foolish to rule out the possibility. A greater threat, however, is the use of smaller nuclear bombs, such as the suitcase and attaché bombs built years ago and not well accounted for today.

Use of a "Dirty Bomb" or RDD

Use of a radiological dispersal device (RDD)—"dirty bomb"—is the most likely scenario. A conventional explosive device could be used to disseminate common radioactive materials. The greatest risk of injury is from the explosive (from blast pressure, fragmentation, and heat). Some radioactive contamination may be present, but it's unlikely to be at lethal levels. Nonetheless, responders will have their hands full monitoring for contamination, decontaminating victims, and dealing with the inevitable fear and panic.

A dirty bomb is far less powerful than a nuclear weapon. Dispersion of radioactive materials would be limited to a few blocks or a few miles, depending on the size of the bomb, the radioisotope involved, and local conditions, such as weather and topography. And it will most likely involve low-level radioactive sources versus those that emit life-endangering levels of radioactivity.

Tactical Considerations



This chapter provides supplemental information on the use of foam, offensive and defensive options, and technical decon methods.

Defensive Options

First responders must be able to identify available defensive options, proper procedures, equipment needed, and appropriate safety precautions. This chapter provides a brief overview of defensive options. Refer to your department SOPs for more information.

Per NFPA's *Hazardous Materials/Weapons of Mass Destruction Response Handbook*, the options that follow are within the scope of what operations level responders can do *if they are performed in a defensive fashion to contain or confine (not stop) the release*.

Absorption

Absorption is the process of absorbing, or picking up, one substance with another. Using a sponge to clean up a spilled drink is a simple example of absorption. Commercial sorbents, such as pads, pillows, booms, or socks, are designed to be used with hazardous materials. Many granular products, such as sawdust, kitty litter, or vermiculite, can also be used as sorbents. Several factors affect whether absorption is a viable option:

- The sorbent must be compatible with the material being absorbed; otherwise, you can make the problem worse. Using sawdust on an oxidizer, for example, could start a fire.
- Sorbents retain the hazardous properties of the materials they absorb. Thus they're considered hazardous waste and must be disposed of accordingly.
- The larger the spill, the more difficult and expensive absorption becomes. Other options may be more cost-effective. On the other hand, solid waste may be more economical to dispose of than the liquid waste would be.

Adsorption

Adsorption also involves picking up the hazardous material. However, the material is not absorbed into the sorbent. Rather, it adheres to the surface of certain sorbents, such as activated charcoal, silica or aluminum gel, fuller's earth, or other clays.

As with absorption, it's important to use a sorbent that's compatible with the hazardous material. However, *adsorption* has the added risk of being an exothermic reaction, generating enough heat to perhaps cause a fire when used with flammable materials.

Defensive Options (continued)

Dilution

Dilution is the process of adding water to a water-soluble material to reduce the hazard. It is seldom a good option, however. Often it takes such so much water that it creates a runoff problem. It's also vital that dilution *not* be used on water-reactive materials. Doing so could create a very flammable or toxic environment.

Vapor Dispersion

Vapor dispersion involves physically dispersing or moving vapors away from certain areas or materials. It is sometimes done with fans, much the way firefighters use smoke blowers to clear smoke out of a fire building. More often, vapor dispersion is done by using a water spray to create turbulence, increasing the rate at which vapors mix with air and reducing the overall vapor concentration.

Responders need to evaluate three major factors when considering vapor dispersion. First, vapor dispersion can sometimes increase the risks, for example, when vapors are reduced from a concentration that is too rich to burn to one that is within the flammable range. Second, when using water for vapor dispersion, it will be necessary to confine and analyze the runoff for contamination. Contaminated water must be disposed of as hazardous waste. Third, when using fans or blowers, the equipment must be rated for the hazardous atmosphere. For example, the equipment must be intrinsically safe if the atmosphere is flammable.

Vapor Suppression (Blanketing)

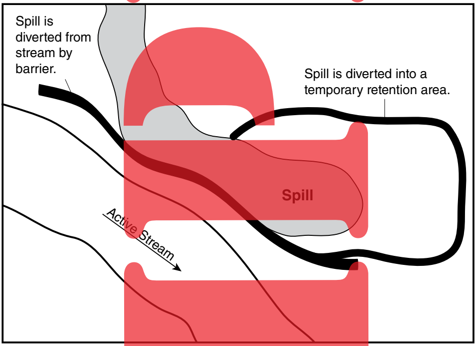
Vapor suppression is done to reduce or eliminate the vapors emanating from a spilled or released material. It is usually done by putting a blanket of foam over the spill. Vapor suppression does not change the hazards (e.g., flammability or toxicity); it merely confines the vapors, thus lowering the risks.

It's important to use foam that is compatible with the hazardous material, to apply the foam gently (e.g., by banking it off an object or by aiming it at the edge of the spill and rolling it onto the material), and to avoid breaking the foam blanket once applied. For more information on foam, refer to pages 12-11 through 12-14.

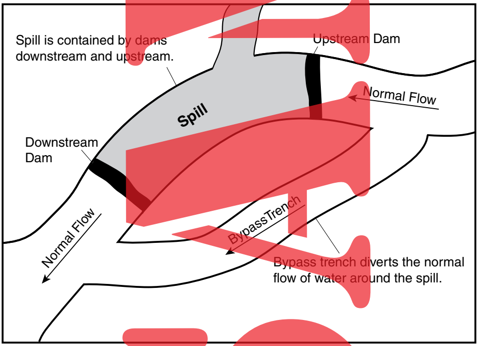
Defensive Options (continued)

Diversion

Diversion is the process of rerouting the flow of a hazardous material to an area where it will do less harm. Covering a storm drain with plastic or diverting a hazardous material around it with dirt or sand are common examples. On a larger scale, it may be necessary to create a barrier to channel a hazardous material away from creeks or waterways or, conversely, to construct a bypass trench to channel the normal flow of water around a spill.



The spill is diverted away from the stream and into a temporary retention area (top view).



The normal flow of water is diverted around a spill (top view).

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Defensive Options (continued)

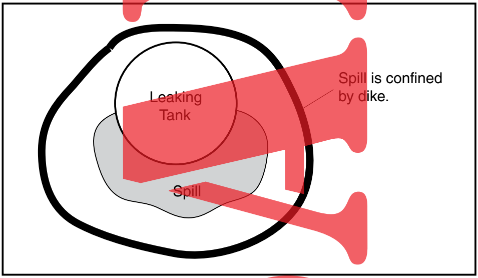
Diversion (continued)

Diversion does not contain a hazardous material; it merely reroutes it. Therefore, it must be done in conjunction with other defensive options. Because diversion puts responders in the path of oncoming hazardous materials, safety is a primary concern. If there's not enough time to safely construct a barrier in the desired location, it may be necessary to sacrifice some intermediate territory and divert the hazardous material at a more distant location.

Diking

Diking also involves using barriers to control the flow of a hazardous material. However, it is different from diversion in that diking is done to confine the material rather than reroute it. Diking can be thought of as a form of secondary containment for a material that has escaped its original container. Dikes are often quickly constructed out of dirt, sand, or other materials found at the scene. Plastic sheets or tarps can be used to help prevent seepage, significantly decreasing the waste disposal costs.

The size of the leak and the degree of hazard presented by the material are important factors in determining how close to construct a dike. If the dike is too close to the source, it may not be sufficient to confine the material and will put responders at greater risk while constructing the dike.



A dike contains the spill from a leaking tank (top view).

Defensive Options (continued)

Retention

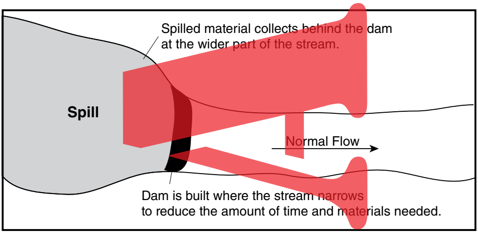
Retention confines a hazardous material by retaining it, often in a bucket, drum, basin, or bladder of some kind. For example, a bucket or drum could be positioned under or next to a leaking container to catch as much material as possible.

Because placing a secondary container next to the source of the leak puts responders in close proximity with the hazardous material, safety is of utmost concern. Retention is not a good option if responders do not have appropriate PPE or if the atmosphere is too dangerous. It's also important to ensure that the bucket, drum, or other container is compatible with the hazardous material.

The top illustration on page 12-5 shows a different form of retention, one where the spill is diverted into a ditch, pit, or other holding area. This may be a viable option if a suitable holding area is available or if responders have time to safely construct one.

Damming

Damming may be used to confine a hazardous material that has spilled into a waterway. It is most effective on slow-moving, narrow waterways. If water is moving quickly, responders will need to construct the dam further downstream just to work safely and to be able to complete the dam before the hazardous material arrives. If the waterway is too wide, the time and materials required to create an effective dam may be prohibitive.



A dam built at the narrow part of a waterway requires less time and materials (top view).

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Defensive Options (continued)

Damming (continued)

Constructing a dam is often time-consuming and labor-intensive, although heavy earth-moving equipment can make the job easier. Other materials can sometimes be used to fortify the dam and reduce the amount of dirt needed. For example, a large log or wood bracing can be used to add strength to the dam, and plastic sheets can be used to prevent erosion or seepage.

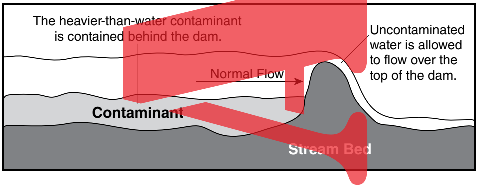
In a large spill, one dam may not be sufficient to contain the entire release. In that case, it may be necessary to build additional dams downstream to catch anything that escapes the first one.

Simple Dams

Water solubility and specific gravity are important properties when determining the right kind of dam to build. If the spilled material is water-soluble, it will be necessary to build a simple dam that contains both the product and the water it contaminates. Water can't be allowed to flow either over or under the dam, because everything is contaminated. Realize that the more water and product you need to contain, the more difficult it's going to be.

Overflow Dams

If the product is not water-soluble and is heavier than water (specific gravity greater than 1), you can build an overflow dam designed to contain the product while allowing uncontaminated water to flow over the top. (Note: Products that are heavier than water are usually toxic. Take appropriate precautions.)



Overflow Dam (side view)

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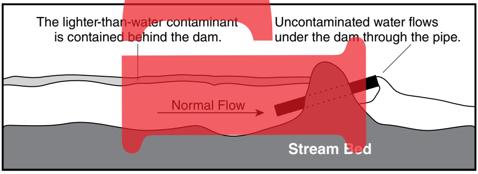
Damming (continued)

Underflow Dams

If the product is not water-soluble and is lighter than water (specific gravity less than 1), you can build an underflow dam designed to contain materials floating on the water while allowing uncontaminated water to flow under the dam through PVC piping. The pipe(s) must be deeper on the upstream side of the dam than on the downstream side. If the pipes aren't deep enough on the upstream side, it can cause a whirlpool that will pull the hazardous material through the pipes.



Underflow Dam (side view)

If PVC piping is not available, it might be possible to use hard suction fire hose instead. A hydrant gate valve can be put on one end of the hard suction hose to control the rate of flow to prevent draining the upstream side of the dam so quickly that the contaminant is pulled through the hose to the downstream side.

Products that are lighter than water are usually flammable or combustible hydrocarbons (fuels). Take appropriate precautions.

Remote Valve Shutoff

Many containment systems are equipped with remote valve shutoffs designed to stop the flow of material in an emergency. For example, most cargo tanks transporting hazardous materials have a manually operated shutoff device located near the front left fender (driver's side). Some have two shutoff devices, one on each side of the trailer. Many of these devices are also equipped with a fusible link that operates automatically in the event of a fire, making it unnecessary for responders to get close.

(continued next page)

Defensive Options (continued)

Remote Valve Shutoff (continued)

At a fixed facility, remote valve shutoffs can be at a different location from the containers, close enough to be easily accessible to workers or emergency responders, but not so close so as to put them in danger. However, it may be necessary to consult with site personnel to determine where these shutoffs are.

Responders should always consult with site personnel before shutting down a system to make sure that doing so won't create problems elsewhere. The same is true when shutting down a pipeline. It's also important to realize that even once a system or pipeline is shut down, there could be sufficient product beyond the control valve to continue leaking or burning for some time.

Foam

The most common use of foam is on fires involving flammable and combustible liquids. Foam works in several ways. It forms a blanket to smother the fire. It suppresses vapors from flammable and combustible liquids, reducing the available fuel. It also serves to cool the fire somewhat. Thus, it impacts all three sides of the fire triangle.

Foam can also be used on hazardous materials spills for vapor suppression under nonfire conditions.

The Limitations and Disadvantages of Foam

Foam is not always safe. It can't be used on water-reactive chemicals or on energized electrical fires. Even when foam is appropriate for the circumstances, if the foam blanket is disturbed by a strong hose stream or by firefighters walking through the foam, the fire can reignite, immediately endangering anyone in the vicinity. It's vital to keep the foam blanket intact at all times and to keep personnel out of the area.

Foam is not always effective. It's designed to be used on horizontal surface fires. It's not capable of blanketing fuels that are flowing vertically, such as burning fuel leaking from an elevated tank. However, some foams can "follow" a flowing fuel fire, even if they can't blanket it. It's also difficult to maintain an unbroken foam blanket over uneven topography.

Firefighting foams are generally effective only on water-immiscible hydrocarbon liquids or polar compounds. They are usually *not* effective on liquefied gases, even hydrocarbon gases like methane or propane. Most are also ineffective against inorganic acids or bases, because the foam bubble walls collapse easily when exposed to a product that's too acidic or alkaline.

Foam is more effective on fuels with lower vapor pressures. The higher the vapor pressure, the more difficult it is for the foam to suppress vapor production.

Environmental and storage conditions, such as temperature extremes, can limit the effectiveness of foam. Refer to the manufacturer's instructions for more information.

Foam (continued)

Types of Foam

There's no one foam that works well for all circumstances. Different types of foam are designed to be used on different types of fuels. Compatibility is an important factor. Obviously, the foam must be compatible with the fuel. However, you may also need to worry about compatibility with other extinguishing agents. Mixing two types of foams, for example, may cause both to become ineffective at extinguishing a fire.

Protein Foam

Protein foam is comprised of natural protein solids that have been broken down chemically. It is strong, elastic, and stable. It has good water retention capabilities and good resistance to heat and burnback. However, protein foam doesn't work well on polar solvents, in extremely cold temperatures, or for subsurface injection. Protein foam is nontoxic and biodegradable after dilution. It is commonly used in concentrations of 3% or 6%.

Fluoroprotein Foam

Fluoroprotein foams are protein foams fortified with fluorinated solvents. Because of its "fuel shedding" ability, fluoroprotein foam can separate from flammable liquids, which makes it more effective under conditions where the foam might become coated with fuel (e.g., after subsurface injection for tank fires or on deep petroleum or hydrocarbon fuel fires). Fluoroprotein foam is resistant to burnback. It is more compatible with dry chemical agents than regular protein foams are. It is nontoxic and biodegradable after dilution. It is commonly used in concentrations of 3% or 6%.

Foam (continued)

Types of Foam (continued)

High-Expansion Foam

High-expansion foam is comprised of synthetic hydrocarbon surfactants. It is designed for use on Class A and Class B fires and works especially well for total flooding of confined spaces. If generated in sufficient volume, it will prevent air from reaching the fire. When heat from the fire converts water in the foam to steam, it has the added benefits of absorbing heat from the burning fuel and displacing oxygen. High-expansion foam has relatively low surface tension, so any foam solution not converted to steam will tend to penetrate Class A materials. When accumulated in depth, high-expansion foam can insulate nearby materials or structures not involved in fire, helping to prevent fire spread.

Aqueous Film-Forming Foam (AFFF)

Aqueous film-forming foam (AFFF) is comprised of synthetically produced materials. AFFF quickly blankets a burning liquid, smothering the fire and retarding vapor production. It forms a self-healing film or aqueous solution between the foam and the surface of the liquid, which enables the foam to reseal open areas caused by agitation of the liquid surface. This characteristic makes AFFF one of the most dependable and versatile foams available.

Although AFFF is used most often on flammable liquid spills to prevent ignition, it can also be used on fires containing both Class A and Class B fuels where deep penetration is needed.

AFFF is compatible with dry chemical. It doesn't need special application devices. It is nontoxic and biodegradable and is available for proportioning to a final concentration of 1%, 3%, and 6% by volume.

AFFF contains glycol ether, which is listed by the EPA as a hazardous air pollutant. Therefore, if used in excess of the reportable quantity, its use will have to be reported to the NRC.

Foam (continued)

Types of Foam (continued)

Alcohol Type Concentrates (ATC)

Alcohol type concentrates were developed for use on water-soluble fuels or on polar solvents, such as alcohols, lacquer thinner, and acetone. A variety of concentrates exist. Some contain a protein or fluoroprotein base. Others contain a base of AFFF concentrate and function similar to AFFF on hydrocarbons. They also produce a floating gel-like mass that allows the foam to build up on water-miscible fuels.

Hazardous Materials Concentrates

Special vapor-mitigating foams have been developed for use on specific types of hazardous materials. One is an alcohol-resistant foam specifically formulated to increase its effectiveness as a foam and increase its stability on toxic, flammable, or corrosive liquids. Others are formulated for use on either acidic or alkaline materials. These foams should be applied only by persons trained in their use.

Class A

Class A foam is designed for both Class A and Class B fires, but it has been used more on Class A or wildland fires than on fires involving flammable liquids. Like other foams, Class A foam is formed as air bubbles surrounded by water. However, unlike other foams, which are formulated to maintain their bubble structure as long as possible, Class A foam is designed to drain the water from its bubble structure to wet the fuels.

Class A foam contains a surfactant to reduce surface tension, allowing better spread and penetration. Its high surface-area-to-mass ratio makes it good at absorbing heat. Meanwhile, the white color reflects radiated heat to keep fuels cooler. Class A foam holds water on vertical surfaces and removes oily substances from fuels, both features that better enable the water to penetrate fuels. Its white color and high visibility helps firefighters identify areas already covered. Five gallons will treat between 500 and 2500 gallons of water, making Class A foam relatively inexpensive.

Offensive Options

According to NFPA's *Hazardous Materials/Weapons of Mass Destruction Response Handbook*, the following tactics are generally considered offensive options *beyond* the scope of operations level responders. However, they're described briefly because incident commanders are expected to understand the purpose and limitations of these options.

Fire Suppression

Fire suppression is generally not within the scope of practice for operations level responders other than firefighters.

When hazardous materials are involved, firefighters must evaluate the situation to determine the best course of action. Sometimes it is best to let the materials burn, for example:

- With flammable liquids, where using water can dramatically spread the product and the fire.
- With water-reactive materials.
- With toxic materials, where fire can destroy the toxic properties and decrease the danger.
- Where flame is impinging on a pressure vessel, posing the risk of a BLEVE.
- With explosives.
- With any incident where the risks outweigh the benefits.

Covering

Covering is physically confining a product, such as by placing a plastic tarp over a dust or powder. Placing a cover or barrier over a radioactive source (usually alpha or beta) to provide additional shielding is another example. So is using an appropriate dry powder extinguishing agent on a combustible metal fire.

Although NFPA's *Hazardous Materials/Weapons of Mass Destruction Response Handbook* groups covering with other offensive actions that are generally beyond the scope of operations level responders, it wouldn't be unreasonable for firefighters in structural firefighting clothing to do any of the examples above *if safe to do so with the particular hazardous material in question*.

Offensive Options (continued)

Dispersion

Dispersion involves using certain chemical or biological agents to break up liquid spills on water. Because this can spread the hazardous material over a larger area and alter the environmental impact, it should be done only with the approval of appropriate environmental protection agencies.

Neutralization

Neutralization is sometimes done with corrosives to change the pH (strength). The pH scale goes from 0 to 14, with 7 being neutral. Materials with a pH from 0 to 6 are acidic. The closer to 0, the stronger the acid. Materials with a pH from 8 to 14 are basic (or caustic). The closer to 14, the stronger the base.

Neutralization, if done correctly, can render a substance safer. However, acids and bases are not compatible with each other, so neutralization can be dangerous. Mixing strong acids and bases can lead to a fire or explosion and severe injury or death. Neutralization should only be done with a *weak* corrosive of the opposite pH.

Neutralization requires expert guidance to ensure the products are compatible and to determine how much of a neutralizing agent is needed to do the job. This may not be a viable option if the amount required exceeds the amount available. Conversely, if too much is used, you could have a larger spill of the opposite pH. Even with the right amount of neutralizing agent, there's more end product requiring proper disposal.

Responders are likely to come in contact with the product during neutralization, so proper PPE is essential.

Offensive Options (continued)

Overpacking

Overpacking is placing the leaking container inside a larger intact container that is compatible with the hazardous material. The leaking container may be plugged or patched first, but it isn't required. The overpack container must then by properly labeled for transport or disposal.

Responders are likely to come in contact with the product, so proper PPE is essential. Responders may need mechanical equipment to help lift the damaged container, depending on how heavy it is. They must also be prepared for the possibility of the weakened container failing further during the process.

Overpacking is usually done for liquids and solids, but it may also be an option for gases. Some industries have special overpack containers, also known as "coffins," designed for gas cylinders. However, given their limited availability and the training required, this option is best suited for events where emergency personnel and industry representatives have preplanned their response.

Plugging and Patching

Plugging and patching can be done individually or together to stop the flow of product from small holes, rips, tears, or gashes. It can be done with commercially available plugs and patches or with plugs and patches improvised on scene.

Plugs or patches must be compatible with the hazardous material and the container. Pressure is another limiting factor; plugs and patches won't stay in place if the container contents are under too much pressure.

Responders are likely to come in contact with the product, so proper PPE is essential. It's not uncommon to encounter problems that make the operation more time-consuming than expected, so it's important to monitor on-air times and plan for additional entries.

Offensive Options (continued)

Pressure Isolation and Reduction

Pressure isolation and reduction differs from the other options in that it deals with intact containers versus breached ones. These are high-risk operations, because responders must work in close proximity to overpressurized containers that could fail with little to no warning. Thermal stress, internal chemical reactions, and overfilling are examples of things that can cause overpressurization.

Several tactics come under the heading of pressure isolation and reduction:

- **Isolating valves**. This involves closing valves upstream from containers filled through pipes.
- **Isolating pumps or energy sources**. If a pressurized vessel is filled by a pump or compressor, shutting the system down or lowering the pressure can reduce the danger. On the other hand, it can greatly *increase* the danger by overpressurizing other vessels, activating or disabling critical safety systems, or triggering other events in a processing operation. This option should only be done by specialists familiar with the system.
- **Venting**. Venting is the controlled release of a product to reduce container pressure. The hazards of the material will dictate whether it can be vented to the atmosphere or must be recaptured somehow.
- **Flaring**. Flaring is the controlled burning of a liquid or gas to reduce container pressure. Flaring may be incorporated into a fixed safety system, for example, at refineries. It can also be done in the field with the right equipment.
- **Hot tapping**. Hot tapping is done to remove product from the container. But unlike other transfer operations, hot tapping involves drilling into the product space, requiring highly specialized equipment designed to prevent the product from escaping during the drilling process.
- **Venting and burning**. Venting and burning is a highly specialized operation that involves using shaped explosive charges to puncture a pressurized tank car to release the contents into a pit for burning. It should be considered as a last resort only when doing nothing (nonintervention) would make matters worse and no other option is viable.

Offensive Options (continued)

Solidification

Solidification involves chemically treating a liquid to turn it into a solid for ease of disposal. For example, some corrosives can be treated with commercial formulations that will turn them into a neutral salt. Adsorption is another example of solidification.

Although the resulting solid is easier to manage than a liquid, it can retain many of the hazardous properties of the original material. Chemical incompatibility is another concern. Therefore, solidification should only be considered on the advice of experts who know what works and understand the risks.

Transfer

A product can sometimes be transferred from one container to another, a common example being gasoline offloaded from an overturned tanker to a new tanker. This makes it possible to salvage the remaining product while reducing the size of the release. With overturned gasoline tankers, offloading is often necessary because the aluminum tanks might otherwise fail under the weight of the remaining gasoline when the tanker is uprighted.

It's vital that product be transferred to a compatible container. Because responders are likely to come in contact with the product, proper PPE is essential. Sometimes special precautions are required, such as bonding and grounding when dealing with flammable liquids. The hazards must be carefully weighed before selecting this option, and proper safety precautions must be in place.

Vacuuming

Some materials can be collected with special vacuums. Vacuums equipped with high efficiency particular air (HEPA) filters will prevent small fibers, dusts, powders, and particulates from being released back into the air. Other vacuums are designed to pick up mercury without releasing mercury vapors. Vacuuming may not be a viable option unless the equipment is rated for the hazards (e.g., flammable or corrosive) of the material.

Technical Decon Methods

Throughout most of this book, the term *decon* (decontamination) has meant flushing with water or soap and water. However, technical decon may include other methods. Some of these will require the expertise of a hazmat team, but first responders should be aware that these options exist.

(NFPA 472 uses the term *technical decon* to denote the planned and systemic process of reducing contamination to a level that is as low as reasonably achievable. It's more extensive than gross decon. The term *technical decon* is used most often when referring to responders and their equipment, but it can include more thorough patient decon.)

Absorption and Adsorption

Absorption and adsorption are more commonly used as defensive control options, so they are described on page 12-3. They work by picking up the material, much the way a sponge does. (Adsorption is generally not considered appropriate for patient decon.) Sorbents must be disposed of properly.

Chemical Degradation

Chemical degradation involves using one material to change the chemical structure of another and render it safer. Disinfecting with bleach is one example. Neutralizing a corrosive is another. However, chemical degradation encompasses more options. Chemical degradation is not appropriate for patient decon.

Because of concerns with chemical incompatibility, chemical degradation should only be considered on the advice of experts who know what works and understand the risks.

Dilution

Dilution (flushing with water) is the most common decon method. Water is usually plentiful and easily accessible. It's economical in comparison to other decon solutions. However, containing and disposing of contaminated runoff is a concern. And when water-reactive chemicals are involved, water can make the situation worse.

Technical Decon Methods (continued)

Disinfection

Disinfection involves applying chemical or antiseptic products to kill microorganisms. Using bleach to kill bloodborne pathogens is a common example.

Although bleach can sometimes be used for patient decon, many medical experts strongly recommend using plain water or soap and water instead. See page 6-13 for more information.

Evaporation

The higher a material's vapor pressure, the more quickly it will evaporate. Evaporation isn't an appropriate strategy for patient decon or for decontaminating responders with a limited air supply. However, time permitting, it can be a viable option for equipment decon. Evaporation as a decon method is less effective on porous materials than on nonporous materials.

Isolation and Disposal

Equipment that can't be effectively decontaminated must be disposed of instead. Anything that must be disposed of should be considered hazardous waste unless proven otherwise. Hazardous waste must be disposed of in accordance with all applicable federal, state, and local laws. Disposal generally must be done by a licensed waste hauler.

Removing a patient's contaminated clothing and placing it in a plastic bag is another example of isolating a contaminant.

Neutralization

Neutralization is described under "Offensive Options" on page 12-16. Neutralization is not appropriate for patient decon.

Solidification

Solidification is described under "Offensive Options" on page 12-19. Solidification is not appropriate for patient decon.

Technical Decon Methods (continued)

Sterilization

In a healthcare setting, equipment is often sterilized by formalin (formaldehyde), ethylene oxide, or steam. Other chemicals, heat, and radiation can also be used for sterilization, depending on the microorganism and equipment involved. Sterilization is not done at a hazmat scene, but it may be necessary as a follow-up to other forms of decon.

Vacuuming

Vacuuming is described under "Offensive Options" on page 12-19.

Washing

Washing is similar to dilution, except that it involves using soap, detergents, or other solutions to increase the effectiveness of water. As with dilution, it's necessary to contain the runoff.

Additional Considerations

This chapter contains miscellaneous other information that may be useful at a hazmat incident or terrorist event:

- Dealing with the Media
- Negligence and Liability
- Guidelines to Minimize Liability
- Pre-Event and Event-Specific Planning
- Evacuation / Shelter Concerns
- Protective Action Messages
- Preservation of Evidence
- Dealing with Children

Dealing with the Media

The media can either help you or hinder you at an emergency. The key to success is knowing how to work with the media ... even when you don't think the media is there. Remember, the media is only as far as the nearest cell phone camera. And anything you do or say can go viral very quickly.

The Rights of the Media

In general, you can deny access to the media only at a legitimate crime scene, at an incident on private property, or when they are interfering with operations and creating a life safety hazard. However, you need to be familiar with your state and local laws.

Working Successfully with the Media

The following are general guidelines for working successfully with the media. Refer to your SOPs for specific information.

- Develop good working relationships with local media personnel ahead of time. Involve them in drills and pre-incident planning.
- Assign a public information officer (PIO or IO) who has training and experience in public information and media relations. (The PIO/IO reports to the incident commander.)
- Establish a joint information center (JIC), if appropriate, so that multiple agencies have a centralized communication hub where they can "speak with one voice" and function more efficiently. (The JIC is led by the information officer.)
- Warn media personnel of the hazards, and provide them with specific safety guidelines. Remember that they are generally not trained in hazardous materials or emergency response.
- Direct the media to a safe location where they can get good photos. Provide an escort if appropriate.
- Provide the media with accurate and updated information. Schedule media briefings at appropriate time intervals.
- Use the media to help warn and inform the public. They have the ability to reach a large audience very quickly.

The Emergency Alert System

The Emergency Alert System is a good tool for warning the public and providing emergency instructions. Your department SOPs should include provisions for using this system.

Dealing with the Media (continued)

Interviewing Dos and Don'ts

The image presented by the media often shapes public perception of you, your agency, and your response efforts. And for many people, perception is reality. Use media interviews as an opportunity to market your agency in a favorable way and to educate the public. The following are some basic guidelines for how to respond to an interview with the media.

Do

- Ask the reporter's name, and use it when talking to him or her.
- Be sensitive to media deadlines.
- Treat all reporters equally. Don't play favorites.
- Chose the site of the interview if possible. Find a safe location where the media can get good pictures, but make sure the pictures they get will show emergency personnel operating safely and correctly.
- Ensure that information has been approved by the incident commander before releasing it to the media.
- Anticipate likely questions and have good answers ready. Media personnel may even tell you what questions they want to ask before the interview so you can better prepare.
- Speak clearly and concisely. Think in terms of good, short sound bites that the media can use to grab audience attention.
- Look at and talk to reporters, not the camera.
- Tell the truth. Even when you can't discuss something, don't lie about it.
- Provide facts, not opinions.
- Be cooperative. Answer questions honestly. If you don't know the answer, say so. If you can find the answer, do so and get back to the media.
- Be assertive. Get bad news out on your terms.
- Be professional.
- Use technical experts if questions are outside your area of expertise.
- Use visual aids if appropriate, particularly when trying to describe something the public may not be familiar with.
- Be patient. Expect that the media may ask some uncomfortable questions. Know how to respond diplomatically.
- Ask for clarification if you don't understand a question.

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Interviewing Dos and Don'ts (continued)

Do (continued)

- Clear up misunderstandings and misinformation as soon as possible, before it adds to the problem.
- Diffuse negative questions quickly and positively by giving a short, honest reply that allows you to transition to the message you want people to hear.
- Repeat important information, especially safety messages.
- Avoid distracting mechanisms.
- Give credit to cooperating agencies.
- Consider establishing a joint information center (JIC) for large incidents.
  - Have a public information officer oversee the activities.
  - Make personnel available to meet the varying needs and time lines of different media (TV, radio, newspaper, etc.).
  - Request assistance from other agencies' public information officers as needed.
  - Work with all agencies to present a united message.

Don't

- Don't try to talk to the media and command an incident at the same time. You can't do both effectively. Keep the functions of incident commander and public information officer separate.
- Don't lie, bluff, or be evasive. Don't say "No comment." Even if you can't discuss something, you don't want to lose credibility or public trust. That can ultimately cause you more harm.
- Don't be defensive or confrontational. A bad attitude can also cause you to lose credibility and public trust.
- Don't try to deny the obvious or minimize something serious.
- Don't place blame.
- Don't release information that hasn't been approved by the incident commander, confidential information (e.g., patient names), or information that would jeopardize a follow-up investigation.
- Don't go "off the record." Anything you say can and will be used against you. Always assume that someone is recording you.
- Don't promise results you can't deliver.
- Don't speculate or fuel rumors. Stick to the facts.
- Don't use jargon that the public won't be familiar with.
- Don't smoke. It looks unprofessional.
- Don't wear sunglasses. Let people see your eyes.

Negligence and Liability

Response agencies and individual responders can be held civilly or criminally liable for what they do (or don't do) at an emergency scene.

Limited Immunities for Emergency Responders

Emergency responders generally have qualified immunity from liability as long as they are working within the scope of employment and any act or omission was performed in good faith and without gross negligence. However, state laws vary. Consult your department SOPs or legal counsel for more information.

Negligence

Negligence is the failure to exercise prudent judgment in carrying out an action where injury or damage may result. *Gross negligence* occurs when a person acts in an outrageous manner, whether or not he or she was working within the scope of employment. All four of the following must be shown in order to prove negligence:

- The defendant had a duty to act
- The defendant failed to act or failed to conform to the standard of care (which may be higher than minimum legal requirements)
- There was an actual loss or damage
- The defendant's action or lack of action caused or contributed to the loss or damage

Negligence can also be applied to actions taken prior to an emergency. For example, an agency can be liable for negligence in hiring, retaining, training, supervising, or assigning an employee.

Other Liability Concerns

- Employers (both the agency and individual supervisors) are responsible for the actions of their employees while they are working within the scope of employment.
- Employees can be personally sued if acting beyond the scope of employment.
- Multiple parties can sometimes be held liable for damages. In some states, if one or more parties are unable to pay, that portion may be spread out among the remaining defendants.

Guidelines to Minimize Liability

The following are some basic guidelines to minimize liability.

Compliance with State and Federal Laws

Various state and federal laws require that communities have plans in place to deal with hazmat/WMD incidents. Some laws apply to facilities that use, store, manufacture, or transport hazardous materials. Others apply to emergency responders.

You can reduce your risk of liability by ensuring that your department is in compliance with applicable state and federal requirements. Among other things, this means having a disaster plan in place, exercising the plan on a regular basis, updating the plan as needed, and following the plan during an emergency.

Other Guidelines

- Know what chemicals can be found in your community. Plan and train to deal with these materials.
- Perform safely and competently within the limits of your training, resources, and capabilities. Stay within the scope of your employment.
- Manage the event using the Incident Command System (ICS) defined in the National Incident Management System (NIMS).
- Follow department SOPs.
- Have a plan in place before taking action. An incident action plan at the first responder level might not have to be as complex as one required for a full-scale incident managed by a trained hazmat team. A simple checklist might be enough if it covers all the key points. Refer to your department SOPs.
- Make sure that all actions fall within the scope of what any reasonable and prudent person would do given the same circumstances and the same level of training.
- Document all response activities. Make sure documentation is thorough and professional. Keep in mind that anything you put in writing may later be used as evidence in court.
- Be sure your documentation is clear, accurate, and specific. Documentation that is sloppy in any way (including grammar, punctuation, and spelling) can hurt your credibility and have negative consequences for you, your agency, and others.
- Make a diligent effort to obtain hazmat/WMD training and to train and practice on a regular basis to ensure competency.

Pre-Event and Event-Specific Planning

Planning is essential for a successful outcome at a hazmat or WMD incident. In fact, it is required by law.

The goal of any plan is to protect life, the environment, and property by identifying the problem and available resources, then making the best use of available resources to minimize the problem. There are two types of plans: pre-event and event-specific.

Pre-Event Plans

Pre-event plans (or contingency plans) are one of the best tools that any community has for responding to a hazmat or WMD incident. Essential components of a good plan include:

- Realistic and specific threat summaries (problem identification and hazard assessment)
- Safety guidelines and procedures
- Clearly defined emergency roles and responsibilities
- Complete list of all local resources, including mutual aid
- One operational and flexible emergency response organization utilizing the Incident Command System (ICS) as defined by the National Incident Management System (NIMS)
- Clear provisions for activating, staffing, and operating the incident command post or emergency operations center (EOC)
- User-friendly operational checklists

These plans should be developed jointly by all agencies that will participate in a hazmat or WMD response. Plans created specifically for private industry should be developed as a cooperative effort between site personnel and the appropriate response agencies. Contingency plans should be exercised, reviewed, and updated on a regular basis to ensure an efficient, effective, and safe response.

Drills and exercises are an important component of the planning process. This is where you find out what really works and what doesn't and where you need to make adjustments to your plan. Other resources, such as CHEMTREC, are often available to participate in local drills and exercises, which adds value and realism to the process.

Pre-Event and Event-Specific Planning (continued)

Event-Specific Plans (Incident Action Plans)

No matter how much pre-event planning you do, many variables can affect the way an incident unfolds. Therefore, the incident commander must develop an incident action plan that is based on the specific event; consistent with SOPs and the local emergency response plan; and within the capability of available personnel, resources, and equipment. The incident action plan must be reviewed for all personnel during a safety briefing held prior to undertaking any operations.

Components of an Incident Action Plan (IAP)

An incident action plan describes the response objectives and the resources required to achieve those objectives. The planning process can be simplified by referencing department SOPs and making modifications as needed. The depth of the plan will vary, depending on the scope of the incident, but a comprehensive incident action plan should include:

- Site map or sketch identifying the location of the release, control zones, command post, decon areas, medical and triage areas, safe access routes, and places of refuge
- Response objectives (including contingency plans)
- Options and resources needed to achieve the objectives
- Personnel roles and lines of authority (e.g., an ICS org chart)
- Site security and access control measures
- Hazard evaluation
- Personal protective equipment
- Work assignments and personnel accountability
- Communications procedures
- Decontamination procedures
- Scene safety and health (designation of a safety officer, environmental and personnel monitoring plans, rehab plans, etc.)
- Emergency procedures (evacuation, medical, etc.)
- Evidence preservation and collection procedures
- Follow-up debriefing and critique

Incident action plans should be in writing whenever possible. Other documents that may be attached include documentation on the material(s) involved and medical monitoring records for all personnel working in chemical protective clothing.

Evacuation / Shelter Concerns

Hurricane Katrina threw a spotlight on problems associated with large-scale evacuations. However, even a relatively small incident will have similar concerns.

Evacuations

There are no easy answers regarding the legality of declaring a mandatory evacuation, how to enforce it if you do, and the consequences that may arise one way or another. However, the Katrina experience illustrated how failure to declare a mandatory evacuation (or to declare it early enough) can result in needless deaths and suffering, extraordinary risks for rescue personnel, and a breakdown of the overall response system when responders confronted by the urgency of rescue must divert attention and resources from other priorities.

Each agency or jurisdiction must determine ahead of time how to handle these situations. However, declaring the evacuation mandatory rather than voluntary delivers a more powerful statement and conveys a higher level of urgency. It implies that people don't have a choice and that the government won't be able to protect them and provide relief if they remain.

Responders who are reluctant to force people from their homes sometimes use the tactic of asking for next-of-kin information should citizens not survive. The question often has sufficient shock value to make people evacuate when they wouldn't otherwise.

The following are some other guidelines for planning and implementing emergency evacuations:

- Be clear and consistent with evacuation messages. People may be reluctant to evacuate if they get conflicting information or don't get information from someone they trust. Be specific about the threat, and use multiple means to get the message out.
- Make sure evacuation plans include realistic contingencies for special needs populations, including those who are elderly, mentally or physically handicapped, hospitalized, or incarcerated. To the extent practicable, try to identify these special needs populations beforehand. However, expect that some won't self-identify before a disaster, and plan accordingly.

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Evacuation / Shelter Concerns (continued)

Evacuations (continued)

- Coordinate with medical facilities to ensure that nonambulatory patients can be evacuated with vehicles that can accommodate wheelchairs, stretchers, and life-support equipment.
- Expect that some people lack the resources (e.g., vehicles and fuel) to evacuate on their own, and plan accordingly.
- Include plans for evacuating and sheltering pets. Some pet owners will refuse to evacuate if it means leaving pets behind.
- Use staged evacuations (e.g., starting with those closest to the problem) as needed to minimize traffic jams. (This same concept applies within large buildings.)
- Implement "contraflow" plans (e.g., redirecting traffic so all highway lanes lead outbound) as appropriate. Recognize, however, that this may hamper other incoming emergency responders, including those arriving in their private vehicles without the benefit of lights and sirens. You may need to provide a route of travel for incoming responders. (This same concept applies inside buildings, where emergency responders may need to use the same stairwells that other people are using to evacuate.)
- Have law enforcement personnel work major intersections to keep traffic flowing.
- Have public works crews reprogram traffic lights if needed.
- Stage fuel trucks along evacuation routes.
- If you plan to use buses for evacuation, mobilize drivers early and stage buses in safe locations.

Emergency Shelters

- When identifying emergency shelters, establish alternate locations in case primary shelters become unsafe. (Disaster relief agencies generally won't operate shelters in a danger zone.)
- Have contingency plans for staffing and supplying impromptu shelters. Evacuees tend to go to the most convenient and familiar shelters they can find, even though the shelters might not be adequate. Good evacuation instructions can alleviate this, but it may not prevent people from opening impromptu shelters out of necessity.
- Make sure that people who have been rescued are brought to safe shelters rather than left somewhere that may become unsafe or that lacks sufficient food, water, etc.

(continued next page)

Evacuation / Shelter Concerns (continued)

Emergency Shelters (continued)

- Make sure evacuees are provided with food, water, proper medical care, functioning toilets (if possible), and a sense of safety as soon as possible. When these basic needs are met, it's much easier to maintain a calm atmosphere.
- Don't depend solely on relief agencies or MREs for feeding evacuees. Establish partnerships with grocery stores, restaurants, and other resources that may be able to provide food and water much sooner.
- Designate a safety officer for each emergency shelter.
- Keep track of people entering and leaving the shelter. Tracking evacuees is critical for reuniting families, ensuring people receive needed medical care, and obtaining adequate resources (people and supplies) to care for evacuees.

Protective Action Messages

Your department SOPs should contain guidelines for developing evacuation and in-place protection instructions. However, the following pages provide a basic template you can use in the absence of such guidelines. You might need to develop protective action messages in several different languages. You might also need alternate means of warning hearing-impaired or other special-risk individuals.

General Announcement

Make a general announcement to the public, identifying all of the key points listed below. Use this general announcement in conjunction with the appropriate portions of the evacuation or in-place protection instructions on the following pages.

1. Identify yourself by rank/title and name.
2. Identify your agency or department.
3. Describe the incident by size/intensity, type, and location.
4. Advise the public that there is potential danger to life and health.
5. Indicate what type of protective action is needed: evacuation (mandatory or voluntary) or in-place protection.
6. Indicate the scope of the area affected (number of blocks, miles, or feet from the incident).
7. Provide a specific description of the areas involved (e.g., east of Winchester Avenue, north of Highway 85).
8. Advise the public of safe evacuation centers or locations.
9. Let the public know where they can get more information (appropriate phone numbers, television or radio stations, web sites, etc.) and how often they can expect updates.

If it's possible that anyone was exposed to or contaminated by the material, identify the following:

1. Type of hazard(s)
2. Symptoms
3. What to do if symptoms persist
4. Whom to notify (name, phone, etc.)

Protective Action Messages (continued)

Evacuation Instructions

1. Stay calm.
2. Gather your family, and take a neighbor or someone else who needs help.
3. *Mandatory evacuation:* Take critical items (medicine, purse, wallet, keys) only if they are immediately available.

   Precautionary evacuation: Take essential items (diapers, baby food, clothes, money). Leave a message in a prominent location (or use social networking tools) to let family and friends know where you are.
4. Turn off all appliances (stove, lights, heaters, etc.).
5. Tie a white towel or pillowcase to the front doorknob or railing to let responders know you have evacuated.
6. Lock your house.
7. Do not use more cars than you have to.
8. Keep windows and vents in the car closed.
9. Go immediately to the home of a friend or relative outside the evacuation area or to a shelter or staging area located at: ____
10. Officers will be stationed at intersections along the way to direct you.
11. If you need transportation, call: ____________________
12. Children at the following schools: ____________________

    ____

    will be evacuated to: ____________________________

    ____
13. Do not drive to your child's school. Pick your child up from the authorities at the shelter.
14. The hazardous material is toxic. Signs and symptoms of overexposure are: ______________________________

    ____
15. If you have any of these signs or symptoms, seek medical help at: ____________________________________
16. Use telephones only if you need emergency service.
17. Other: ____

Protective Action Messages (continued)

In-Place Protection Instructions

1. Get inside your home or other building as quickly as possible.
2. Close all doors, windows, fireplaces, vents, or other openings. Use duct tape, foil, or plastic wrap to seal leaks.
3. Turn off all heating, ventilation, and air conditioning systems. Close vents.
4. Close drapes, curtains, and shades. Stay away from external windows.
5. Use stairwells whenever possible. Limit use of elevators.
6. Use telephones only if you need emergency service.
7. Turn on the radio or television for information, or go to a reliable web site. Tune in to the Emergency Alert System.
8. Stay inside until the authorities announce that it is safe to come out.

Post-Incident Instructions

You might also need to provide people with instructions about what to do after the incident. It might be advisable to change filters on heating, ventilation, and air conditioning (HVAC) equipment; clean exposed surfaces; or discard food that was left out. Contact your local or state health department for assistance.

Use your agency's web site as a resource for providing information to the public or for pointing the public to other web sites where they can get reliable information.

Preservation of Evidence

Preservation of evidence is important at any hazmat incident or terrorist event. It helps in determining the nature of the incident (e.g., what materials were present and what caused the release), developing safeguards to prevent future problems, identifying negligent or guilty parties, and prosecuting a case in court.

Observing for Things of Evidentiary Value

Recognizing that something might have evidentiary value is a critical first step in the preservation of evidence.

- Be alert for evidence *throughout* the area, not just at the seat of the release or point of origin.
- Don't overlook trash cans and Dumpsters. Perpetrators sometimes leave evidence in nearby trash containers, perhaps hiding the evidence in soiled diapers, sanitary napkins, used food wrappers, or other "disguises" that most people wouldn't search.
- Take note of anything suspicious, even if it seems not to be directly related to the incident. Sometimes the most important clues are those that seem unrelated.

Things worth observing include, but are not limited to:

- The presence, location, and condition of victims
- Comments by victims and witnesses
- Suspicious people, behavior, or activity
- People or vehicles leaving the scene
- Unusual odors, vapors, chemicals, sounds, smoke, or flames
- Unexplained or suspicious containers
- Labels, placards, or other hazmat marking systems
- Condition of a structure (lights on or off, doors locked or unlocked, fire protection systems working or not, etc.)
- Blocked driveways, exits, emergency equipment, etc.
- Booby traps
- Illicit drugs or weapons
- Broken glass or metal fragments
- Unusual debris, trash, or electrical components
- Discolored leaves or other materials
- Dead insects, birds, or animals
- Forensic evidence that might help identify a perpetrator (e.g., fingerprints, footprints, blood, hairs, fibers, cigarette butts)
- Tire tracks
- Anything that appears to be *missing* from the scene

Preservation of Evidence (continued)

Protecting Evidence

Protect evidence as much as possible to the extent that it does not hamper emergency operations.

- Identify locations and items of potential evidentiary value. In addition to things listed on the previous page, consider discarded PPE and other items that may have picked up evidence transfer during response activities. Remember, the most important evidence is sometimes found where least expected.
- Secure and isolate any areas where evidence is located. Minimize the number of people allowed into the area.
- Secure and isolate any apparent source location (e.g., blast area or spill release point).
- Touch as little as possible. Do not disturb the scene more than is necessary to ensure your safety, treat the injured, and protect the evidence from being damaged or destroyed.
- Leave fatalities and body parts where they are unless necessary to protect them from further damage.
- If you must disturb evidence, pay close attention to what you see and do. Document your activities afterwards so the scene can be reconstructed.
- Flag evidence items with cones or markers.
- When cutting through clothing to treat injured patients, avoid cutting through potential evidence (e.g., holes made by bomb fragments).
- To the extent possible, protect evidence in patients' wounds.
- Use care when decontaminating evidence. Because standard decon methods can destroy some evidence, such as fingerprints, it may be necessary to securely package and label contaminated items for further processing. Coordinate with law enforcement to ensure the safety of those who will process the evidence later.
- Secure and isolate exposed food in the area. Contaminated food products can be a good source of evidence in the event of a chemical or biological incident.
- Identify transient evidence early so it can be photographed, documented, and sampled, as appropriate, before it's lost.
- Place light-colored tarps on the ground in areas where evidence transfer is likely (e.g., access and exit corridors, tool drop stations, decon corridors, treatment areas, and rehab areas). The tarps provide a secondary means to collect evidence.

(continued next page)

Preservation of Evidence (continued)

Protecting Evidence (continued)

Protecting evidence includes protecting its *integrity*—protecting the evidentiary value. Failure to follow proper procedures can result in evidence being ruled inadmissible in court.

- Work under the direction of trained crime scene investigators who can ensure proper procedures are followed.
- Obtain a search warrant if appropriate.
- Keep out unauthorized personnel.
- Keep a record of who enters and leaves the scene.
- Coordinate with other key players (e.g., law enforcement agencies having jurisdiction, laboratory analysts, medical examiner, prosecuting attorneys) to ensure their requirements are met.
- Protect evidence from becoming contaminated.
- Use gloves to prevent transferring your fingerprints and body oils to the evidence.
- Use proper evidence collection containers. Evidence can dry out, spoil, or otherwise be destroyed if not packaged properly. Requirements vary depending on the type of evidence.
- Maintain an unbroken chain of custody.
- Release a potential crime scene only when all personnel are satisfied that the scene was thoroughly searched.

Preservation of Evidence (continued)

Documenting Evidence

Good documentation is essential.

- Begin documenting the incident as soon as possible, even if you only have time for rough notes. Don't rely on memory alone.
- Concentrate first on documenting things that may be moved (e.g., patients) or that could be lost or destroyed (e.g., evaporating liquids or tire tracks in melting snow).
- Use multiple forms of documentation (written notes, voice recordings, photos, video tape, etc.) as appropriate.
- If possible, take photographs before moving anything. Take closeups of the evidence itself, preferably with a scale to show size. Take additional photos to show the location of the evidence in relation to the rest of the scene.
- Photograph all stages of the investigation.
- Create a log of all photos taken.
- Take measurements and make sketches as a backup to your photographs.
- When documenting the location of evidence, measure distances to stationary landmarks, such as walls or doors.
- Compile a thorough evidence log, complete with information about chain of custody.
- If possible, obtain photographs, blueprints, maps, or other documentation that can help you evaluate conditions prior to the incident.
- Be sure your documentation is clear, accurate, and specific. Documentation that is sloppy in any way (including grammar, punctuation, and spelling) can hurt your credibility and have negative consequences for you, your agency, and others.

Preservation of Evidence (continued)

Collecting Evidence

Ideally, evidence collection should be done by people who have received special training. Evidence can easily be contaminated or rendered inadmissible in court if not handled properly. There are different requirements for handling and packaging different types of evidence. It's beyond the scope of this book to go into depth on evidence collection, but the following are some basic guidelines that apply in almost every situation.

- Wear appropriate PPE to prevent exposure.
- Use an organized search pattern to ensure nothing is missed. Be sure to check potential hiding places and areas that are difficult to access.
- Have at least two people working as a team. This makes the process easier and allows each person to serve as witness to the evidence collection process. A three-person team may be better if there's enough room to work: one person to collect the evidence, one to do the documentation, and one to act as a safety monitor and lend a hand if needed.
- Collect small samples, particularly with hazardous materials. Collect enough to be useful for laboratory analysis, evidence in court, etc., but not so much that it creates a hazard for others who handle the samples later.
- Field screen samples, as appropriate, with nondestructive testing to identify specific hazards before sending samples to a laboratory. Properly package and label evidence based on identified hazards to protect laboratory personnel.
- Collect control samples when applicable (e.g., uncontaminated debris to compare against the sample in question).
- Package each item separately.
- Use clean containers for everything you collect, and make sure the type of container (e.g., glass, metal, plastic) you use is appropriate for the type of evidence you put in it.
- If evidence containers are breakable (e.g., glass), package them carefully to protect against breakage.
- Tag each item of evidence with the date, your name or initials, and a number that corresponds to your evidence log.
- Maintain an unbroken chain of custody.
- Prevent secondary contamination. Decon evidence containers and sampling equipment as needed. Decon or dispose of your protective clothing. Thoroughly wash your hands after collecting or handling samples.

Dealing with Children

It is often necessary to modify our approach when dealing with children involved in a hazmat incident or terrorist event, particularly when children are separated from their parents. These pages provide some basic guidelines that responders can modify or supplement based on their own experience with children.

Differences in Vulnerability

Children are generally more vulnerable to injury (physical and psychological) than adults are for a number of reasons:

- Young children, in particular, do not have the cognitive ability to comprehend the dangers and choose the appropriate response.
- Young children, in particular, do not have the motor skills needed to escape the danger.
- The exposure potential is greater with children than with adults because:
  - Children breathe faster than adults.
  - A child's skin surface area relative to body weight is greater than an adult's.
  - A child's skin is more permeable than an adult's.
  - Children are more likely to have scrapes, wounds, or other openings in the skin through which contaminants may enter.
  - Children are shorter than adults, so they're more likely to inhale materials that are heavier than air.
- Children are less tolerant of dehydration, a risk with any substance that causes diarrhea and/or vomiting.
- Side effects of vaccines and medications may be more severe in children.
- A child's immune system is less developed than an adult's.
- Children are often more frightened by these events than adults are and often lack the reasoning and coping skills to deal with their fears. (Conversely, some children handle these events much better than adults do either because they don't understand everything enough to be scared or because disaster training they receive in school makes them better prepared than their parents are.)

Dealing with Children (continued)

Strategies for Dealing with Children

- Remain calm. If the adults around them display fear, anxiety, or anger, children will be more afraid.
- Try to reunite children with their families.
- Be honest. Explain the basic facts in simple, age-appropriate language. It's not necessary to provide a lot of detail.
- Avoid making promises you can't keep. Use neutral statements instead. (Example: "We're doing everything we can to help your mommy" versus "Everything will be okay.")
- Address their fears, being careful not to minimize or invalidate their feelings in trying to reassure them.
  - Talking about their fears is often healthy for children, whereas keeping their fears bottled up can make the event seem more threatening.
  - Younger children who don't have the language skills may do better if encouraged to draw pictures describing their fears.
  - Older children may not want to talk about it. Don't force them, but keep the invitation open and let them talk when they're ready.
  - A child's fear is not just about the event. It's about being killed or injured, losing a parent, being left alone, etc. It's important to understand their underlying fears.
- Know that it's okay to admit you're afraid too if done in a way that doesn't add to their anxiety.
- Be willing to admit when you've made a mistake.
- Reassure children that people are working to keep them safe.
- Adjust medical and other procedures as appropriate for the age or size of the children.
- Explain what children can expect to happen to them (decon, medical care, etc.) and how they can help.
- Let children participate to the extent it's appropriate. Even little chores can help them develop a sense of regaining control and normalcy in their lives.
- Shelter children from images (e.g., injured persons, disturbing television broadcasts) that might add to their anxiety.
- Be careful what you say. The humor responders often use to cope with tragedy is not appropriate around children.
- Particularly for younger children, provide comfort items (e.g., a teddy bear or blanket) that they can hold on to.
- Seek assistance from trained counselors, mental health professionals, or teachers.

Resources for Information or Assistance

This chapter contains a brief overview of some of the resources that may be available to provide information or assistance during a hazardous materials incident or terrorist event.

Many of the agencies listed will provide technical assistance and/or facilitate dispatch of emergency response personnel. Some notifications may be required depending on the material involved, the population or environment threatened, or the state in which the incident occurred. National phone numbers have been included in this chapter. However, you will need to fill in the appropriate phone numbers for your state or local agencies. You can add to this list as appropriate. Refer to your department SOPs for more information.

List of Resources

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List of Resources (continued)

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List of Resources (continued)

The Emergency Response Guidebook (ERG)

The *Emergency Response Guidebook* (ERG) was developed for use by firefighters, police, and other emergency service personnel who may be the first to arrive on the scene of a transportation incident involving hazardous materials. It contains basic, generic information to help first responders *during the initial response phase of the incident.*

Information Found in the ERG2008

- An **Introduction** with basic information on how to use the guidebook, safety precautions, and whom to call for assistance.
- A **Table of Placards** that identifies guide pages to use if you can see a UN/DOT placard but do not know the product name or 4-digit identification number.
- **Rail Car and Road Trailer Identification Charts** that identify guide pages to use if you can see the container shape but do not know the product name or 4-digit identification number.
- **Hazard Identification Codes** used on some intermodal containers to help identify primary and subsidiary hazards.
- A **Number Index** (yellow border) listing materials by their 4-digit identification numbers. Each is cross-referenced to a material name and a guide for emergency information.
- A **Material Name Index** (blue border) listing materials by name. Each is cross-referenced to a 4-digit identification number and a guide for emergency information.
- **Numbered Guides** (orange border) identifying potential hazards, public safety recommendations, requirements for protective clothing, and emergency response guidelines for dealing with fire, spill or leak, and hazmat exposures. These pages provide only the most essential guidance in a form that is designed for first responders with limited hazmat training.
- A **Table of Initial Isolation and Protective Action Distances** (green border) for protecting people from spills involving materials that are considered toxic by inhalation or which produce toxic gases upon contact with water.
- **Other information** on protective actions, protective clothing, fire and spill control, chemical and biological agents, etc.
- A **glossary**.

Note: A searchable version of the ERG can be found online at http://phmsa.dot.gov/hazmat/library/erg.

The Emergency Response Guidebook (continued)

Limitations of the ERG

Although the *Emergency Response Guidebook* is one of the most useful tools for first responders, it has several limitations:

- It is designed for use in transportation accidents (assuming the material is unconfined in an open environment) and may be of limited value at fixed facilities unless you know the chemical name or identification number. Even when the chemical name and identification number are available, the information may still be of limited value, since the ERG is geared for outdoor incidents rather than indoor incidents.
- Some products won't be listed in the *Emergency Response Guidebook* either because they are not regulated by the DOT or because they are listed under another name.
- The book contains basic, generic information for the *initial response phase* of an incident. It will be necessary to refer to other reference sources for more specific information, as well as for instructions for dealing with extended incidents.
- There can be several different chemical names associated with the same 4-digit identification number. Without more information, it may be very difficult to determine what product you are dealing with, the specific hazards involved, and the appropriate safety precautions.
- There can be several different listings for the same chemical name, each with a slightly different description. However, each product may have significantly different hazards. Again, it is necessary to obtain more specific information.
- The orange-bordered guides do not apply when materials of different classes and divisions become mixed in an accident.
- The Table of Initial Isolation and Protective Action Distances (green border) is geared towards the first 30 minutes of a *spill*. It does not reflect fire conditions or extended incidents. (If materials are involved in a fire, use the isolation distances under "Public Safety" in the orange-bordered guide pages instead.)

It is important that you be familiar with how to use this resource *before an incident occurs* in order to use it effectively when you actually need it.

The Emergency Response Guidebook (continued)

Key Points for Using the ERG

The following key points are provided to reinforce the competencies outlined in NFPA 472. They are not a substitute for familiarizing yourself with the ERG or for training required by 29 CFR 1910.120 and 40 CFR Part 311.

Determining the Appropriate Guide

- If you have no information about the identity or type of hazardous material, use Guide 111 until additional information becomes available. (Exception: If the material is an unidentified explosive, use Guide 112.)
- If you can't identify the hazardous material but can see the cargo tank or rail car involved, refer to the Road Trailer Identification Chart or Rail Car Identification Chart. If what you see at the incident matches any of those drawings, use the guide listed until additional information becomes available.
- If you can't identify the hazardous material but can narrow it down to a hazard class, refer to the Table of Placards. Use the appropriate guide until more information becomes available.
- If you can identify the material's 4-digit identification number, refer to the number index (yellow border) to determine the correct guide.
- If you know the name of the material, refer to the material name index (blue border) to determine the correct guide.

Using the Number (Yellow) or Name (Blue) Index

- Watch for multiple entries. Some 4-digit identification numbers have several names associated with them (and vice versa). That's a red flag; look closer at the name and description. What's the concentration? Is the material a solid, liquid, or gas? Is it inhibited or stabilized? Is it a pure substance or a mixture? These factors can make a difference in selecting the correct guide.
- If you can't determine the correct guide because there are multiple entries and you don't know which is the closest fit, err on the side of safety and use the guide reflecting the worst-case scenario until more information becomes available.

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The Emergency Response Guidebook (continued)

Key Points for Using the ERG (continued)

Using the Number (Yellow) or Name (Blue) Index (continued)

- When you see the letter P after a guide number (e.g., 119P), it means the material is subject to polymerization. The guides themselves contain numbers only, no letters. (See pages 5-36 to 5-37 for an explanation of polymerization.)
- Materials highlighted in the number index (yellow border) or name index (blue border) are also listed in the Table of Initial Isolation and Protective Action Distances (green border) because they are considered toxic by inhalation or they produce toxic gases upon contact with water. (The ERG2008 highlights these materials in green in the yellow- and blue-bordered sections to make it more obvious that users should refer to the green-bordered pages.)

Using the Guides (Orange Border)

- You can quickly determine what presents the greatest risk (health hazards or fire/explosion hazards) by which one is listed first under "Potential Hazards" in the guides.
- The first section under "Public Safety" identifies the initial isolation distance. Evacuation distances for a large spill or fire are listed at the bottom of the page.
- The guides can help you determine whether structural firefighters' protective clothing or chemical protective clothing would be more appropriate. However, this is not a substitute for more informed decisions based on manufacturer recommendations and information in MSDSs and other reference sources.

Determining Evacuation Distances for Fires

- If a material highlighted in the number index (yellow border) or name (blue border) index is either on fire or threatened by fire, you should refer first to the appropriate guide (orange border) rather than the Table of Initial Isolation and Protective Action Distances (green border) for evacuation distances. The evacuation distances in the guides are based on protection against the fragmentation hazard of a fire or explosion, which may be more important than the toxicity hazard during the initial response phase.

The Emergency Response Guidebook (continued)

ERG Checklist for Field or Classroom Use

Use this checklist to help you identify important information.

Identify the Product and Guide Number

- Name of material (blue section)
- UN/NA Identification number (yellow section)
- Hazard class and division (ERG2008 page 14) *
- Placard (ERG2008 pages 16-17) *
- Rail car (ERG2008 page 18) *
- Road trailer (ERG2008 page 19) *
- Guide number (per any of the pages cited above)

* Use only if you don't know name or identification number.

Determine Isolation and Protective Action Distances

From Guide (orange section)
- Immediate isolation distance
- Initial downwind evacuation distance
- For tank, rail car, or tank truck involved in fire:
  - Isolation distance - all directions
  - Initial evacuation distance - all directions

From Table of Initial Isolation and Protective Action Distances (green section) *
- Initial isolation distance - all directions **
- Downwind protective action distance - day **
- Downwind protective action distance - night **

* This section applies if the material is highlighted in the yellow or blue section. However, if the material is on fire or threatened by fire, refer first to the guide (orange section), because fragmentation may be a greater risk than toxicity initially.

** Use the correct table based on the spill size. The ERG defines a *small* spill as one involving one small package (e.g., up to a 55-gallon drum), a small cylinder, or a small leak from a large package. It defines a *large* spill as a spill from a large package or multiple spills from many small packages.

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ERG Checklist for Field or Classroom Use (continued)

Identify the Potential Hazards

- Polymerization potential (indicated by "P" after guide number in yellow/blue sections)
- Primary hazard (health or fire/explosion) (identified by which one is listed first in the guide)
- Health hazards
- Fire or explosion hazards

Identify the Recommended PPE

- Protective clothing
- Respiratory protection
- Limitations of personal protective equipment

Note: Do not use PPE you are not trained or authorized to use.

Identify Emergency Response Recommendations

- Fire
- Spill or leak
- First aid

Note: Not everything listed will be appropriate in all situations. Whether or not you should attempt a particular emergency response action depends on several factors, including but not limited to:

- Your level of training
- Your organization's SOPs
- Limitations of your PPE
- Resources available
- The size and severity of the incident
- The hazards and risks involved
- Potential outcomes to life, the environment, and property
- Potential for secondary events

Shipping Papers

Types and Locations of Shipping Papers

Request shipping papers as soon as possible. A responsible party should bring them to you in an emergency, but you need to know where to find them if that is not the case.

- A **bill of lading** is used for materials transported by **highway**. It must be kept in the cab within easy reach of the driver.
- Materials transported by **rail** must be listed on a **waybill** and/or **consist**. These documents are kept with the conductor or engineer either on the engine or on the caboose (if there is one).
- A **dangerous cargo manifest** is used for materials transported by **water**. If on a *ship*, it must be kept in a designated holder on or near the vessel's bridge. The ship's captain or master is responsible for it. If on a *barge*, the dangerous cargo manifest must be kept in a readily accessible location, with a copy furnished to the person in charge of the towing vessel.
- An **airbill** is used for materials transported by **air**. It must be kept with the pilot in the cockpit. (It may also be attached to the outside of packages.)

Information Found on Shipping Papers

Shipping papers must be in English (in the U.S.) and contain *at least* the information below. Many shipments contains multiple products, so check carefully to identify *all* of the hazardous materials involved. Look at attachments (e.g., MSDSs) for hazard and safety information.

- Proper shipping name of the material
- UN/DOT hazard class and division number
- The 4-digit identification number (with UN or NA prefix)
- The packing group if applicable (indicates degree of danger)
- Gross weight or volume of the material
- Shipper's name and address
- 24-hour emergency telephone number
- Name and address of the consignee (destination of shipment)
- The letters "RQ" if it's a reportable quantity under CERCLA

Rail shipping papers also contain a Standard Transportation Commodity Code (STCC). If this seven-digit number begins with 49, it signifies a hazardous material; if 48, a hazardous waste.

Material Safety Data Sheets

Material safety data sheets (MSDS) are used at fixed facilities. They may also be attached to shipping papers in transportation. They are generated by the chemical manufacturer or shipper.

Required Information

While the format of MSDSs can vary greatly, they all must contain the information below and must be written in English for use in the United States. (See next page for safety data sheet requirements under GHS.)

- Manufacturer name and contact information
- Hazardous ingredients / chemical identity
- Physical and chemical characteristics
- Fire and explosion hazard data
- Reactivity data
- Health hazard data
- Precautions for safe handling and use
- Control measures
- Emergency and first aid procedures
- Date of MSDS preparation or last change

Limitations of Material Safety Data Sheets

- It is required that MSDSs be readily accessible during each work shift to employees when they are in their work areas. However, that does not guarantee that you will be able to find someone who can produce an MSDS for you.
- It is not uncommon for an MSDS to be incomplete, inaccurate, or out of date. The information must be compared with at least two other reference sources.
- Because there is no standard format for existing MSDSs, it may be difficult to find and interpret the available information. Poor print quality can also make an MSDS difficult to read.
- If a manufacturer has omitted little details, such as temperature scale (˚F, ˚C, or ˚K), it's harder to accurately determine hazards, protective measures, and mitigation strategies. Again, check other reference sources.
- Facilities sometimes change products, but fail to obtain new MSDSs. However, up-to-date MSDSs can often be obtained quickly by fax through the manufacturer or CHEMTREC. Some manufacturers make MSDSs available online.

GHS Safety Data Sheets (SDS)

Required Information

The Globally Harmonized System of Classification and Labelling of Chemicals (GHS) outlines a specific format for safety data sheets (SDS), which will ultimately replace older MSDSs as manufacturers update their documentation. The section headings are listed below.

1. Identification of the material and supplier
2. Hazardous identification
3. Composition / information on ingredients
4. First aid measures
5. Firefighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls / personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information

Each section must contain specific information. For example, under Hazardous Identification (section 2), the manufacturer must identify the GHS classification and the GHS label elements (symbols, signal word, and hazard/precautionary statements). All of these items are standardized under the GHS.

For More Information

It's beyond the scope of this book to go into detail on the GHS. However, you can find more information at the following web sites:

- United Nations Economic Commission for Europe (UNECE)
  http://www.unece.org
  Follow the links: Transport, then Dangerous Goods
- Occupational Safety & Health Administration (OSHA)
  http://www.osha.gov
  Follow the link: Hazard Communication

Mandatory Notification Centers

As indicated on page 2-22, some notifications are mandatory for all incidents involving a reportable quantity of hazardous materials. Among the many reasons for this is to provide a focal point for additional reporting. These notification centers will know what other agencies should be contacted by law and which ones can provide valuable guidance and assistance to you in the field. The preexisting relationships they have with these agencies will help them cut through the red tape that can make it difficult for you to reach these agencies directly. Going through these channels also makes it possible to get state and/or federal funding if the incident qualifies for it.

Contact	**Phone Number**
Fire Department Having Jurisdiction	911 or ______________
Local Emergency Planning Committee (LEPC) *	____________________
State/Tribal Emergency Response * Commission (SERC/TERC) and/or	____________________
State 'Single Point of Contact' * (state notification/warning center)	____________________
National Response Center (NRC)	(800) 424-8802
Others ____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________
____________________	____________________

* These agencies may be called by different names in different states. Fill in the correct phone numbers for your area.

Local Emergency Responders

Local emergency responders (fire, EMS, and law enforcement) are most often notified of an emergency when someone calls 911. However, you should know their seven-digit (or ten-digit) emergency and business phone numbers for three reasons:

- It may be the most expedient way to contact them if calling from a cell phone.
- You may want to reach a particular resource within the agency, rather than go through a dispatcher.
- Radio communications are usually recorded. While some of your incident communications *should* be recorded for documentation purposes, there may be other conversations you don't want recorded. Some telephone lines are recorded too, but others are not. You should know the difference.

Use the spaces below to write in additional phone numbers for these agencies.

Fire Department

In addition to their fire suppression responsibilities, most fire departments also provide emergency medical services. A growing number have their own hazmat teams.

Call 911 or

Contact	**Phone Number**

Local Emergency Responders (continued)

Emergency Medical Services (EMS)

EMS personnel provide emergency medical care. However, unless they meet the requirements under NFPA 472 and 473 (for training, PPE, etc.), they cannot enter the hot or warm zones. They should wait until patients have been adequately decontaminated and brought out to a designated treatment area in the cold zone.

Call 911 or

Contact	Phone Number

Law Enforcement

Law enforcement personnel are used most often for scene control and protective actions outside contaminated areas. They may have incident command authority, depending on the location of the emergency. However, specific roles and responsibilities vary from one jurisdiction to another. Often law enforcement has investigation responsibility or will share that responsibility with other agencies. If criminal or terrorist activities are suspected, law enforcement involvement is mandatory.

Call 911 or

Contact	Phone Number

Local Emergency Responders (continued)

Neighboring Agencies / Response Teams

While you're on the hot seat, personnel from neighboring agencies or response teams may provide either mutual aid or telephone assistance to help ease your burden.

Contact	**Phone Number**

Emergency Operations Center (EOC)

Emergency Operations Centers (EOC) provide a focal point for coordinating resources during emergencies and disasters. The EOC may be staffed by representatives from the response agencies in the field, from other city or county departments (e.g., city manager's or mayor's office, legal counsel, finance, building department), and from regional, state, and federal resources.

Most EOCs have multiple phone lines, each dedicated for a specific agency or position.

Agency / Position	**Phone Number**

Communications Services

Dispatch / Communications

Your dispatcher or communications center can call other resources for you to reduce your burden in the field. In some communities, dispatch teams are even sent into the field with mobile communications equipment to assist with major incidents. Contact your dispatchers and/or communications center by phone rather than by radio for any sensitive communications.

Contact	Phone Number

Telephone Companies

Telephone companies will restore communications to areas affected by an emergency. They can also provide emergency phones and phone lines for responders and the public.

Contact	Phone Number

Amateur Radio Operators

Amateur radio operators generally provide early assessment of damage and casualties in their neighborhoods, provide backup communications when regular resources break down or are overwhelmed, coordinate between different agencies that may not have compatible radio frequencies, shadow emergency personnel to assist with communications needs, handle messages, and help citizens communicate with family. They use their own equipment to provide voice, data, and video communications.

Contact	Phone Number

Community Resources

Community Emergency Response Teams

Community emergency response teams (CERT) are an excellent resource for citizen volunteers who can help with activities outside the immediate hazard area, for example, rendering first aid, providing traffic control, evacuating neighbors, identifying whether neighbors are accounted for, checking on the elderly and disabled, caring for children separated from their parents, serving food and water to responders, and setting up shelters. Prior to an incident, these volunteers can help their neighbors prepare for an emergency. CERT team members can also participate in disaster drills as either "victims" or aides.

CERT Coordinator	Phone Number

Faith-Based Organizations

Faith-based organizations (churches, temples, etc.) can assist mental health professionals in helping responders and citizens deal with the emotional effects of a major incident. Because such organizations also do community service or outreach programs, they may have resources to help with caring for their neighbors, setting up shelters, or doing other support functions.

Contact	Phone Number

Other Local Resources

Public Works Department

The local public works department will usually be able to provide dirt, sand, absorbent materials, hand tools, barricades, and other equipment, as well as personnel to assist with tasks (e.g., dam construction) outside contaminated areas.

____

Public Works Department

Public Utilities

A utility company can help you shut off utilities to control hazards or, conversely, can establish utilities to a remote area or one that has been cut off in an emergency.

Gas ____________________

Electric ____________________

Water ____________________

Flood District Office

Areas subject to flooding may have a local flood district office that can provide information and assistance during hazmat incidents in a potential flood area.

____

Flood District Office

Sewer Department or Sewage Treatment Plant

The sewer department and the sewage treatment plant must be notified anytime a hazardous material enters the sewer system.

Sewer Department ____________________

Sewage Treatment Plant ____________________

Other Local Resources (continued)

Industry Resources

Facilities that manufacturer, use, treat, or transport hazardous materials may have additional resources, including emergency response teams, technical experts, equipment, and extinguishing or control agents. They may have mutual aid agreements with other facilities and/or public emergency response agencies.

Contact	**Phone Number**

Contractors

Independent contractors may provide heavy equipment such as bulldozers, cranes, etc.

Contact	**Phone Number**

Licensed Waste Haulers

Licensed waste haulers can help ensure that hazardous waste (including the released material and anything it contaminates) is properly disposed of.

Contact	**Phone Number**

Other Local Resources (continued)

Disaster Relief Agencies

Disaster relief agencies such as the American Red Cross and the Salvation Army can provide shelter, food, clothing, and emergency medications; assist with health and mental health services; handle inquiries from concerned family members outside the disaster area; and help those affected by the disaster to access other available resources and recover from their losses. The Red Cross also collects donations of blood and blood products and makes them available to disaster victims through the medical community.

Contact	**Phone Number**
American Red Cross	
Salvation Army	

Medical Examiners / Coroners

Medical examiners and coroners can help with most of the responsibilities of dealing with the dead, including protecting evidence on the bodies and clothing, identifying victims, and storing the bodies. They may be able to help determine cause of death when victims have been killed by an unknown material, although that depends on the resources available to them and their level of training. Medical examiners are physicians; coroners are not.

Bodies should be thoroughly decontaminated before they are handed over to a medical examiner or coroner. However, to protect medical examiners and coroners against accidental exposure from any residual contaminants that may be present, be sure to provide sufficient information about the material(s) involved and appropriate protective measures.

Contact	**Phone Number**

Other Local Resources (continued)

Equipment / Supplies - Purchase or Rental

At a major incident, you may need materials from stores that sell or rent hardware, camping supplies, office supplies, etc. List any resources you anticipate needing.

Contact	Phone Number
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

Restaurants and Grocery Stores

Extended incidents often require feeding emergency responders. This process is often easier if your agency has open purchase orders with local restaurants or grocery stores. If you anticipate needing to feed responders, place your food order early. Don't wait until responders are hungry and suffering from low blood sugar levels. Getting food to an incident scene takes time.

These resources may also prove vital in an evacuation if relief agencies can't provide sufficient food and water.

Contact	Phone Number
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________
______________________________	______________________________

School District Superintendents

School district superintendents must be notified of any release that may endanger the students. However, the school districts in your area should also be considered a valuable resource. They can be used to notify students and their parents of the emergency. They may need to assist with evacuation efforts. They may also be a resource for school buses to transport other people in the endangered areas. Fill in the appropriate numbers below.

Schools

Contact	Phone Number

District Offices

Contact	Phone Number

Colleges

Contact	Phone Number

Media / PIOs

The media can be a valuable resource for warning the public about a hazmat incident or terrorist event, as well as for educating the public before an incident occurs. Pages 13-3 through 13-5 provide general guidelines on dealing with the media. Consider, also, requesting assistance from other agencies' public information officers (PIO) so that no one person has to shoulder the whole burden of what can be a very stressful responsibility.

Blogs and other social networking tools are also a valuable resource for disseminating information ... and one that may require diligent monitoring to catch and correct misinformation spread by others.

PIOs from Neighboring Agencies

Contact	Phone Number

Media Contacts

Contact	Phone Number

Health & Medical Resources

Hospital Emergency Departments

The hospitals in your area can be a valuable resource for information on treatment protocols and decontamination measures.

You also have a responsibility to your local hospitals. You may need to notify them of the incident so that they can be prepared to receive patients transported from the scene or walk-in traffic from exposed citizens in the area. (See page 6-30 for a list of things that should be communicated to medical personnel.) Some areas require that patients be transported only to "appropriate receiving centers" that meet specific requirements for dealing with hazmat exposures. Refer to your department SOPs.

Early notification is extremely important if protective actions are required, since hospitals need to implement their own emergency response plans to protect patients who can't easily be moved.

Hospital or Clinic	Phone Number

Mental Health Professionals

Mental health professionals can help both responders and citizens deal with the emotional effects of a major incident.

Contact	Phone Number

Health & Medical Resources (continued)

State and County Health Departments

Some incidents will require notification of your state or county health department. However, health departments are also a valuable resource for industrial hygienists, toxicologists, environmental health specialists, and others. Some have organized hazmat teams or personnel trained to the technician level who can assist other organized hazmat teams.

State Health Department ______________________

County Health Department ______________________

U.S. Centers for Disease Control and Prevention (CDC)

The U.S. Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, should be notified of incidents or outbreaks that may involve infectious substances. The CDC can assist with agent and disease identification; treatment advice; obtaining vaccines, antibiotics, and other medical supplies; and coordination between multiple agencies worldwide. The first phone number below is the 24-hour emergency hotline.

(770) 488-7100

The following are some other important CDC phone numbers:

Bioterrorism Preparedness and Response Program	(404) 639-0385
Coordinating Office of Terrorism Preparedness and Emergency Response	(404) 639-7405
Public Inquiries	(800) CDC-INFO (800) 232-4636

Local or Regional Poison Control Centers

Poison control centers are an excellent resource for information on toxicity of materials, signs and symptoms of exposure, protective clothing, potential for secondary contamination, decon, patient treatment, and antidotes. They may coordinate the flow of information between the field and receiving hospitals. Some communities mandate calling the poison center as part of their hazmat response protocols. The national phone number below automatically connects callers to the appropriate poison center.

(800) 222-1222

Agency for Toxic Substances and Disease Registry (ATSDR)

The Agency for Toxic Substances and Disease Registry (ATSDR) has a 24-hour emergency hotline for information regarding treatment protocols, antidotes, decontamination, etc. The ATSDR utilizes a network of on-call specialists, including EHS scientists, toxicologists, chemists, and physicians, to assess the problem and provide recommendations. It's also an excellent resource for information on tire fires.

(770) 488-7100 (CDC)

Health & Medical Resources (continued)

National Disaster Medical System (NDMS)

Within the U.S. Department of Health and Human Services (DHHS) is the National Disaster Medical System (NDMS) responsible for managing the federal government's medical response to major emergencies and disasters. NDMS has three components:

- Medical response (personnel, supplies, and equipment) to a disaster area when local resources are overwhelmed.
- Patient movement from a disaster area to unaffected areas.
- Definitive medical care at participating hospitals in unaffected areas.

The NDMS is made of several specialized teams:

- Disaster Medical Assistance Teams (DMAT) provide medical care during a disaster or other event. Within the DMATs are highly specialized teams that deal with specific medical conditions, such as crushing injuries, burns, and mental health emergencies.
- Disaster Mortuary Operational Response Teams (DMORT) provide victim identification and mortuary services.
- National Veterinary Response Teams (NVRT) provide veterinary services following major disasters or emergencies.
- National Nurse Response Teams (NNRT) provide nurses when local resources are overwhelmed by a WMD incident.
- National Pharmacy Response Teams (NPRT) assist in chemoprophylaxis or immunization when local resources are overwhelmed by a disease outbreak.

These resources can be requested through your state notification center or office of emergency services.

____

State Notification Center (Office of Emergency Services)

Strategic National Stockpile (SNS)

The CDC's Strategic National Stockpile (SNS) has large quantities of medicine and medical supplies to protect the American public if there is a public health emergency severe enough to deplete local supplies. A state's governor's office can request SNS assets from the CDC or HHS (Department of Health and Human Services). If federal authorities agree that SNS assets are needed, supplies can be delivered to any state in the U.S. within 12 hours.

(770) 488-7100 (CDC)

The initial response consists of *12-hour Push Packages*—caches of antibiotics, chemical antidotes, antitoxins, life-support medications, IV supplies, airway maintenance equipment, and medical/surgical items designed to rapidly deliver a broad spectrum of assets for a generic event or ill-defined threat.

The 12-hour Push Packages are supplemented by *vendor managed inventory (VMI) supplies*. If the incident requires additional pharmaceuticals and/or medical supplies, VMI will be shipped to the scene within 24 to 36 hours. If a particular threat (e.g., a chemical or biological warfare agent) has been identified, VMI could be part of the initial response to provide specific antidotes or other supplies.

A *Technical Advisory Response Unit (TARU)* is deployed with SNS assets to coordinate distribution with state and local officials.

Health & Medical Resources (continued)

Medical Centers and Supply Caches

Use this space to identify the location of additional resources.

Adult trauma centers ...

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Pediatric trauma centers ...

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Adult burn centers ...

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Pediatric burn centers ...

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Hyperbaric chambers ...

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Established field hospitals ...

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____

Other speciality hospitals or medical centers ...

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____
____
____
____

(continued next page)

Health & Medical Resources (continued)

Mass casualty trailers with medical supplies ...

Mass decedent capability ...

Regional decontamination units ...

Replenishment of medical supplies during long-term incidents ...

Mass-casualty antidotes (for applicable chemical and biological warfare agents, organophosphate pesticides, opiates, radioactive materials, etc.) ...

Replacement transport units (ambulances) ...

National Response Center (NRC)

About the National Response Center

The National Response Center (NRC) is operated by the U.S. Coast Guard. It is tasked with receiving reports of releases of hazardous substances into the environment.

After receiving a report of an incident, the NRC will immediately notify the predesignated federal on-scene coordinator (FOSC) and other federal agencies as appropriate. Additionally, the NRC is the contact point for activation of the National Response Team (NRT). The NRT is comprised of 16 federal agencies (identified below) that may provide support (e.g., technical advice, access to additional resources and equipment, or coordination with regional response teams) during hazardous materials incidents.

- Department of Agriculture (USDA)
- Department of Commerce, National Oceanic and Atmospheric Administration (NOAA)
- Department of Defense (DOD)
- Department of Energy (DOE)
- Department of Health and Human Services (HHS)
- Department of Homeland Security (DHS)
  - Coast Guard (USCG)
  - Customs Service
  - Federal Emergency Management Agency (FEMA)
- Department of the Interior (DOI)
- Department of Justice (DOJ)
- Department of Labor (DOL)
- Department of State (DOS)
- Department of Transportation (DOT)
- Environmental Protection Agency (EPA)
- General Services Administration (GSA)
- Nuclear Regulatory Commission (NRC)

Each of these agencies is further divided with more specific resources, for example, the Federal Bureau of Investigation (FBI) and the Bureau of Alcohol, Tobacco and Firearms (ATF).

Because the NRC is a focal point for so many agencies, calling the NRC meets all federal reporting requirements. However, you may need to make additional state or local notifications.

National Response Center (continued)

Services Provided

According the NRC web site, the NRC provides the following services to enhance the Federal Response System.

- For the **Environmental Protection Agency**, the NRC receives incident reports, then disseminates telephonic and electronic (fax, email) reports of oil discharges and chemical releases to the cognizant EPA Federal On-Scene Coordinator.
- For the **Federal Emergency Management Agency**, the NRC acts as a 24-hour contact point to receive earthquake, flood, hurricane, and evacuation reports.
- For the **Nuclear Regulatory Commission** and the **Department of Energy**, the NRC makes telephonic notification of incidents involving radioactive material releases into the environment.
- For the **Department of the Interior**, the NRC receives reports of incidents involving Trans-Alaskan Pipeline oil and electronically forwards the reports to appropriate DOI representatives.
- For the **Department of Defense**, incidents involving transportation emergencies with DOD munitions or explosives are recorded and referred for action to the Army Operations Center. Any transportation anomaly involving hypergolic rocket fuels and oxidizers are recorded and immediately passed to the Air Force Operations Center.
- The NRC established the **Domestic Preparedness Chemical/Biological Hotline** in conjunction with DOD and DOJ. The NRC takes reports on potential or actual domestic terrorism and coordinates notification and response with the **Soldier and Biological Chemical Command** and the **Federal Bureau of Investigation**.
- For the **Department of Health and Human Services**, releases of etiological and biological agents are recorded at the NRC and referred to the **Centers for Disease Control**.
- For the **Federal Railroad Administration**, the NRC maintains the 24-hour *Rail Emergency Hotline* to take reports of railroad incidents involving hazardous materials, grade crossing fatalities, accidents resulting in injury or death of railroad employees, and the refusal of railroad employees to submit to toxicological testing.

National Response Center (continued)

The National Response System

The National Response System is the government's mechanism for emergency response to releases of hazardous substances and waste. It consists of three high-level organizations:

- **Federal On-Scene Coordinators** (FOSC) are federal officials, predesignated by the EPA for inland areas and by the Coast Guard for costal or major navigable waterways. They coordinate all federal containment, removal, disposal efforts, and resources during an incident. They also coordinate federal efforts with the local community's resources.
- The **National Response Team** (NRT) consists of 16 federal agencies (identified on page 14-34). The NRT is a planning, policy, and coordinating body. It provides policy guidance prior to an incident and does not respond directly to an incident. However, it can provide assistance to an FOSC, usually in the form of technical advice or access to additional resources and equipment at the national level.
- The 13 **Regional Response Teams** (RRT) are also primarily planning, policy, and coordinating bodies, but provide guidance and assistance to FOSCs. They may also provide assistance to state and local governments in preparing, planning, or training for emergency response.

There are also four special-force components:

- The Coast Guard **National Strike Force** consists of three national strike teams trained and equipped to respond to major oil spills and chemical releases.
- The Coast Guard **Public Information Assist Team** consists of public affairs specialists prepared to complement the existing FOSC public information capabilities.
- The EPA **Environmental Response Team** is a group of specially trained scientists and engineers whose capabilities include multimedia sampling and analysis, hazard assessment, cleanup techniques, and technical support.
- The National Oceanic and Atmospheric Administration has **Scientific Support Coordinators** to provide expertise in such areas as environmental chemistry, oil slick tracking, pollutant transport modeling, and natural resources at risk. They also provide liaison to the scientific community.

National Response Center (continued)

Reporting Requirements

The following summary of when to call the NRC is provided as a guide only and must not be used to determine compliance with federal reporting requirements. When in doubt, contact the NRC as soon as practical.

Oil Spills: The responsible party must notify the NRC upon learning of an oil spill or discharge from a vessel or facility operating:

- In or along U.S. navigable waters;
- On the Outer Continental Shelf;
- In a deepwater port; or
- From a vessel transporting oil from the Outer Continental Shelf.

Gas Pipeline Releases: The responsible party must call the NRC to report a release of any toxic, corrosive, or flammable gas, liquefied natural gas (LNG), or gas from an LNG facility that causes any of the following:

- Death or injury requiring hospitalization
- Property damage exceeding $50,000 (including the value of lost product and the cost of cleanup and recovery)
- Emergency shutdown of an LNG facility
- Incident deemed significant by the operator

Liquid Pipeline Releases: The responsible party must call the NRC when a pipeline system failure releases a hazardous liquid or carbon dioxide that causes any of the following:

- Death or injury requiring hospitalization
- Explosion or fire not intentionally set by the operator
- Property damage exceeding $50,000 (including the value of lost product and the cost of cleanup and recovery)
- Pollution of any body of water that:
  - Violates applicable water quality standards
  - Causes a discoloration of the surface of the water or adjoining shoreline
  - Deposits a sludge or emulsion beneath the surface of the water or upon adjoining shorelines
- Incident deemed significant by the operator

(continued next page)

National Response Center (continued)

Reporting Requirements (continued)

Transportation Accidents: The person in physical possession of a hazardous material must notify the NRC of any transportation accident (including loading, unloading, and storage) if:

- As a direct result of a hazardous material:
  - A person is killed or requires hospitalization
  - The general public is evacuated for one hour or more
  - A major transportation artery or facility is closed or shut down for one hour or more
  - The operational flight pattern or routine of aircraft is altered
- Fire, breakage, spillage, or suspected contamination involves:
  - A radioactive material
  - Infectious waste (other than a diagnostic specimen or regulated medical waste)
- A release of a marine pollutant exceeds 119 gallons (450 liters) for a liquid or 882 pounds (400 kg) for a solid
- A continuing danger to life exists at the scene

Chemical Releases: The responsible party must notify the NRC of all releases of hazardous substances exceeding the reportable quantities (indicated by "RQ" on an MSDS or shipping papers).

Other Releases: Discharges from a hazardous waste treatment or storage facility must be reported by the emergency coordinator at the facility. Abandoned dump or waste sites should be reported by anyone having knowledge of such a site.

Information to Provide the NRC

Provide the NRC with as much information as possible:

- Your name, address, and phone number
- Name and contact information for the responsible party if known
- Date, time, and location of the incident
- The extent of injury, if any
- Identity and quantity of material released
- Type of incident and nature of hazardous materials involvement
- Whether a continuing danger to life exists at the scene

(800) 424-8802
or (202) 267-2675

Department of Homeland Security (DHS)

The Department of Homeland Security (DHS) is, in essence, an umbrella organization for the various agencies it coordinates. The DHS also leverages resources within the more than 87,000 federal, state, and local governmental jurisdictions that have homeland security responsibilities.

The major components that currently make up the Department of Homeland Security are as follows:

- Directorate for National Protection and Programs
- Directorate for Science and Technology
- Directorate for Management
- Office of Policy
- Office of Health Affairs
- Office of Intelligence and Analysis
- Office of Operations Coordination
- Federal Law Enforcement Training Center (FLETC)
- Domestic Nuclear Detection Office (DNDO)
- Transportation Security Administration (TSA)
- U.S. Customs and Border Protection (CBP)
- U.S. Citizenship and Immigration Services (USCIS)
- U.S. Immigration and Customs Enforcement (ICE)
- U.S. Coast Guard (USCG)
- Federal Emergency Management Agency (FEMA)
- U.S. Secret Service

Responders seeking assistance should continue to contact those agencies either directly or through the National Response Center (NRC) as appropriate.

Transportation Related Resources

CHEMTREC

CHEMTREC (Chemical Transportation Emergency Center) is a hotline for emergency responders to obtain critical information and assistance for hazmat emergencies. It's operated as a public service by the American Chemistry Council in Arlington, Virginia.

CHEMTREC's emergency call center is linked to the largest network of chemical and hazmat experts in the world. When necessary, the call center's emergency service specialists can establish direct communications between these experts, CHEMTREC personnel, and responders at the scene of an incident.

When calling CHEMTREC, provide the details listed below:

- Your name, title, and organization
- Assistance you need right away (MSDS, medical help, etc.)
- Callback numbers (incident location and dispatch center)
- Fax number (for faxing MSDSs or other documents)
- Description of the incident (fire, spill, etc.) and actions taken
- ERG guide pages being used on scene
- Location and time of the incident
- Name of material(s) involved (preferably trade name) or other identifying information (placard, CAS number, etc.)
- Size or amount of release
- Local conditions (weather, terrain, proximity to exposures)
- Type and number of injuries or exposures
- Type or description and number of containers or packages
- Shipper or manufacturer
- Carrier name and rail car or truck number
- Consignee (facility to which the material is being shipped)

(800) 424-9300

(703) 741-5500 if calling from outside the U.S.
Call (800) 262-8200 for nonemergency information

CHEMTREC is a registered trademark

Transportation Related Resources (continued)

Canadian Transport Emergency Centre (CANUTEC) — Canada

CANUTEC is Canada's equivalent of CHEMTREC. It provides a national bilingual (French and English) advisory service and is staffed by professional chemists experienced and trained in interpreting technical information and providing emergency response advice.

(613) 996-6666
(call collect)

Cellular: *666 (Canada only)
Call collect (613) 992-4624 for nonemergency information.

Emergency Transportation System for the Chemical Industry (SETIQ) — Mexico

The SETIQ is Mexico's equivalent of CHEMTREC. It is a service of the National Association of Chemical Industries (ANIQ).

01-800-00-214-00
(for calls in the Mexican Republic)
5559-1588
(for calls originating in Mexico City and the Metropolitan Area)
+52-55-5559-1588
(for calls originating elsewhere)

Additional Emergency Phone Numbers

The ERG2008 contains additional emergency phone numbers for the United States, Canada, Mexico, Argentina, Brazil, and Columbia.

Transportation Related Resources (continued)

National Transportation Safety Board (NTSB)

The National Transportation Safety Board (NTSB) is charged with investigating every civil aviation accident in the United States and significant accidents in the other modes of transportation and with issuing safety recommendations aimed at preventing future accidents. The NTSB determines the probable cause of:

- all U.S. civil aviation accidents and certain public-use aircraft accidents
- selected highway accidents
- rail accidents involving passenger trains or any train accident that results in at least one fatality or major property damage
- major marine accidents and any marine accident involving a public and a nonpublic vessel
- pipeline accidents involving a fatality or substantial property damage
- releases of hazardous materials in all forms of transportation
- selected transportation accidents that involve problems of a recurring nature

Contact the NTSB through your NTSB and/or FAA Regional Comm Center. The NTSB's main number (Monday through Friday, 8:30 a.m. to 5:00 p.m.) is (202) 314-6000.

____

NTSB Comm Center

____

FAA Regional Comm Center

Among the many resources within the NTSB is the **Office of Transportation Disaster Assistance**, which provides a number of services, including family/victim support, family assistance centers, and interagency coordination to help communities and commercial carriers deal with a major transportation disaster. Contact the Office of Transportation Disaster Assistance at:

(800) 683-9369

or (202) 314-6290

Transportation Related Resources (continued)

U.S. Department of Transportation (DOT)

The U.S. Department of Transportation (DOT) develops the regulations governing the transportation of hazardous materials. The DOT also publishes the *Emergency Response Guidebook* (ERG).

The requirements for notifying the DOT of a hazmat transportation accident are identified on page 14-38. The DOT can be notified by calling the NRC.

(800) 424-8802 (NRC)
or (202) 267-2675

U.S. Coast Guard (USGC)

The U.S. Coast Guard has a variety of responsibilities that include responding to maritime disasters, providing assistance during natural disasters, and cleaning up oil spills and hazardous materials. The Coast Guard staffs the National Response Center and has incident command authority for incidents involving vessels under way or at anchor.

The Coast Guard must be notified for any reportable quantity of a hazardous material spilled or released in a navigable waterway or on the coastal zone. Any spill or release that threatens a navigable waterway should be reported as well to facilitate a prompt response.

The Coast Guard can be reached through the NRC.

(800) 424-8802 (NRC)
or (202) 267-2675

Transportation Related Resources (continued)

Railroads

The appropriate railroad should be contacted for any incident involving rail transportation of hazardous materials. Railroad personnel can help identify the product and the supplier or manufacturer if you can provide them with a rail car number or other identifying information. They may also be able supply heavy equipment to help deal with the problem. Some railroads even have their own hazmat teams.

Contact the specific railroad directly whenever possible. You may be able to get help from the Association of American Railroads (AAR) if necessary. The AAR can be contacted through the National Response Center (NRC). Another resource is CHEMTREC. It has 24-hour contacts with the AAR and the major railroads and carriers.

(800) 424-8802 (NRC)
or (202) 267-2675
(800) 424-9300 (CHEMTREC)

Other Contacts	Phone Numbers

Bureau of Explosives

The Bureau of Explosives is a division of the Association of American Railroads (AAR). It can provide technical advice regarding railroad incidents involving explosives. You can contact the Bureau of Explosives through CHEMTREC.

(800) 424-9300 (CHEMTREC)

Transportation Related Resources (continued)

State and Local Transportation Agencies

Your state and local transportation agencies can assist with a number of functions, including closing roads, rail lines, subways, bus lines, etc.; providing buses for evacuation or transportation of the injured; and providing staffing and equipment to deal with incidents that impact transportation routes.

Contact	Phone Number

Air Traffic Control Center

It may be necessary to request a temporary flight restriction over the impacted area. This is done by calling the air traffic control center having jurisdiction. Identify what area you want restricted. The air traffic control center will then contact the National Flight Data Center to request that a *Notice to Airmen* (NOTAM) message be sent to all flight service stations. Pilots will be notified of the flight restriction when they file their flight plans.

The air space will be restricted to all but those aircraft involved in the disaster relief efforts. Accredited news media generally have an exception to the flight restrictions, but should first contact the public information officer assigned to the incident to request permission and identify any concerns that might impact their safety.

Contact	Phone Number

Defense and Military Resources

U.S. Department of Defense (DOD)

Military shipments can be a particular problem because they are sometimes transported in unmarked vehicles for security. You may have to depend on the driver for information about the materials being transported. It is also important to realize that the military has its own marking system for hazardous materials. (Refer to page 3-32 for more information.)

For assistance at emergencies involving materials being shipped by, for, or to the Department of Defense (DOD), call one of the following numbers day or night:

- Call the U.S. Army Operations Center for incidents involving explosives and ammunition. (Call collect.)

(703) 697-0218

- Call the Defense Logistics Agency for emergencies involving hazardous materials other than explosives and ammunition.

(800) 851-8061

Chemical and Biological Hotline

The Chemical and Biological Hotline provides technical assistance to emergency responders at incidents involving chemical and biological warfare agents. The hotline is staffed 24 hours a day, 365 days a year by the National Response Center (NRC). NRC duty officers take reports of actual or potential domestic terrorism and link emergency calls with SBCCOM (U.S. Army Soldier and Biological Chemical Command) for technical advice on dealing with weapons of mass destruction and with the FBI (Federal Bureau of Investigation) to initiate the federal response actions. The NRC also provides reports and notifications to other federal agencies as necessary.

(800) 424-8802 (NRC)
or (202) 267-2675

National Guard

The National Guard (which is comprised of units from the Army and the Air Force) has both federal and state roles. At a federal level, National Guard units may be mobilized for war or to provide assistance during national emergencies (such as national disasters or civil disturbances).

When not mobilized or under federal control, National Guard units report to the governors of their respective state or territory (Puerto Rico, Guam, Virgin Islands) or to the commanding general of the District of Columbia National Guard. At this level, National Guard units may be called into action during a variety of local or state emergencies, including fires, floods, storms, tornadoes, hurricanes, earthquakes, civil disturbances, hazmat incidents, and terrorist events.

Within the National Guard are the WMD Civil Support Teams. Refer to the next page for a description.

The National Guard can be requested through your state notification center or office of emergency services.

____

State Notification Center (Office of Emergency Services)

Defense and Military Resources (continued)

National Guard WMD Civil Support Teams (CST)

The National Guard WMD Civil Support Teams (CST) were created to assist civil authorities at a domestic terrorism incident by:

- Assessing hazards and current and projected consequences
- Advising civilian responders on appropriate actions through on-site testing and expert consultation
- Facilitating military support during emergencies and suspected WMD incidents

Fifty-five (55) CSTs are located in each state (two in California) and U.S. territory. Each team consists of 22 full-time National Guard members and is outfitted with an impressive array of state-of-the-art military and commercial detection, analysis, and communications equipment beyond the resources of most local responders. The teams are trained and equipped to both military and civil standards in order to operate in an area containing unknown contamination.

Although CSTs are a federal resource, they're considered first and foremost to be *state* assets, performing under the command and control of the governors of the states in which they are located. This enables them to respond to incidents as part of a state response, well before federal resources would be requested. If the President declares a national disaster, the CSTs become "federalized," but would still support local and state officials.

CSTs are on call 24 hours a day, 7 days a week. An advance team is deployable within 90 minutes; the regular team, within three hours. Depending on proximity, weather, and road conditions, CSTs may travel by land or air. CSTs can be requested through your state notification center or office of emergency services.

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State Notification Center (Office of Emergency Services)

Other State and Federal Resources

The following pages provide brief descriptions of other state and federal agencies or organizations that can assist you in handling a hazardous materials emergency or terrorist event. Many of these can be reached through the National Response Center (NRC) or your state notification center (e.g., Office of Emergency Services or State Warning Center), in which case, you can be managing the incident while someone else is making the phone calls. However, there is room for you to write in local and state phone numbers for convenient use in the field.

Emergency Management Agency (EMA)

Local or regional emergency management agencies can obtain mutual aid resources (e.g., transportation for evacuees, evacuation shelters, and heavy equipment) above and beyond what fire and law enforcement personnel normally have at their disposal.

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Local Emergency Management Agency

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County or Regional Emergency Management Agency

Federal Emergency Management Agency (FEMA)

The Federal Emergency Management Agency (FEMA) has the lead role in consequence management (recovery efforts after a disaster) once the incident escalates to a federal level. FEMA can be contacted through the NRC.

(800) 424-8802 (NRC)
or (202) 267-2675

Other State and Federal Resources (continued)

U.S. Environmental Protection Agency (EPA)

The U.S. Environmental Protection Agency (EPA) can provide immediate assistance on oil spills and other hazardous materials releases, as well as alert regional emergency response teams. The EPA can be contacted through the NRC.

____

Regional EPA Office

(800) 424-8802 (NRC)

or (202) 267-2675

Other Environmental Protection Agencies

You may need to notify environmental protection agencies (other than EPA) within your state or local area. These may include air quality management districts, water quality control boards, etc. These resources vary from state to state.

Contact	Phone Number
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Emergency Response Networks

A variety of emergency response networks are available through CHEMTREC to deal with specific chemicals, including chlorine (CHLOREP), sulfur dioxide (SMART), vinyl chloride (VCNET), pool chemicals, and several others. These resources can be contacted through CHEMTREC.

(800) 424-9300 (CHEMTREC)

Other State and Federal Resources (continued)

Federal Bureau of Investigation (FBI)

The Federal Bureau of Investigation (FBI) has the lead role in responding to terrorist events. The FBI is often a good resource for other hazmat incidents involving criminal activities. The FBI can be contacted through the NRC.

____

Local or Regional FBI Office

(800) 424-8802 (NRC)
or (202) 267-2675

Bureau of Alcohol, Tobacco and Firearms (ATF)

The Bureau of Alcohol, Tobacco and Firearms (ATF) can supplement the efforts of local law enforcement personnel at incidents involving alcohol, tobacco, firearms, explosives, and arson. ATF can be contacted through the NRC.

____

Local or Regional ATF Office

(800) 424-8802 (NRC)
or (202) 267-2675

Drug Enforcement Administration (DEA)

The Drug Enforcement Administration (DEA) can supplement the efforts of local law enforcement personnel at incidents involving clandestine drug labs or the illegal dumping of drug lab waste products. The DEA can be contacted through the NRC.

____

Local or Regional DEA Office

(800) 424-8802 (NRC)
or (202) 267-2675

Other State and Federal Resources (continued)

U.S. Department of the Interior (DOI)

The U.S. Department of the Interior is the nation's principal conservation agency, having responsibility for most of our nationally owned public lands and natural resources. It is comprised of eight bureaus: Bureau of Indian Affairs, Bureau of Land Management, Bureau of Reclamation, U.S. Fish & Wildlife Service, Minerals Management Service, National Park Service, and Office of Surface Mining, and U.S. Geological Survey. The Department of the Interior should be notified of any incident that threatens the nation's public lands or natural resources. It can be contacted through the NRC.

(800) 424-8802 (NRC)
or (202) 267-2675

State Forestry Department

The state forestry department must be notified of any incident that is located in or threatens a state or national forest.

Forestry Department

State Agricultural Department

Your state agricultural department is often a good resource for information regarding pesticide incidents.

Agricultural Department

Other State and Federal Resources (continued)

U.S. Department of Energy (DOE)

The Department of Energy (DOE) can provide information or response teams to assist with radiological incidents. It can be contacted through the NRC or CHEMTREC.

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Local or State Department of Energy Office

(800) 424-8802 (NRC)

or (202) 267-2675

(800) 424-9300 (CHEMTREC)

Local or State Radiological Officer

Your local or state radiological officer can provide assistance for dealing with radiation incidents. You can usually access a radiological officer when you contact your state notification center.

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Local or State Radiological Officer

U.S. Postal Inspection Service (USPIS)

The United States Postal Inspection Service (USPIS) is the law enforcement arm of the United States Postal Service. Its jurisdiction is defined as "crimes that may adversely affect or fraudulently use the U.S. Mail, the postal system or postal employees." The USPIS has several investigative teams, each of which focuses on different types of crimes. Among those is the Dangerous Mail Investigations Unit, which is responsible for detecting and preventing prohibited mailings, mail bombs, and dangerous mail inclusive of hazmat and weapons of mass destruction. Contact the U.S. Postal Inspection Service at:

(877) 876-2455

Other State and Federal Resources (continued)

National Weather Service

Many incidents can be impacted by conditions such as wind speed and direction, temperature, rain, and humidity. The local office of the National Weather Service may provide prerecorded forecasts and/or assistance from a live operator.

____

Local National Weather Service Office

U.S. Chemical Safety and Hazard Investigation Board (CSB)

The Chemical Safety and Hazard Investigation Board investigates chemical accidents at fixed industrial facilities. To report a chemical accident, contact the NRC. The NRC will in turn relay accident information to the Chemical Safety and Hazard Investigation Board.

(800) 424-8802 (NRC)
or (202) 267-2675

Urban Search and Rescue (US&R) Task Force

Urban Search and Rescue (US&R) task forces are designed to locate, rescue/extricate, and provide initial medical stabilization to victims trapped in confined spaces. US&R task forces are part of FEMA. FEMA can be contacted through the NRC.

(800) 424-8802 (NRC)
or (202) 267-2675

Animal Assistance

U.S. Fish & Wildlife Service

The U.S. Fish & Wildlife Service can provide assistance in dealing with incidents that threaten streams, lakes, waterways, and other fish and game reserves. Notification may be mandatory, depending on the material and the circumstances of the incident. Contact the U.S. Fish & Wildlife Service through the NRC.

(800) 424-8802 (NRC)
or (202) 267-2675

ASPCA National Animal Poison Control Center

The National Animal Poison Control Center, a division of the American Society for the Prevention of Cruelty to Animals (ASPCA), operates a 24-hour hotline staffed by specially trained veterinary toxicologists who provide information and advice to both animal owners and veterinarians. The staff can help assess the situation, compare signs and symptoms to what is known about how chemicals affect various animal species, determine if treatment is needed, and provide appropriate treatment protocols. The Center has an extensive collection of scientific journals, books, and databases at its disposal and works closely with chemical manufacturers. (There may be a small fee for services.)

(888) 426-4435

Police K-9 Units and Other Animal Resources

Many canine resources can provide invaluable assistance in an emergency. Examples include police dogs; accelerant, bomb, or drug detection dogs; search and rescue dogs, and cadaver dogs.

Contact	**Phone Number**
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Animal Assistance (continued)

Emergency Animal Rescue Service (EARS)

The Emergency Animal Rescue Service (EARS) is a volunteer-driven program of United Animal Nations (UAN) to shelter and care for animals displaced by natural disasters and other crises. UAN has more than 2500 trained EARS volunteers—experienced caregivers who can respond to any disaster, anywhere in the United States and Canada within 24 hours. EARS works with local agencies to set up and operate temporary shelters and care for displaced animals when local animal control organizations are overburdened or have been directly hit by the disaster.

(800) 440-EARS (3277)

Animal Rescue Groups

Animal rescue groups can help rescue trapped and injured animals, plus coordinate with local vets and animal hospitals to provide medical care.

Contact	Phone Number

Local Animal Agencies

Animal agencies, such as animal control, humane society, and SPCA, can help round up and care for loose animals.

Contact	Phone Number

Animal Assistance (continued)

Local Veterinarians and Animal Hospitals

Local veterinarians and animal hospitals may be needed to help assess and treat animals injured by hazardous materials.

Vet or Animal Hospital	Phone Number
______________________	______________________
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Pet Stores and Other Animal Supply Outlets

Pet stores and other animal supply outlets may be able to provide cages, leashes, food, and other items to help contain and care for animals separated from their owners.

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Additional Resources

Use this space to identify the location of additional resources.

Radios and communications equipment ...

Incident command vests, forms, and other supplies ...

Rehab supplies for responders ...

Other ...

Internet Resources

There are a tremendous number of resources on the Internet—far too many to list in this book. However, the following pages list various national agencies or organizations that are key players in hazardous materials or terrorism, most of which have links to many other resources.

Unless otherwise indicated, the resources listed are agencies within the United States and the URLs lead to each agency's home page. (All the web sites listed in this section were confirmed in July 2010.)

Selected Web Sites of Interest

Agency for Toxic Substances & Disease Registry (ATSDR)
http://www.atsdr.cdc.gov/

American Association of Poison Control Centers
http://www.aapcc.org/

American Chemistry Council
formerly the Chemical Manufacturers Association (CMA)
http://www.americanchemistry.com

American College of Emergency Physicians (ACEP)
http://www.acep.org/

American Conference of Governmental Industrial Hygienists
http://www.acgih.org/

American Industrial Hygiene Association
http://www.aiha.org/

American National Standards Institute
http://www.ansi.org/

American Petroleum Institute (API)
http://www.api.org/

American Red Cross (ARC)
http://www.redcross.org/

Internet Resources (continued)

ASPCA National Animal Poison Control Center
http://www.aspca.org

Association of American Railroads (AAR)
http://www.aar.org

Bureau of Alcohol, Tobacco and Firearms (ATF)
http://www.atf.gov/

Canadian Transport Emergency Center (CANUTEC)
http://www.tc.gc.ca

Centers for Disease Control and Prevention (CDC)
http://www.cdc.gov

Chemical Abstracts Service (CAS)
http://www.cas.org/

Chemical, Biological, Radiological and Nuclear Defense Information Analysis Center (CBRNIAC)
http://www.cbrniac.apgea.army.mil/

Chemical Manufacturers Association
now the American Chemistry Council
http://www.americanchemistry.com

Chemical Safety and Hazard Investigation Board (CSB)
http://www.chemsafety.gov

Chemical Transportation Emergency Center (CHEMTREC)
http://www.chemtrec.com/

CHEMTREC
http://www.chemtrec.com/

The Chlorine Institute
http://www.chlorineinstitute.org

Coast Guard (USCG)
http://www.uscg.mil

Compressed Gas Association
http://www.cganet.com/

Internet Resources (continued)

Computer-Aided Management of Emergency Operations (CAMEO)
http://www.epa.gov/emergencies/content/cameo/

Counter-Terrorism Training and Resources for Law Enforcement
http://www.counterterrorismtraining.gov/

Department of Defense (DOD)
http://www.defense.gov/

Department of Energy (DOE)
http://www.energy.gov/

Department of Health and Human Services (DHHS)
http://www.dhhs.gov
http://www.hhs.gov

Department of Homeland Security
http://www.dhs.gov
http://www.ready.gov
http://www.dhs.gov/xgovt/grants/index.shtm

Department of Justice (DOJ)
http://www.justice.gov/

Department of Transportation (DOT)
http://www.dot.gov
http://phmsa.dot.gov (Pipeline and Hazardous Materials Safety)
http://phmsa.dot.gov/hazmat/library/erg (ERG)

Drug Enforcement Administration (DEA)
http://www.justice.gov/dea

Emergency Animal Rescue Service (EARS)
United Animal Nations
http://www.uan.org

Emergency Nurses Association (ENA)
http://www.ena.org/

Emergency Response Guidebook (ERG)
http://phmsa.dot.gov/hazmat/library/erg

Internet Resources (continued)

Environmental Protection Agency (EPA)
http://www.epa.gov

Federal Bureau of Investigation (FBI)
http://www.fbi.gov/

Federal Emergency Management Agency (FEMA)
http://www.fema.gov

Federal Railroad Administration
http://www.fra.dot.gov/

The Fertilizer Institute (TFI)
http://www.tfi.org/

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

International Association of Fire Fighters (IAFF)
http://www.iaff.org

Mine Safety and Health Administration
http://www.msha.gov/

National Association of Emergency Medical Technicians (NAEMT)
http://www.naemt.org/

National Association of EMS Educators (NAEMSE)
http://www.naemse.org/

National Association of EMS Physicians (NAEMSP)
http://www.naemsp.org/

National Association of SARA Title III Program Officials (NASTTPO)
http://www.nasttpo.com/home/

National Communications System
http://www.ncs.gov

National Disaster Medical System (NDMS)
http://www.hhs.gov/aspr/opeo/ndms/index.html

Internet Resources (continued)

National Emergency Management Association (NEMA)
http://www.nemaweb.org

National Fire Academy (NFA)
http://www.usfa.dhs.gov/nfa/

National Fire Protection Association (NFPA)
http://www.nfpa.org

National Guard
http://www.ng.mil/
http://www.ang.af.mil/ (Air National Guard)
http://www.arng.army.mil/ (Army National Guard)

National Institute for Occupational Safety and Health (NIOSH)
http://www.cdc.gov/niosh/

National Institutes of Health
U.S. Department of Health and Human Services
http://www.nih.gov/

National Oceanic and Atmospheric Administration (NOAA)
http://www.noaa.gov

National Response Center (NRC)
http://www.nrc.uscg.mil/nrchp.html

National Response Team (NRT)
http://www.nrt.org/

National Safety Council (NSC)
http://www.nsc.org/

National Sheriffs' Association (NSA)
http://www.sheriffs.org/

National Terror Alert
http://www.nationalterroralert.com/

National Transportation Safety Board (NTSB)
http://www.ntsb.gov

Internet Resources (continued)

National Voluntary Organizations Active in Disaster (NVOAD)
http://www.nvoad.org/

Nuclear Regulatory Commission (NRC)
http://www.nrc.gov/

Occupational Safety and Health Administration (OSHA)
http://www.osha.gov

Operation Respond Institute (OREIS)
http://www.oreis.org

Salvation Army
http://www.salvationarmy.org/

Spill Control Association of America
http://www.scaa-spill.org/

Terrorism Liaison Officer Information Network
http://tlo.org/

Transportation Security Administration
http://www.tsa.gov

U.S. Army Medical Research Institute of Chemical Defense (USAMRICD)
http://usamricd.apgea.army.mil/

U.S. Army Medical Research Institute of Infectious Disease (USAMRIID)
http://www.usamriid.army.mil/

U.S. Army Soldier and Biological Chemical Command (SBCCOM)
http://www.globalsecurity.org/military/agency/army/sbccom.htm

U.S. Customs and Border Protection
http://www.customs.gov

U.S. Fire Administration (USFA)
http://www.usfa.dhs.gov/

U.S. General Services Administration
http://www.gsa.gov

Internet Resources (continued)

U.S. Immigration and Customs Enforcement
http://www.ice.gov/

United States Secret Service
http://www.secretservice.gov

World Health Organization
http://www.who.int/en/

State Homeland Security Agencies

Alabama Department of Homeland Security
http://www.homelandsecurity.alabama.gov/

Alaska Division of Homeland Security
and Emergency Management
http://www.ak-prepared.com/

American Samoa Department of Homeland Security
http://americansamoa.gov/asdhs/index.htm

Arizona Department of Homeland Security
http://azdohs.gov/

Arizona Division of Emergency Management
http://www.dem.azdema.gov/

Arkansas Department of Emergency Management
http://www.adem.arkansas.gov/

California Emergency Management Agency
http://www.calema.ca.gov/

Colorado Division of Emergency Management
http://dola.colorado.gov/dem/

Connecticut Department of Emergency Management
and Homeland Security
http://www.ct.gov/demhs/

Delaware Emergency Management Agency
http://dema.delaware.gov/

Internet Resources (continued)

Florida Department of Law Enforcement
http://www.fdle.state.fl.us/

Georgia Emergency Management Agency
http://www.gema.state.ga.us/

Guam Homeland Security
http://www.guamhs.org/main/

Hawaii State Civil Defense
http://www.scd.state.hi.us/

Idaho Bureau of Homeland Security
http://www.bhs.idaho.gov/

Illinois Emergency Management Agency
http://www.state.il.us/iema/

Illinois Homeland Security
http://www.ready.illinois.gov/

Indiana Department of Homeland Security
http://www.in.gov/dhs/

Iowa Homeland Security and Emergency Management
http://www.iowahomelandsecurity.org/

Kansas Division of Emergency Management
http://www.accesskansas.org/kdem/

Kentucky Division of Emergency Management
http://kyem.ky.gov

Kentucky Office of Homeland Security
http://homelandsecurity.ky.gov

Louisiana Office of Homeland Security
and Emergency Preparedness
http://gohsep.la.gov/

Maine Emergency Management Agency
http://www.state.me.us/mema/

Internet Resources (continued)

Maine Homeland Security
http://www.maine.gov/mema/homeland/

Maryland Emergency Management Agency
http://www.mema.state.md.us

Massachusetts Emergency Management Agency
http://www.mass.gov/mema

Michigan Homeland Security
http://www.michigan.gov/homeland/

Minnesota Homeland Security and Emergency Management
http://www.hsem.state.mn.us/

Mississippi Emergency Management Agency
http://www.msema.org/

Mississippi State Office of Homeland Security
http://www.homelandsecurity.ms.gov/

Missouri Office of Homeland Security
http://www.dps.mo.gov/HomelandSecurity

Missouri State Emergency Management Agency
http://www.sema.dps.mo.gov/semapage.htm

Montana Disaster and Emergency Services
http://dma.mt.gov/des/

Montana Homeland Security
http://dma.mt.gov/des/homelandsecurity/

Nebraska Emergency Management Agency
http://www.nema.ne.gov/

Nevada Homeland Security
http://homelandsecurity.nv.gov/

New Hampshire Homeland Security
and Emergency Management
http://www.nh.gov/safety/divisions/hsem/

Internet Resources (continued)

New Hampshire Homeland Security
http://www.nh.gov/homelandsecurity/

New Jersey Office of Homeland Security and Preparedness
http://www.state.nj.us/njhomelandsecurity/

New Mexico Department of Homeland Security
and Emergency Management
http://www.nmdhsem.org

New York State Emergency Management Office
http://www.security.state.ny.us/

North Carolina Crime Control & Public Safety
http://www.nccrimecontrol.org/

North Dakota Department of Emergency Services
http://www.nd.gov/des/

Ohio Homeland Security
http://homelandsecurity.ohio.gov/

Oklahoma Office of Homeland Security
http://www.ok.gov/homeland/

Oregon Homeland Security (Oregon State Police)
http://www.oregon.gov/OSP/CTS/index.shtml

Pennsylvania Office of Homeland Security
http://www.homelandsecurity.state.pa.us/

Rhode Island Emergency Management Agency
http://www.riema.ri.gov/

South Carolina Emergency Management Division
http://www.scemd.org/

South Dakota Office of Emergency Management
http://dps.sd.gov/

South Dakota Office of Homeland Security
http://dps.sd.gov/homeland_security/default.aspx

Internet Resources (continued)

Tennessee Office of Homeland Security
http://www.state.tn.us/homelandsecurity/

Texas Homeland Security
http://www.texashomelandsecurity.com/

Utah Division of Homeland Security
http://publicsafety.utah.gov/homelandsecurity/

Vermont Department of Public Safety
http://www.dps.state.vt.us/

Vermont Department of Homeland Security
http://hsu.vermont.gov/

Virginia Department of Emergency Management
http://www.vdem.state.va.us/

Washington Military Department
Emergency Management Division
http://emd.wa.gov/

West Virginia Division of Homeland Security and Emergency Management
http://www.wvdmaps.gov/

Wisconsin Homeland Security
http://homelandsecurity.wi.gov/

Wyoming Office of Homeland Security
http://wyohomelandsecurity.state.wy.us

Notes

Appendix

This chapter contains miscellaneous other information:

- Bibliography
- Index
- About the Author
- Other Products by Firebelle Productions

15-2

Bibliography

For easier organization, I've grouped Internet sources towards the end of the bibliography. However, instead of including every web page or document used in my research, I limited the list to those sources that were significant in answering my questions and those sources that my readers may wish to check out themselves.

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About the Author

Jill Meryl Levy owns her own business called Firebelle Productions. She is an author and publisher, specializing in books on hazardous materials and more effective writing. She is also now a paralegal, specializing in legal research and writing.

Jill has worked in the field of safety education since 1981 when she was hired by the City of Santa Clara Fire Department (CA). Later, during her employment at Hewlett-Packard Company in Cupertino (CA), Jill began producing brochures, booklets, and newsletters as a means to communicate safety information to a large employee population. The publications became so popular that she was soon producing brochures and booklets on a corporate-wide basis.

Jill first got involved with hazardous materials while working with the Governor's Office of Emergency Services California Specialized Training Institute (CSTI) on the 1994 and 1995 revisions of its *Hazardous Materials Technician/Specialist* curriculum. In 1995 she became a CSTI-certified hazardous materials specialist and a first responder outreach instructor. Jill has also assisted the California State Fire Marshal's Office with curriculum revision projects.

Jill was a volunteer firefighter for the Santa Clara County Fire Department in California from 1980 to 2009. In her spare time, Jill enjoys home construction, remodeling, quilting, and fencing (foil, épée, and saber).

Other Books by Jill Meryl Levy

- Hazardous Materials and WMDs: A Field Guide for Awareness Level Personnel
- The First Responder's Pocket Guide to Radiation Incidents
- Hazmat Chemistry Study Guide
- The Hazmat Chemistry Mini Review
- The Hazmat Chemistry Pocket Pal
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