Hazardous Materials and WMDs

A Field Guide for Awareness Level Personnel

(2008 Edition)

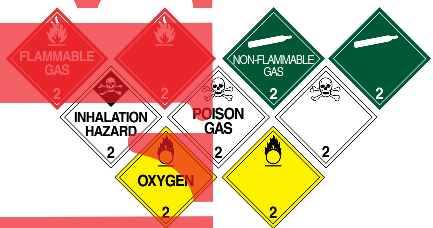
Jill Meryl Levy

Firebelle Productions

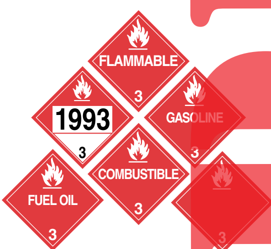
Color Reference Chart

Shown below are color renditions of the UN/DOT labels and placards illustrated in Chapter 3. More color illustrations are provided on the inside back cover.

Class 1: Explosives and Blasting Agents



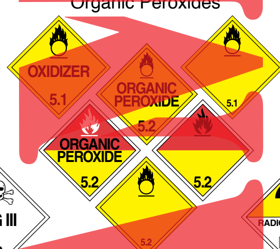
Class 2: Gases and Cryogenic Liquids



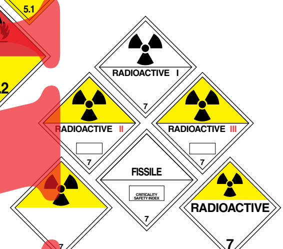
Class 3: Flammable and Combustible Liquids

Class 4: Flammable Solids, Spontaneously Combustible Materials, Dangerous When Wet Materials

Class 5: Oxidizers and Organic Peroxides



Class 6: Poisonous and Infectious Substances



Class 7: Radioactive Materials

Class 9: Misc. Hazmats

Class 8: Corrosives

Mixed Load

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Campbell, CA

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How to Use This Book

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

1. **The Basics** covers the core responsibilities for all awareness level personnel.

2. **Beyond the Basics** contains additional guidelines for people who may be part of an emergency response system but are not operations level responders.

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.

5. **Assessing the Hazards** covers ways in which hazardous materials cause harm, toxicity and risk, toxicological terms, occupational exposure limits, properties of flammable liquids, and other chemical and physical properties.

6. **Medical Management of Hazmat Exposures** provides information on the risk of secondary contamination, patient decon guidelines, triage, EMS treatment protocols, handling the dead, and coordinating with other medical providers.

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.

9. **Chemical Warfare Agents** has general information on nerve agents, blister agents, blood agents, choking agents, and riot control agents.

(continued next page)

How to Use This Book (continued)

10. **Biological Warfare Agents** provides general information on biological warfare agents and "white powder incidents."

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

12. **Resources for Information and Assistance** contains a brief overview of the ERG, shipping papers, and material safety data sheets. It also contains some phone numbers you may find useful.

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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Preface

Why This Book Was Written

Hazardous Materials and WMDs: A Field Guide for Awareness Level Personnel was conceived for two reasons. One, 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 deal with 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's Target Audience: Awareness Level Personnel

This book addresses most of the NFPA 472 (2008 edition) competencies for **awareness level personnel** (still called *first responder awareness level* in 29 CFR 1910.120).

Awareness level personnel are those persons 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.

Another Book for Operations Level Personnel and Incident Commanders

This book is a condensed version of *The First Responder's Field Guide to Hazmat & Terrorism Emergency Response*—which 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).

Preface (continued)

Another Book for Operations Level Personnel and Incident Commanders (continued)

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.

The First Responder's Field Guide to Hazmat & Terrorism Emergency Response also covers most of the **incident commander** competencies.

No "One Size Fits All" Approach

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. 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.

Preface (continued)

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) specifically refers to 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 what's required by law) because they are considered the standard of care.

Your Responsibility

This book is *just a guide*. It's not intended as a tool to determine regulatory compliance. It's not intended to replace formal 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.

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Because this book evolved from others I've written, I give credit to everyone who provided input for this field guide, *The First Responder's Field Guide to Hazmat & Terrorism Emergency Response*, and *The First Responder's Pocket Guide to Radiation Incidents*. (For simplicity, people are listed below in alphabetical order, with title and affiliation as of the last time they reviewed any draft.)

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✦ ✦ ✦

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The explosives photographs were provided by Greg Smith.

Some of the graphics in this book exist in the public domain.

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
AEGL	Acute Exposure Guideline Level
AIHA	American Industrial Hygiene Association
ALARA	As Low As Reasonably Achievable
ammo	Ammunition
ANFO	Ammonium Nitrate and Fuel Oil
APR	Air Purifying Respirator
ATF	Bureau of Alcohol, Tobacco and Firearms
atm	Atmospheres
BLEVE	Boiling Liquid Expanding Vapor Explosion
Bq	Becquerel
BVM	Bag-Valve Mask
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
CFR	Code of Federal Regulations
CG	Phosgene
CHEMTREC	Chemical Transportation Emergency Center
Ci	Curie
CK	Cyanogen Chloride
CL	Chlorine
CN	Chloracetophenone (Tear Gas, Mace)
cpm	Counts per Minute
CR	Dibenzoxazephine (Tear Gas)
CS	Chlorobenzylidenemalononitrile (Tear Gas)
CSI	Criticality Safety Index
CST	Civil Support Team (National Guard)
CX	Phosgene Oxime

Acronyms and Abbreviations (continued)

Decon	Decontamination
DHS	Department of Homeland Security
DM	Diphenylaminearsine Chloride (Adamsite)
DNA	Deoxyribonucleic Acid
DOT	Department of Transportation
DOT-E	Department of Transportation Exemption
DOT-SP	Department of Transportation Special Permit
EMS	Emergency Medical Services
ERG	Emergency Response Guidebook
EPA	Environmental Protection Agency
ERPG	Emergency Response Planning Guideline
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
HMIS®	Hazardous Materials Identification System
HN	Nitrogen Mustard
HRCQ	Highway Route Controlled Quantity
HVAC	Heating, Ventilation, and Air Conditioning
IAP	Incident Action Plan
IC	Incident Commander
ICS	Incident Command System
IDLH	Immediately Dangerous to Life and Health
IED	Improvised Explosive Device
IM	Intermodal
IMS	Incident Management System

Acronyms and Abbreviations (continued)

JIC	Joint Information Center
L	Lewisite
LC	Lethal Concentration
LD	Lethal Dose
LEL	Lower Explosive Limit
LEPC	Local Emergency Planning Committee
LNG	Liquefied Natural Gas
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
mmHg	Millimeters of Mercury
MOT	Materials of Trade
mR/hr	Millirems per Hour
rem	Millirems
MSDS	Material Safety Data Sheet
MSST	Maximum Safe Storage Temperature
NA	North America
NBC	Nuclear, Biological, and Chemical
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NIOSH	National Institute for Occupational Safety and Health
NRC	National Response Center
NRT	National 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
PCB	Polychlorinated Biphenyl
PCP	Pest Control Product
PEL	Permissible Exposure Limit
PIO	Public Information Officer
PPE	Personal Protective Equipment

Acronyms and Abbreviations (continued)

ppb	Parts per Billion
ppm	Parts per Million
PS	Chloropicrin (Mace)
psi	Pounds per Square Inch
rad	Radiation Absorbed Dose
REL	Recommended Exposure Limits
rem	Radiation Equivalent Man
RNA	Ribonucleic Acid
RQ	Reportable Quantity
SADT	Self-Accelerating Decomposition Temperature
SCBA	Self-Contained Breathing Apparatus
SCO	Surface Contaminated Objects
SDS	Safety Data Sheet
SERC	State Emergency Response Commission
SOP	Standard Operating Procedure
START	Simple Triage and Rapid Treatment
STEL	Short-Term Exposure Limit
Sv	Sievert
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
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
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.

While every reasonable effort has been made to ensure accuracy, the author, Firebelle Productions, and the individuals who helped review this document shall have neither liability nor responsibility to any person or entity with respect to any loss or damage caused, or alleged to be caused, directly or indirectly by the information contained in this book.

If you do not wish to be bound by the above, you may return this book to Firebelle Productions for a full refund.

The Basics

Awareness level personnel are people 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. This chapter will guide you that far.

However, this book is also written for people who may be part of an emergency response system but are not operations level responders. Their responsibilities may go beyond what is presented in this chapter. Thus it is up to each reader to use what is applicable at his or her level and leave the rest for appropriate personnel.

Lay a Safe Foundation

What occurs in the first minutes of a hazmat incident or terrorist event significantly affects what happens in the hours that follow.

At the awareness level, your responsibility is to get the ball rolling by recognizing the problem, calling for trained personnel, and securing the area. Do everything you can to ensure your safety so that you don't become part of the problem or endanger the lives of others.

Perform the Following Tasks Safely

- Detect the presence of hazardous materials/WMDs.
  (See the clues on page 1-4.)
- Identify the problem. Survey the incident from a safe location (upwind, uphill, upstream) to obtain information for emergency responders.
  (See the guidelines on pages 1-5 to 1-6.)
- Call for trained personnel (911 or the appropriate number in your area). (Additional notifications may be required.)
  (See page 1-7.)
- Isolate and deny entry, then prepare for additional protective actions (evacuation or in-place protection) as appropriate.
  (See pages 1-8 to 1-10.)
- Ensure your safety first, last, and always.
  (See page 1-11 in addition to the safety reminders throughout this chapter.)

Your responsibilities may go beyond those listed above, and for that reason, you'll find a lot of additional information throughout this book. 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.

Detect the Presence of Hazardous Materials or WMDs

It's not always immediately obvious when hazardous materials or WMDs are present. Many hazmat/WMD incidents are initially reported to emergency responders 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 a 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 (upwind, uphill, upstream), and use binoculars if needed.
- Be cautious of touching anything from the scene (including patients and shipping papers) that may be contaminated.

Identify the Problem

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

Define the Problem

- What type of incident is this? Fire, spill, odor complaint, etc?
- Has anyone been injured? If so, how many people? What type of injuries?
- Has the container been damaged? Has any product been released?
- Are there any indications of criminal or terrorist activity? (See Chapter 7 for more information.)

These are just a few examples. The more details you can provide, the better.

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.

Possible sources for product identification include:

- Placards, labels, pipeline markers, or other marking systems
- Shipping papers and material safety data sheets (MSDS)
- Facility employees, vehicle driver, or other responsible party
- Business plans, facility preplans, etc.
- Hazardous waste manifests

Identify the Problem (continued)

Identify the Product (continued)

When you can't positively identify the product, provide the best information available:

- The four-digit UN/NA identification number on a placard. (Sometimes this is as good as a chemical name. Sometimes it merely narrows it down to a small number of similar products, all of which have the same UN/NA identification number.)
- Labels, placards, or other markings. (See Chapter 3 for more information.)
- Container shapes. (See Chapter 4 for more information.)

Be Wary

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 indicating a mixed load shipment.
- Shipping papers or MSDSs are unavailable or inaccessible.
- There are any indications of criminal or terrorist activity.

Collect Hazard Information from the ERG

Once you call for trained personnel (see page 1-7) and isolate the area (see pages 1-8 to 1-10), begin collecting hazard information from the current edition of the *Emergency Response Guidebook* (ERG) or other available reference sources. (If you're not familiar with how to use the ERG, see pages 12-3 to 12-8).

Call for Trained Personnel

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

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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 do not 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

For most awareness level personnel, the notification responsibility ends with calling 911. Dispatchers and emergency responders will take it from there. However, various laws require the responsible party to report a release. So if you're somehow responsible for the hazardous material involved, you may need to make additional notifications (or coordinate with emergency responders who do so). (See pages 2-6 to 2-9 for more information.)

Isolate and Deny Entry

Establish an Initial Isolation Zone (Perimeter)

Set up an *initial isolation zone, or perimeter,* to keep people out of danger. This step is also known as *isolate and deny entry*.

- Direct potentially contaminated people to a safe refuge area where they can be evaluated and decontaminated if needed by emergency responders.
- Direct witnesses who may have important information to remain on scene in a safe location until interviewed and released by emergency responders.
- Establish the initial isolation zone based on information in the ERG or other reference sources, department SOPs, or the recommended distances on the following page.
- 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.
- Use existing barriers (gates, fences, etc.) whenever possible. They are generally more reliable than barrier tape and traffic cones.
- Do not use flares if flammable vapors are suspected.

Prepare for Additional Protective Measures As Needed

Depending on the circumstances, a hazmat team may set up control zones (hot, warm, and cold). This is not an awareness level responsibility. However, awareness level personnel should be familiar with these control zones. (See page 2-10 for more information.)

The incident may require protective actions (evacuation or sheltering in place). These are activities that awareness level personnel may be able to assist with. (See pages 2-20 to 2-27 for more information.)

Isolate and Deny Entry (continued)

Recommended Distances - Outdoor Incidents

If you know the product, use the *Emergency Response Guidebook* (ERG) for recommended safe distances. If you don't know the product, you can use the distances below, which have been 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—the 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.

- **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 8-19)

Isolate and Deny Entry (continued)

Recommended Distances - Outdoor Incidents (continued)

Adjust isolation distances as needed based on wind, rain, topography, fire, etc. If you don't know the hazards of the material, consider its form; any gas 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 a single, 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.

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 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). Anticipate that the product may spread via air handling systems, floor drains, etc., and adjust accordingly.

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.

Ensure Your Safety First, Last, and Always

From the moment you recognize a hazmat incident or terrorist event, you should be doing everything possible to ensure your safety so that you don't become part of the problem or endanger the lives of others. The guidelines below supplement everything that has already been emphasized throughout this chapter.

Follow Basic Safety Guidelines

- Maintain a safe distance (upwind, uphill, upstream), and use binoculars as needed.
- Do not drive through spills or clouds.
- Treat all materials as hazardous until proven otherwise.
- Observe *all* hazards. Most chemicals have multiple hazards associated with them. Other dangers on scene may include traffic, tripping hazards, electrical hazards, sharp objects, or bad terrain.
- Be alert for signs of criminal or terrorist activity, including the possibility of secondary events or devices. Don't touch suspicious items.
- 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.
- 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.
- 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*. Don't, however, go near the hazardous material to do so.
- Avoid the temptation to engage in rescue operations. Rescue is not an awareness level function. (When faced with major events, such as 9/11 and the Oklahoma City bombing, it's not unreasonable for people at all levels to pitch in and do what is needed. But otherwise, you're more likely to become part of the problem and further endanger the lives of emergency responders.)

Beyond the Basics

Where Chapter 1 was designed to address the needs of all awareness level personnel, this one goes beyond the basics for the benefit of those who may be part of an emergency response system but are not operations level responders.

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

How to Use This Chapter

Most of the awareness level responsibilities were outlined in the first chapter. However, if you are part of the emergency response network, your responsibilities may go further.

Potential Responsibilities

This chapter covers other functions that an awareness level person might be involved with. Refer to the following topics as appropriate.

(Note: Patient care is covered separately in Chapter 6.)

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

If you work at a facility that manufactures, uses, stores, or transports hazardous materials, the law requires your employer to inform you about those materials and the risks they pose. However, you can encounter hazardous materials almost anywhere you go in the course of your normal duties:

- 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)

Report on Conditions

If you're first on scene as part of the emergency response effort, you'll need to give a report on conditions as soon as possible.

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

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.

Make Additional Notifications As Appropriate

At the awareness level, your primary responsibility is to get trained emergency responders on scene as quickly as possible. The dispatchers and/or emergency responders will usually do the rest.

However, if you're somehow responsible for the hazardous material involved, you may need to make additional notifications (or coordinate with emergency responders who do so). 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. (Some regulations require notifications be made for *threatened* releases also in order to track and evaluate near-miss accidents.)

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 2-8 and 2-9 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 or (202) 267-2675
Others ____________________	___________________
__________________________	___________________

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

Make Additional Notifications (continued)

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 (leak, spill, fire, etc.) and environment affected (air, land, water)
- Time, duration, and estimated quantity of the release
- The extent of injury, if any
- 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
- Whether a continuing danger to life exists at the scene

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 (e.g., EPA, FBI, health department) are often mandatory, depending on the hazardous material involved, the population or environment threatened, the location in which the incident occurred, or circumstances of the event.

Often these additional notifications will be made by the National Response Center (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.

Make Additional Notifications (continued)

Reporting Requirements

The following summary of when to call the National Response Center (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)

Make Additional Notifications (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

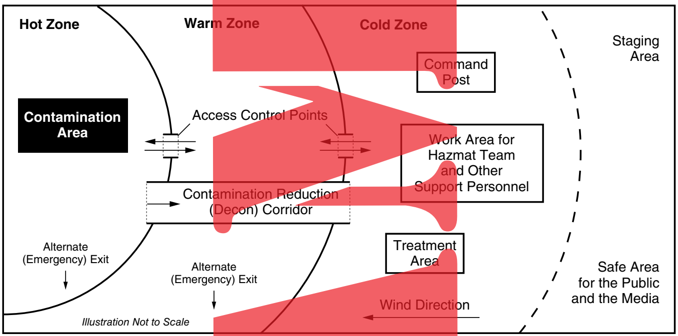
Chemical Releases: The responsible party must notify the NRC of all releases of hazardous substances exceeding the reportable quantities (indicated by “RQ” on an MSDS or shipping papers).

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.

Enforce Control Zones

You should have already set up an initial perimeter to isolate and deny entry. (See page 1-8.) A hazmat team will subsequently set up *control zones* based on established exposure limits and the results of atmospheric monitoring. The three control zones are as follows:

- **Hot (Exclusion) Zone** - 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** - Zone where decontamination activities take place. It requires the use of proper PPE once contaminated people or equipment enter the zone.
- **Cold (Support) Zone** - 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

At the awareness level, you might have a role to play in the cold zone, but there's no reason for you to be in the hot or warm zones.

Work Within the Incident Command System (ICS)

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

Initial Duties

Awareness level personnel with a basic understanding of the Incident Command System can easily establish command and set the stage for success until relieved by someone of higher authority. If you are first on scene:

- 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.

Work Within the Incident Command System (continued)

Personnel Accountability

Any response to a hazmat/WMD incident 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. If you're part of the emergency response system, you're expected to do the following:

- Check in at the command post or staging area, as appropriate.
- Remain under the supervision of whomever you've been assigned to until you are reassigned or released from the incident. There should be no freelancing.
- When you're ready to leave the scene, check out through your supervisor or the command post, as appropriate.

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.

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.

Plan Your Activities

NFPA 472 does not include planning a hazmat response as an awareness level competency. However, you or your agency may have responsibility for specific components of the plan (e.g., patient care or evacuation). The following are basic guidelines to supplement your department SOPs.

Overall Incident Strategy

At the awareness level, you shouldn't be engaged in defensive or offensive actions. (Possible exceptions might include shutting off a remote valve or helping to build a dam well downstream of the product.) However, it's important to understand the overall incident strategy.

- 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.
- **Offensive actions** are those conducted to stop the release. They are usually done by hazardous materials technicians.

General Safety and Security Measures

Each component of the incident action plan has its own safety and security concerns. So even if your responsibilities are limited (e.g., patient care or evacuation), you need to evaluate the safety and security risks and plan accordingly. The following are a few key points.

- Identify potential problems or risks before taking action.
- 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.

(continued next page)

Plan Your Activities (continued)

General Safety and Security Measures (continued)

- Develop a communications plan. Make sure all personnel have reliable radios (or cell phones) and are on appropriate channels. Have a backup plan (e.g., hand signals or air horn blasts) in case of an emergency or equipment failure.
- 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. (See pages 2-20 to 2-27.)
- 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.
- Take appropriate measures to protect personnel from heat stress or hypothermia.
- Identify procedures to preserve any evidence you might discover. (See pages 2-36 to 2-40.)
- Follow your department SOPs, and stay within the limits of your training, resources, and equipment.
- Document your activities.

Emergency Medical Services

- Identify whether there are multiple patients, whether triage is needed, and how triage will be accomplished.
- Determine if patients have been adequately decontaminated. (Although there are some circumstances where medical care can be started before patients have been fully decontaminated, that's generally beyond the scope of awareness level personnel.)
- If contaminated patients have already left the scene, alert area hospitals.
- Determine the level of medical care needed.
- Determine resources needed (EMS providers, PPE, medical supplies). Request additional resources as needed.

Participate in the Safety Briefing

A safety briefing must be conducted to make sure that all personnel understand the objective and their responsibilities.

Items Typically Covered in a Safety Briefing

The items below are typically part of a full safety briefing. Ideally, even awareness level responders would be included in that briefing. However, it's not uncommon for some people to be excluded, because not all activities on scene can come to a halt to hold a meeting.

If you are not included in the safety briefing for some reason, be sure that your supervisor reviews with you any of the components that apply to your role at the incident:

- Preliminary evaluation of the incident
- Hazards/risks and appropriate safety measures:
  - The material and its container
  - Other hazards on site (traffic, trip/fall, 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

Wear Appropriate PPE (Personal Protective Equipment)

NFPA 472 does not include wearing personal protective equipment (PPE) as an awareness level competency. And for the most part, awareness level personnel shouldn't be in a position to need it. However, there are some notable exceptions.

PPE Required in the Workplace

You may be required to wear gloves, goggles, eye protection, or other PPE as part of your job. Any of the following resources should identify the appropriate PPE:

- Material safety data sheets (MSDS)
- Container labels
- Department SOPs or safety manuals
- Facility signage

It's beyond the scope of this book to address the limitations of the equipment or how to use it. Consult the manufacturer's instructions and your department's PPE program.

Emergency Medical Services

No special protective gear is required when caring for patients who have been thoroughly decontaminated. Universal precautions or body substance isolation procedures should suffice. (See page 6-6.)

The same is true for patients who have been exposed only to a gas, unless the concentration was great enough to have condensed into a patient's clothing. In that case, the patient must be decontaminated before awareness level personnel can safely render care.

Note: 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)

Healthcare Facilities

In general, the same guidelines that apply to EMS personnel in the field apply to personnel in healthcare facilities. However, there's always the risk of walk-in patients who weren't decontaminated at the scene.

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.) It's beyond the scope of this book to address the limitations of the equipment or how to use it. Consult the manufacturer's instructions and your department's PPE program.

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.

Law Enforcement

If you're in law enforcement, there's a reasonable chance you could someday use or be exposed to riot control agents. In that environment, you should wear department-issued respiratory protection and cover exposed skin.

Respect the Need for Decon

Decon (decontamination) is not an awareness level function. However, decon is addressed in this book for three reasons:

- You need to understand the importance of it. (See below.)
- There's no reason you can't help set up a decon station. (See next page.)
- It's probably unrealistic to expect people to hold off helping an injured family member, friend, or coworker, despite warnings that one should be properly trained and have proper PPE before attempting patient decon. Therefore, some basic guidance is warranted. (See pages 6-8 to 6-11 for general patient decon information.)

The Importance of Decon

Decon 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. 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. Decon should be done anytime contamination is suspected.

General Decon Concepts

- Personnel used for decon must be trained and have proper PPE.
- Emergency decon must be in place before emergency responders attempt rescue.
- Patients who can walk should be directed to walk to the decon area or emergency showers so that responders need not go into the hot zone unnecessarily.
- 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.

Respect the Need for Decon (continued)

Locating the Decon Station

If you're asked to help set up a decon station, do so in a location that will allow the decon team 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. (PPE is not required until contaminated people or equipment enter the warm zone.)
- Choose a location that is large enough to safely contain all activities and where the decon team 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.
- Set up multiple stations if needed (e.g., for men and women, for ambulatory and nonambulatory patients, for children and adults, or for patients and responders). More stations require more resources, but it can help responders 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 the decon team won't have to depend on generators.
- 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 responders still need to be concerned about containing runoff water used for decon.

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 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.
- 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 proper PPE.
- 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)

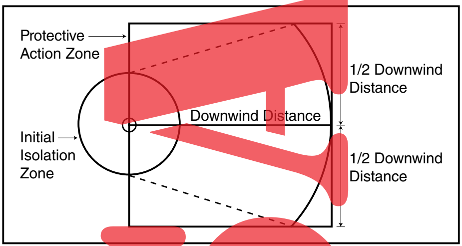
Protective Action Distances

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 a single 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

Implement Protective Actions (continued)

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, etc.) and how often they can expect updates.

If it's possible 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.)

Implement Protective Actions (continued)

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 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: ____

Implement Protective Actions (continued)

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. 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.

Implement Protective Actions (continued)

Hurricane Katrina threw a spotlight on problems associated with large-scale evacuations. However, even a relatively small incident will have similar concerns.

Evacuation Concerns

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.

(continued next page)

Implement Protective Actions (continued)

Evacuation Concerns (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 Shelter Concerns

- 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)

Implement Protective Actions (continued)

Emergency Shelter Concerns (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.

Address the Special Needs of Children

It is often necessary to modify your 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 you can modify or supplement based on your 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.)

Address the Special Needs of 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 that might add to their anxiety (e.g., injured persons, disturbing television broadcasts).
- Be careful what you say. The humor adults sometimes use to cope with tragedy may not be appropriate around children.
- Particularly for younger children, provide comfort items (e.g., a teddy bear) that they can hold on to.
- Seek assistance from trained counselors, mental health professionals, or teachers.

Address the Media As Appropriate

Dealing with the media is not necessarily an awareness level function. However, given the broad range of people who fall into this category, it's possible that you may be tasked with that responsibility. The following pages are complete enough to be used by emergency response agencies. Use what is applicable at your level. Refer the rest to the appropriate personnel.

The Rights of the Media

The media have legal right of access at an emergency scene in order to keep the public informed. In general, the only times the media may be denied access is 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 the specific laws that apply in your state.

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.

Address the Media As Appropriate (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" 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.

(continued next page)

Address the Media As Appropriate (continued)

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 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 the camera or tape recorder is on.
- 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.

Beware Illicit Laboratories

Illicit laboratories deserve special mention because of the unique hazards they present. Illicit laboratories for the manufacture of drugs, WMDs, and other weapons can be found virtually anywhere in your community—in buildings, in vehicles, or in remote outdoor locations. 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.)

Beware 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.

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.

Beware Illicit Laboratories (continued)

Dealing with illicit laboratories is beyond the scope of awareness level personnel. However, the following guidelines are provided because you need to know what to do if you encounter an illicit laboratory.

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 (both inside and outside).
- 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 vehicles at a safe distance, pointing in the direction of egress if possible.
- Preserve evidence as much as possible.
- Isolate and decon contaminated personnel and equipment.

Help Preserve Evidence

Although NFPA 472 does not include preservation of evidence as an awareness level competency, there are many scenarios in which you might have some responsibility for evidence. Thus the following guidelines are provided with the caveat that you should be working only in areas where hazardous materials are *not* present.

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

Protecting Evidence

Protect evidence as much as possible to the extent that it does not hamper emergency operations. Remember, however, that you should be working only in areas where hazardous materials are *not* present.

- 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).
- 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.
- 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., treatment and rehab areas). The tarps provide a secondary means to collect evidence.

Help Preserve 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.

Help Preserve Evidence (continued)

Documenting Evidence

Good documentation is also essential to protecting the evidentiary value of anything you collect.

- 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., 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.

Help Preserve 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. (Remember, you should be working only in areas where hazardous materials are *not* present.)

- Wear appropriate PPE. (Even if hazardous materials are not present, you may need PPE to protect against blood and bloodborne pathogens, sharp objects, and other concerns.)
- 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.
- When collecting samples, collect a large enough sample to be useful for laboratory analysis, evidence in court, etc. (At the awareness level, you shouldn't be collecting anything hazardous. When hazardous substances are involved, there's also a need to keep sample sizes small to avoid exposing other people to danger.)
- Collect control samples when applicable (e.g., uncontaminated debris to compare against other samples).
- 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.
- Thoroughly wash your hands after handling evidence.

Facilitate Cleanup and Disposal

Cleanup and disposal are not awareness level functions. However, if you are (or represent) the person responsible for the hazardous material, you need to understand the legal and financial obligations. The following is a brief overview.

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. 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.

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.

Debrief As Appropriate

Terminating a hazmat/WMD incident generally involves a debriefing, a post-incident analysis, and a critique. Responders at the awareness level may be involved in some of these meetings.

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. An effective debriefing should:

- Inform personnel 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 and results.
- Summarize the activities performed.
- Identify damaged and contaminated equipment.
- Assign information-gathering responsibilities for a post-incident analysis and critique.
- Assess the need for a critical incident stress debriefing.

Post-Incident Analysis

The post-incident analysis is a reconstruction of the incident conducted to establish a clear picture of events, ensure the incident is properly documented, determine who is financially responsible, and 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, not on finding fault with individual performance. However, it should also constructively address any violations of generally accepted safe operating practices, laws, standards, etc. How did the violations affect the outcome? What changes might be needed in managing future incidents?

Document As Appropriate

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. Follow your department SOPs.

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.

EMS Records

EMS records will generally require the following information.

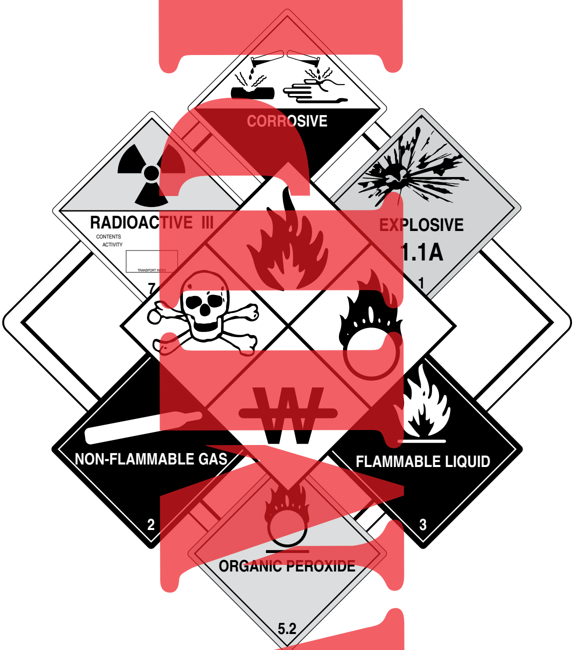
- Detailed information on the material and its health effects
- Pertinent information on each patient treated or transported
- Routes, extent, and duration of exposure
- Actions taken to limit exposure and contamination
- Decontamination performed
- Medical care rendered

Employee Exposure Records

If you've been exposed to the hazardous material, make sure it's documented. It's important to document all exposures, whether or not you are experiencing any symptoms immediately afterwards. It's 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.

OSHA requires employers to keep exposure records for 30 years. Although employees have a right to obtain copies of these documents, it's 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.

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.

Note: Color illustrations are provided on the inside of the front and back covers.

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.

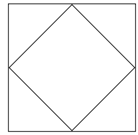
The 4-Digit UN/NA Identification Number

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 may 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. 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

Placards and labels can 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 page 3-21.) 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 for identifying the materials.

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.
- Vehicles are not always properly placarded. *Most* shippers try to be diligent, but vehicles sometimes contain the wrong placards or no placards at all. Even packages may be improperly labeled.
- 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 - Inhalation Hazard Zone A or B)
- 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 - other than Inhalation Hazard Zone A or B)
- Corrosives (Class 8)
- Miscellaneous (Class 9)

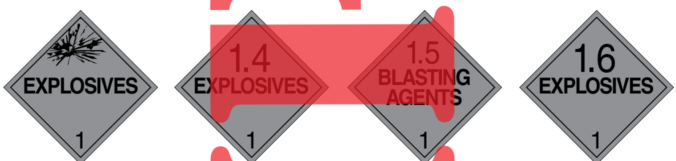
Dangerous Placards - Mixed Load

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



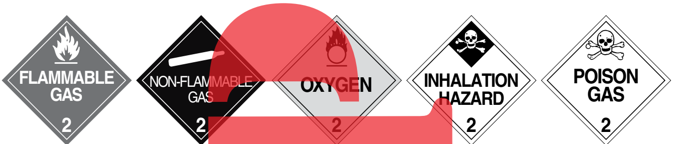
- One reason explosives are so dangerous is that they contain both an oxidizer and a fuel component in their structures. Two sides of the fire triangle are already complete.
- Many people have been killed by explosives because they underestimated the hazard potential.
- There is little difference between 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.
- The NFPA *Fire Protection Handbook* suggests evacuating to a distance of at least 2000 feet (600 meters) for fires involving explosives. The ERG shows distances up to 1 mile (1600 meters).
- 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 a lower explosive limit (LEL) of not higher than 13% or a flammable range of at least 12%, regardless of the LEL. Beware "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. 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 behave much like pressure vessels in an emergency.
- Cryogenic liquids are time-sensitive and cannot be stored for too long before they warm up and expand. If a cryogenic cylinder or tank has been damaged and the insulation compromised, the danger is even greater.

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*.
- Closed containers exposed to direct flame impingement are likely to fail unless cooled quickly.
- 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. Thus firefighters will sometimes let the product burn and protect exposures instead.
- 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.

Class 3 - Flammable and Combustible Liquids (continued)

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 will be easier to ignite in hot environments (e.g., if spilled on hot asphalt on a hot day).
- 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).

See pages 5-16 to 5-24 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)

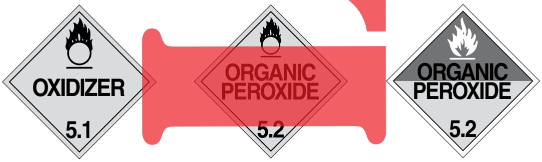
- Flammable solids burn vigorously and persistently once ignited. Metal shavings, dusts, or powders can be very dangerous under the right conditions because there is so much surface area available to burn. Combustion can be so rapid and produce sufficient pressure that it results in a dust explosion.
- 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.
- 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.
- Organic peroxides are flammable and unstable; they are more dangerous than ordinary oxidizers. 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. Withdraw to a safe distance—at least 2000 feet (600 meters).
- Some organic peroxides can form highly unstable, shock-sensitive crystals on the outside of the container if exposed to air.
- 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. 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)

- Avoid contact with poisonous or infectious substances.
- Good sources for information about these products include your local poison control center, CHEMTREC, and the CDC.
- 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). 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). PG I is the most dangerous and has two hazard zones, *generally* described as shown below. (Per 49 CFR 173.133, hazard zone also depends on vapor concentration.)

Zone	**LC_{50} greater than**	**LC_{50} less than or equal to**
A	—	200 ppm
B	200 ppm	1000 ppm

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 11-18.) 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 11-10 to 11-13.)
- 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.
- 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. (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.

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, 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.) Often the extent of the injury is not immediately obvious, something corrosive burns (acids and bases) have in common with thermal burns.

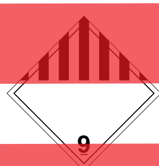
- The *strength* of a corrosive is measured by pH. The pH scale goes from 0 to 14, with 7 being neutral. Materials with a pH from 0 to 6 are acidic. The closer to 0, the stronger the acid. Materials with a pH from 8 to 14 are basic. The closer to 14, the stronger the base.
- Corrosives are also measured 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.
- Smoke from burning corrosives is also very dangerous.
- Acids and bases are not compatible with each other.
- 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 page 5-25 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	CONSUMER COMMODITY
ORM-D	**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:

- 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 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. (Color versions of these illustrations are provided on the inside of the front and back covers.)

- 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.

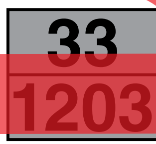
Examples of Canadian Transport Placards

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:

- Doubling of a digit indicates an intensification of the hazard. The example above (33) signifies a highly flammable liquid.
- If a digit is followed by zero (e.g., 30), the initial digit is sufficient to convey the hazard.
- 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. However, these markings are also sometimes found on individual containers.

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*.

Copyright © 2007, National Fire Protection Association, Quincy, MA 02269. This warning system is intended to be interpreted and applied only by properly trained individuals to identify fire, health, and stability hazards of chemicals. The user is referred to recommended classifications of certain chemicals in the *NFPA Fire Protection Guide to Hazardous Materials*, which should be used as a guideline only. Whether the chemicals are classified by NFPA or not, anyone using the 704 system to classify chemicals does so at their own risk.

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	Position	What It Signifies
Blue	Left	Health Hazards
Red	Top	Flammability Hazards
Yellow	Right	Instability Hazards
White	Bottom	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 (W̶) 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 W̶ 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 W̶ 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 know that this 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.

NFPA 704 Marking System (continued)

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.

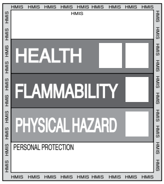
NFPA 704 Marking System (continued)

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.
- 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®)

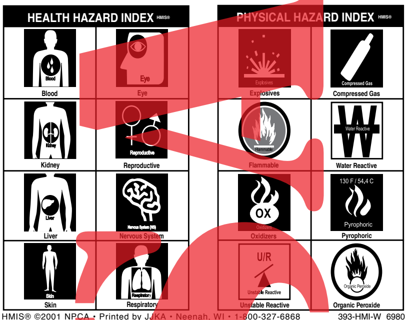
The Hazardous Materials Identification System (HMIS®) developed by the National Paint & Coatings Association (NPCA) is similar to the NFPA 704 system in its use of colors and numbers (0 to 4) to quickly communicate the relative hazards. However, HMIS® labels have a different purpose. They're designed 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).

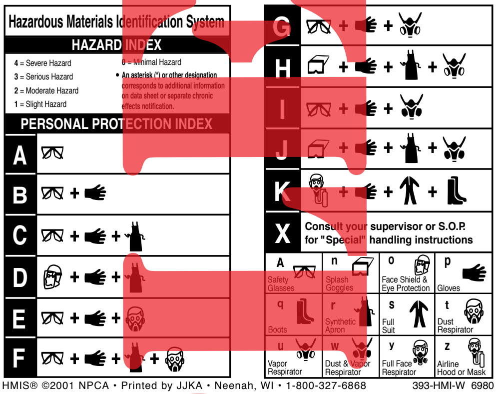
It's beyond the scope of this field guide to describe HMIS® labels in detail. However, the following are some other key features:

- 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 at 800-327-6868. 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

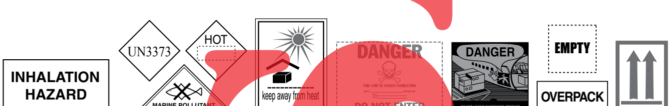
- Nearly all military ordnance are designed to cause significant damage to life and/or property. Use extreme caution.
- Military drivers may be under orders not to identify their cargoes. But if a military driver rapidly abandons the vehicle, it's a good clue that you should withdraw immediately. Use 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.

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. This is another indication that hazardous materials are present. The following are just a few examples.

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 ANSI Standard A13.1-1996 for pipe identification. However, it is a *standard*, not a regulation, so view label colors with caution.

Label Color	**Significance** *(if applied per ANSI standards)*
Yellow	High-hazard materials (flammable, explosive, toxic, corrosive, radioactive, high temperature, or high pressure)
Green	Low-hazard liquids or liquid mixtures
Blue	Low-hazard gases or gaseous mixtures
Red	Fire suppression materials (water, foam, carbon dioxide, or halon)

Facilities elsewhere may use other colors. For example, in Mexico, a red label indicates a flammability hazard, a yellow label indicates dangerous fluids, and a green label indicates low-risk fluids.

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. (A brief overview of safety data sheets and how they differ from MSDSs is provided on page 12-11.)

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/eye 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.)

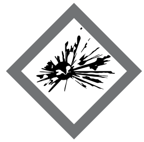
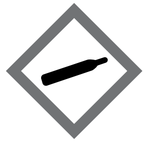
The GHS contains a "menu" of suggested standardized statements for use on labels. These statements fall under the major headings below. (The details are beyond the scope of this book.)

- Physical hazards
- Prevention of potential misuse and exposure to health
- Appropriate action in the event of an accident
- Environmental protection and appropriate disposal
- Special statements for consumer products

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

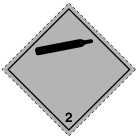
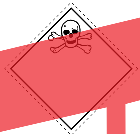
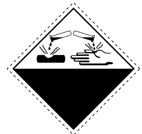
GHS Labels

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. (See the inside back cover for color versions.)

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	

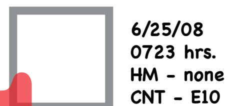
Urban Search & Rescue (US&R) Marking System

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*.

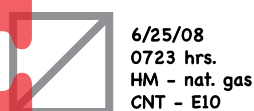
Structure/Hazards Evaluation Marking (FEMA)

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.

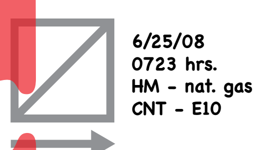


Structure is significantly damaged. Some areas are relatively safe, but other areas may need shoring, bracing, or removal of falling and collapse hazards.



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)

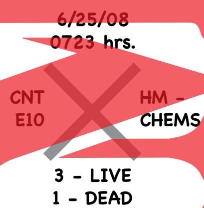
Search Assessment Marking (FEMA)

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.)

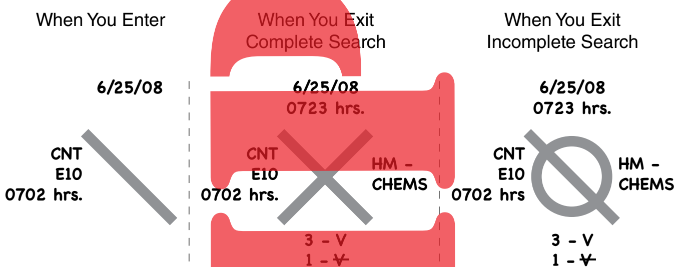
The location of victims inside a building must also be marked with spray paint, surveyor's tape, flags, or other markers. And all markings must be updated when victims are removed. This prevents a duplication of efforts and helps keep responders safe.

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

Other Markings

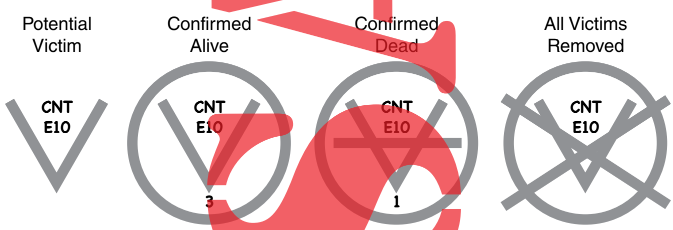
The markings on this page are *not* part of FEMA's September 2003 *Field Operations Guide*, but other agencies have adopted them to communicate additional information. They're similar to the FEMA markings, with the following exceptions:

- 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."



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.



Container Recognition

Container shape alone is often a good clue that hazardous materials are present. Some containers are distinct enough that it's possible to determine what *type* of hazardous materials are involved, even when no other information is available.

This chapter provides an overview of different containers, what they're used for, and general safety considerations for awareness level personnel.

General Overview

What This Chapter Covers

This chapter groups containers and packages as listed below.

- Nonbulk Packaging
- Bulk Packaging (other than those below)
- Intermodal Tanks
- Cargo Tanks
- Rail Cars
- Facility Containers
- Pipelines

Each is described briefly, with an emphasis on what types of products they are likely to contain. The most important safety information, however, has been consolidated into these first three pages to avoid repeating it throughout the chapter.

Container Recognition 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.
- Placards are not required on vehicles 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 wary of unlabeled containers and abandoned drums.
- Tanks are sometimes referred to by the specifications to which they were built (e.g., MC-306, DOT-406). While it's not necessary to know the specifications, it's helpful to recognize the shorthand expressions emergency responders might use.

General Overview (continued)

General Warnings

- 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.
- Any container can be used to smuggle contraband (e.g., drugs or weapons). Be wary.
- Containers with crystals on the outside can be extremely sensitive to shock and friction. They should be treated as if they are potentially explosive.

Container Failure Potential

- Any 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 a safety relief device. (A BLEVE is a *boiling liquid expanding vapor explosion*.)
- 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.

General Overview (continued)

Pressure Vessels

- Any container with gases or liquids under pressure can fail catastrophically from direct flame impingement. Withdraw immediately.
- 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 kilometers). The greatest danger is generally at the ends of the tank, but there is still significant risk at the sides. The ERG2008 suggests evacuation distances of 0.5 to 1 mile (0.8 to 1.6 kilometers), depending on the product.
- A rising sound from a venting relief device and discoloration of the tank due to fire are indications of an impending BLEVE.
- Gases or liquids under pressure have 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 also travel a considerable distance from the source and greatly increase the scope of the incident.

Cryogenic Liquid Vessels

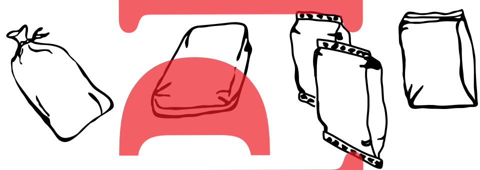
- Cryogenic liquid containers are very much like pressure vessels. The same warnings regarding container failure apply.
- Cryogenic liquids have even greater expansion ratios than compressed gases do.
- Cryogenic liquids are time-sensitive and cannot be stored for too long before they warm up and expand. If a cryogenic cylinder or tank has been damaged and the insulation compromised, the danger is even greater.
- Cryogenic 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.
- 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).

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.

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).

Bags



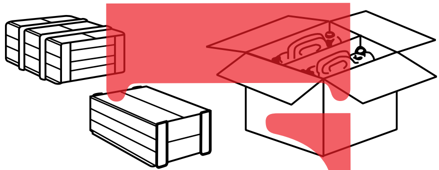
- Bags are used for solid materials such as fertilizers, pesticides, and caustic powders.

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.

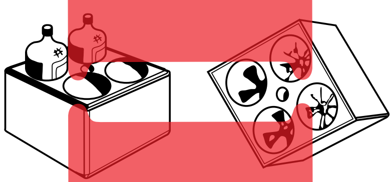
Nonbulk Packaging (continued)

Boxes



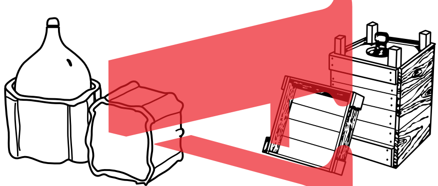
- Almost any kind of hazardous material can be found in boxes, since they are commonly used as outer packaging for other containers. Boxes are used mostly for liquids and solids, but they can also contain small compressed gas cans or cylinders.
- Absorbent or vermiculite might be used to protect inner packaging and help absorb the contents in the event of breakage.

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.

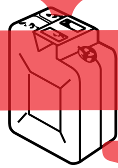
Carboys



- 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.

Nonbulk Packaging (continued)

Jerricans



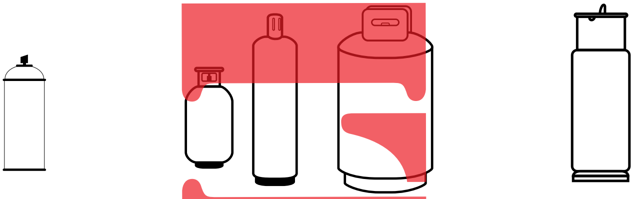
- Metal or plastic jerricans are used for liquids such as antifreeze and other specialty products.

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.
- Some drums are equipped with safety relief devices.

Nonbulk Packaging (continued)

Cylinders

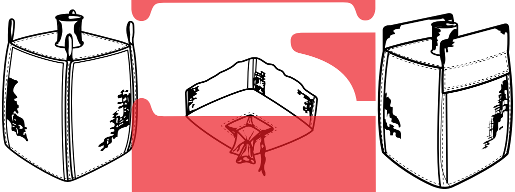


- Aerosol containers (above left) are used for hazardous materials such as cleaners, lubricants, paint, toiletries, and pesticides. They contain a propellant, which is often a flammable gas.
- Uninsulated cylinders (above center) are used for pressurized and liquefied gases, such as acetylene, LPG, chlorine, and oxygen.
- Insulated cylinders (above right) are used for cryogenic liquids, such as liquid argon, helium, nitrogen, and oxygen (LOX).
- 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.
- 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.

Bulk Packaging

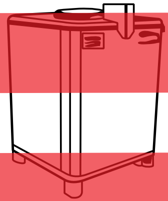
The larger bulk packaging pictured on the following pages may be found on various transport vehicles or at fixed facilities.

Bulk Bags



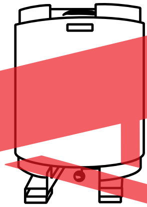
- Bulk bags are used for solid materials such as fertilizers, pesticides, and water treatment chemicals.

Portable Bins



- Portable bins are used for solid materials such as ammonium nitrate fertilizer and calcium carbide.
- They are commonly found in agricultural areas.

Nonpressure Portable Tanks



- These tanks are used for liquids such as water treatment chemicals, liquid fertilizers, and flammable solvents.

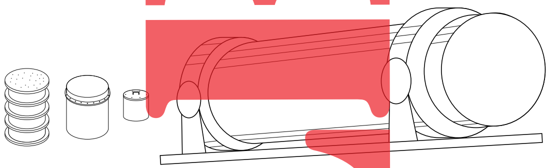
Ton Containers (One Tons)

Source: Union Pacific Railroad

- Ton containers are used for liquefied gases such as chlorine, sulfur dioxide, and phosgene.
- 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)

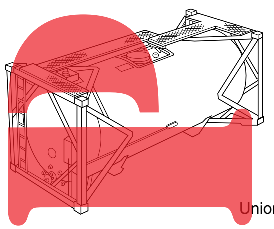
- Radioactive materials are transported in a variety of packages, from small nonbulk containers to large casks. You should recognize radioactive packaging more by labels or placards than by container shape, because the containers can vary greatly and can be packed inside other boxes or crates.
- *Excepted 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 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.

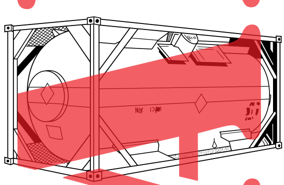
Nonpressure Intermodal Tanks



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.
- These tanks can also be referred to as IM-101 or IM-102.

Pressure Intermodal Tanks

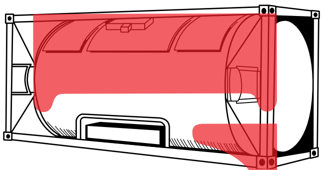


Source:
Union Pacific Railroad
and NFPA

- Pressure intermodal tanks 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.
- These tanks can also be referred to as IMO Type 5 or DOT Spec 51.

Intermodal Tanks (continued)

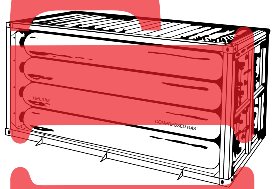
Cryogenic Intermodal Tank Containers



Source:
Union Pacific Railroad

- Cryogenic tanks carry refrigerated liquefied gases, such as liquid argon, nitrogen, oxygen (LOX), and helium.
- These tanks can also be referred to as IMO Type 7.

Tube Modules



Source:
Union Pacific Railroad

- Tube modules are used for pressurized gases, such as helium, nitrogen, and oxygen.

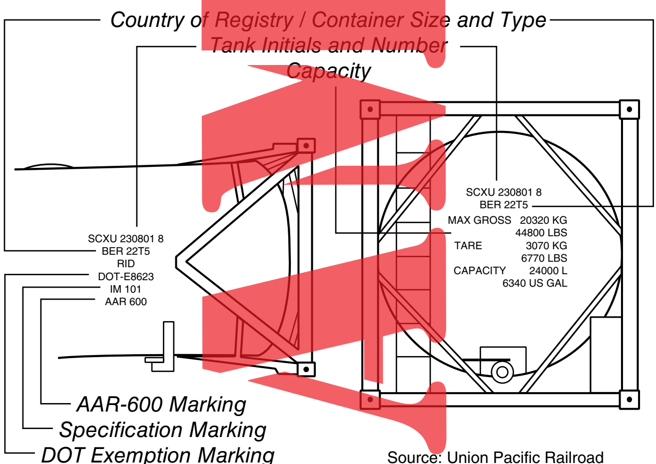
Intermodal Tanks (continued)

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. It is more important that you know what to look for so that you can relay that information when you call 911.

- *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, the shipper or emergency responders 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.
- 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.
- *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).

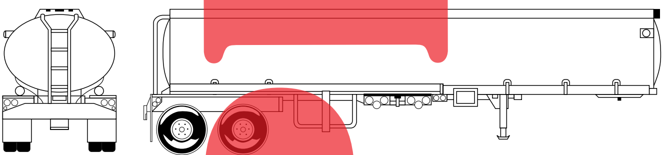
The transport vehicles also contain identification numbers that can be used, with the aid of the shipper or CHEMTREC, to determine the products involved.

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

Cargo Tank Trucks

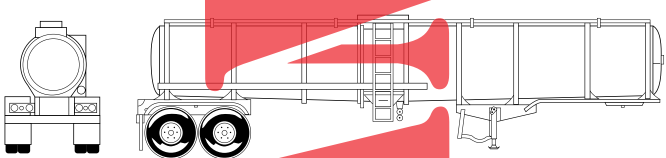
The illustrations and descriptions on the following pages are generalizations only and should not be relied upon for positive identification. For example, many MC-306 or DOT-406 cargo tanks have an elliptical appearance from the rear, but some appear circular instead. Some cargo tanks have insulation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

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.
- Some of these tanks have multiple compartments, each with different products. Determine the number of compartments by counting the number of discharge valves.
- These tanks can also be referred to as MC-306 or DOT-406.

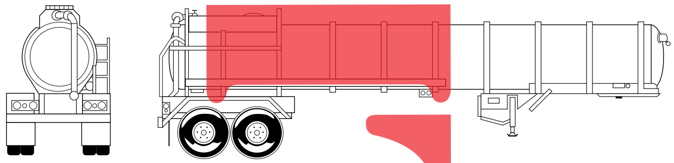
Low-Pressure Cargo Tanks (MC-307/DOT-407)



- Low-pressure cargo tanks are used to transport flammable and combustible liquids, mild corrosives, some poisons, and a wide variety of other liquids.
- Many of the tanks are insulated to protect temperature-sensitive commodities.
- 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.

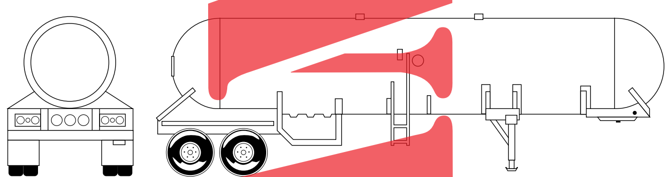
Cargo Tanks (continued)

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



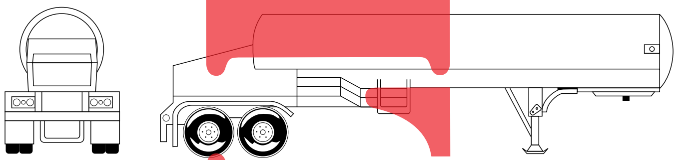
- Corrosive liquid cargo tanks are used to transport corrosive liquids and other heavy or high-density liquid products. They can also be used to transport water.
- These tanks are generally built as a single compartment, but some have multiple compartments.
- Corrosive liquid cargo tanks are smaller than most other tanks because they carry heavier products.
- These tanks generally have circular cross sections and external stiffening rings that provide added strength. However, some have insulation or jackets that can conceal the distinguishing characteristics.
- 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 can also be referred to as MC-312 or DOT-412.

Pressure Cargo Tanks (MC-331)



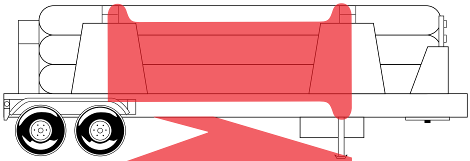
- High-pressure cargo tanks are used to transport LPG, chlorine, anhydrous ammonia, and other gases that have been liquefied through compression.
- Pressure cargo tanks have circular cross sections and rounded (spherical) heads. The upper two thirds are generally painted white or another reflective color to reflect heat from the sun.
- These tanks can also be referred to as MC-331. The smallest ones are sometimes called *bobtails*.

Cryogenic Liquid Cargo Tank (MC-338)



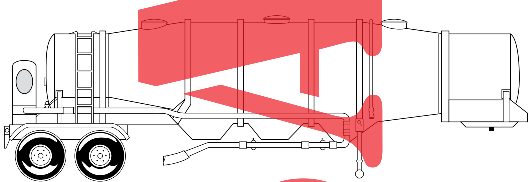
- Cryogenic liquid cargo tanks are used to transport gases that have been liquefied through temperature reduction. Examples include liquid oxygen (LOX), nitrogen, and argon.
- The fittings are housed in a cabinet at the center or rear of the truck.
- The tanks are generally stenciled with the name of the product or the words "Refrigerated Liquid."
- These tanks can also be referred to as MC-338.

Compressed Gas Trailer (Tube Trailer)



- Tube trailers carry multiple cylinders of compressed gases, such as oxygen, nitrogen, and hydrogen.

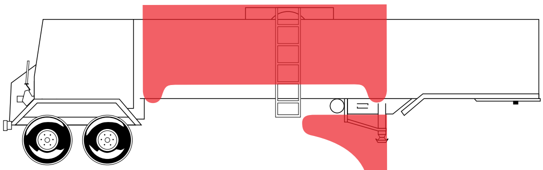
Pneumatically Offloaded (Dry Bulk) Hoppers



- Pneumatically offloaded hoppers, also known as dry bulk hoppers, carry dry materials such as ammonium nitrate fertilizer, dry caustic soda, plastic pellets, and cement.

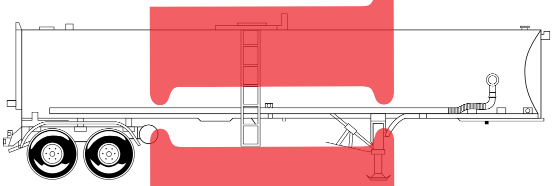
Cargo Tanks (continued)

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.

Asphalt Trailers

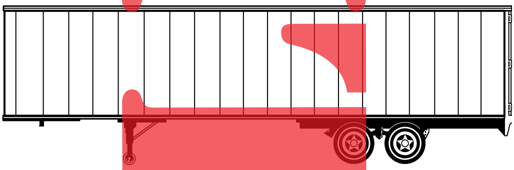


- Asphalt trailers transport asphalt cutback (a mixture of asphalt and a flammable or combustible liquid).

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.

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.

Cargo Tanks (continued)

Cargo Tank Markings and Features

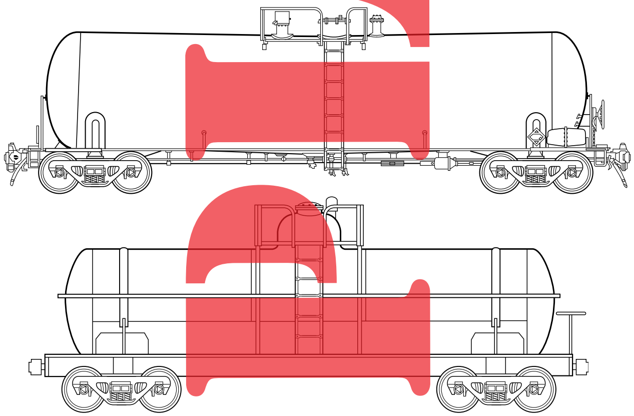
The following are some additional clues to help you recognize tankers that are transporting hazardous materials.

- 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.
- 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.

Rail Cars

Rail incidents involving hazardous materials are relatively infrequent. However, when they do occur, they can be very serious.

Nonpressure Tank Cars (General Service or Low-Pressure)

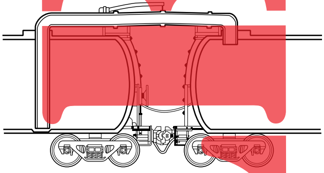


Source: Union Pacific Railroad and NFPA

- 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, juice, and other food products.
- These tanks can generally be distinguished by at least one manway for access to the tank's interior and 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).
- 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.

Rail Cars (continued)

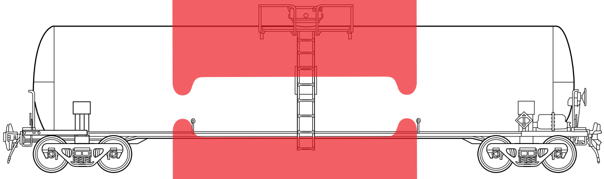
Tank Train®



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.
- After loading, the hoses are purged of liquid and the valves between them close automatically, isolating each car.

Pressure Tank Cars

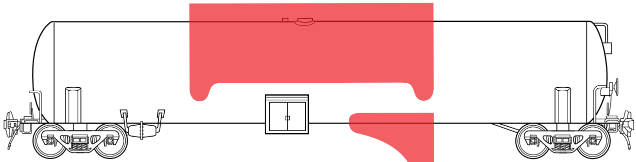


Source: Union Pacific Railroad and NFPA

- 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.
- 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.
- 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.

Rail Cars (continued)

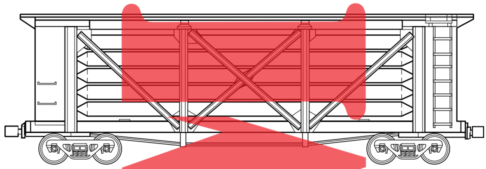
Cryogenic Liquid Tank Cars



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.
- 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.

High-Pressure Tube Cars



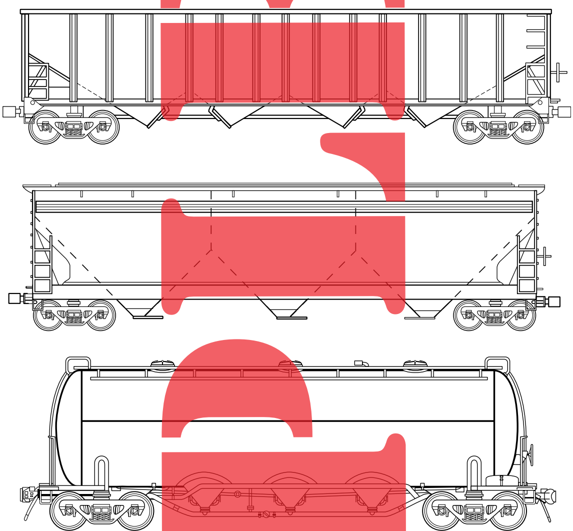
Source: Union Pacific Railroad

High-pressure tube cars have been mostly phased out in recent years, but it may still be possible to 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.
- 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.
- These tank cars can also be recognized by a specification marking that begins with DOT-107.

Rail Cars (continued)

Hopper Cars



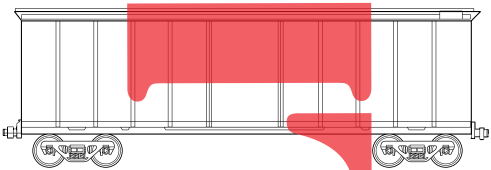
Source: Union Pacific Railroad

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.
- The pneumatically unloaded covered hopper cars can also be recognized by a specification marking that begins with AAR-207.

Rail Cars (continued)

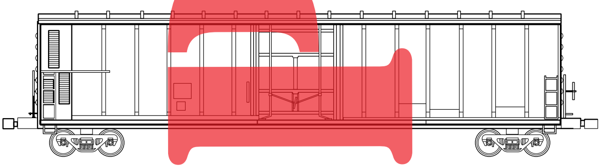
Box Cars



Source: Union Pacific Railroad

- Box cars can carry nonbulk and bulk packages of chemicals, but they are also used to transport nonhazardous materials.

Refrigerator Cars

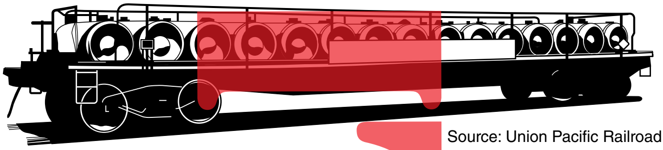


Source: Union Pacific Railroad

- 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.
- 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.
- 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.

Rail Cars (continued)

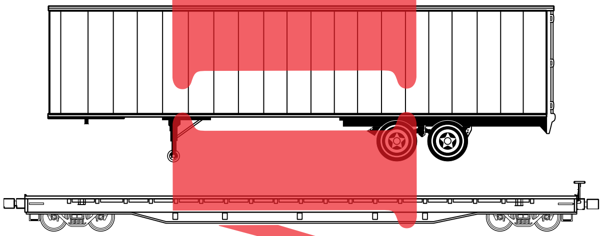
Multiunit Tank Car Tanks



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.
- These tanks may contain a specification marking that begins with DOT-106 or DOT-110.

Trailers and Containers on Flat Cars



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).

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. (See page 3-5.)
- *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. It's more important that you know what to look for so that you can relay that information when you call 911.

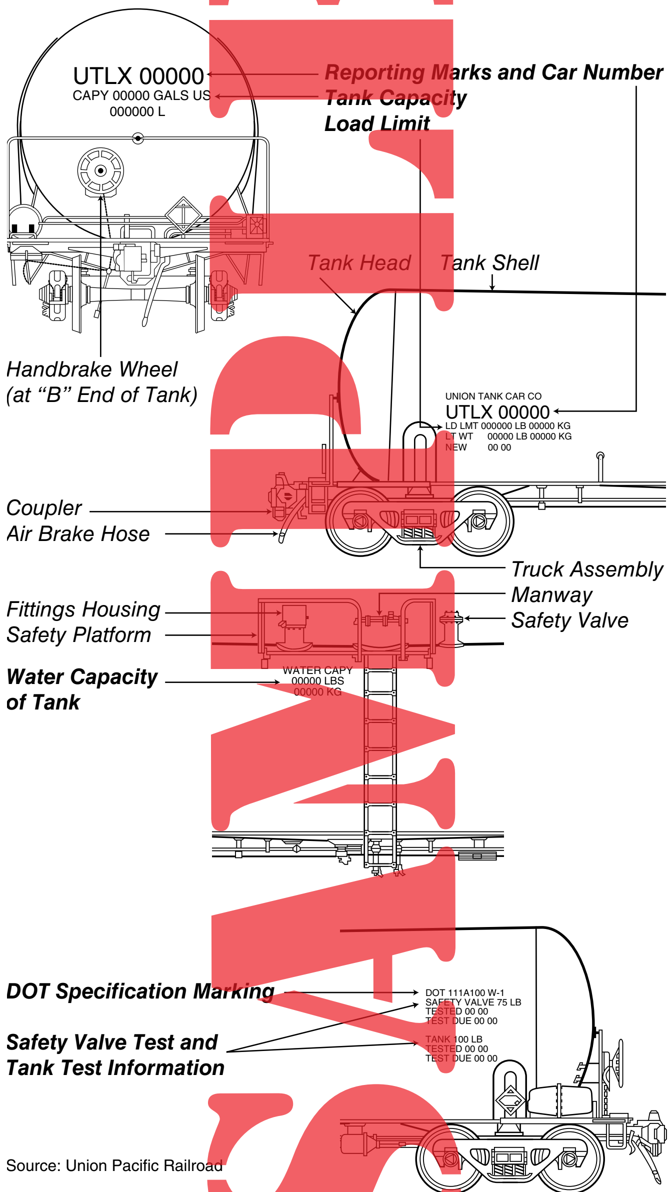
- *Reporting marks and number* are stenciled on both sides (left) and both ends of the tank. The reporting marks and number are now also being stenciled on the top so that a rail car can be identified if it is on its side after an accident. They can be used to obtain information about the contents from 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)

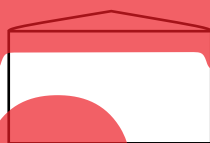


Source: Union Pacific Railroad

Facility Containers

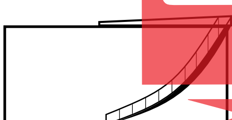
Hazardous materials can be found at fixed facilities in many types of containers. The next few pages will focus only on large storage tanks and piping systems, since everything else was covered earlier in this chapter. The capacity of these tanks can range from a few hundred gallons or liters to millions of gallons or liters, depending on the facility.

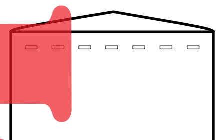
Atmospheric (Nonpressure) Fixed-Roof Tanks



- Atmospheric fixed-roof tanks store flammable, combustible, or corrosive liquids.

Floating Roof Tanks (Open and Covered)

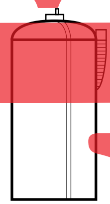




- Floating roof tanks store flammable and combustible liquids that readily vaporize.
- The floating roof is designed to move up and down on top of the liquid to limit the vapor space and reduce the risk of a fire.
- Covered floating roof tanks (above right) have a fixed roof with an internal floating roof underneath. They can be distinguished by large vents at the top of the tank shell.

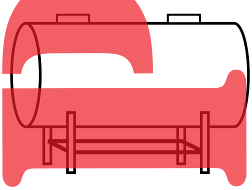
Facility Containers (continued)

Vertical Dome Roof Tanks



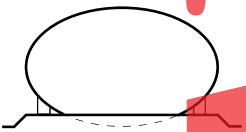
- Vertical dome roof tanks contain flammable and combustible liquids, fertilizers, chemical solvents, etc.

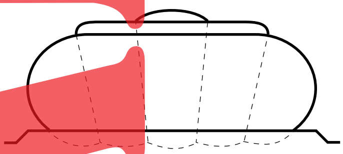
Low-Pressure Horizontal Tanks



- 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.

Spheroid and Noded Spheroid Tanks

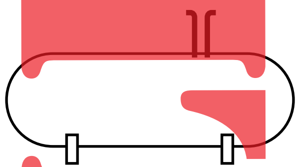




- Spheroid and noded spheroid tanks are low-pressure storage tanks used to store liquid petroleum gas (LPG), methane, propane, and some flammable liquids, such as gasoline and crude oil.

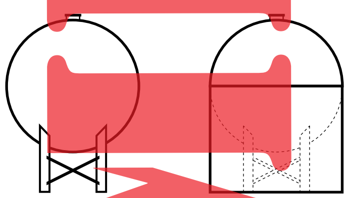
Facility Containers (continued)

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.

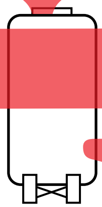
High-Pressure Spherical Tanks



- 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.

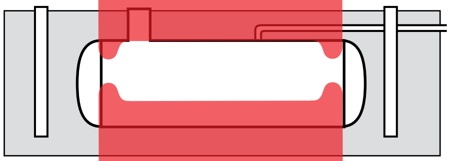
Facility Containers (continued)

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 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.

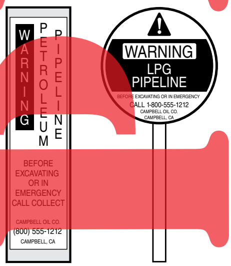
Underground Storage Tanks



- 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).
- Underground tanks are more subject to corrosion than above-ground tanks are and can develop leaks that can go undetected unless they have proper double containment and monitoring systems.

Pipelines

- Examples of materials transported by pipeline include petroleum products, natural gas, anhydrous ammonia, nitrogen, and chlorine.
- 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.)
- Pipeline markers, like the examples below, provide a signal word (e.g., *Warning*), product identity (or class), name of the pipeline company, and a 24-hour emergency phone number.



- Pipeline markers are generally found at public road crossings, railroad crossings, and various spots along the line. However, 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.
- The ERG2008 lists the following as 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

Assessing the Hazards

This chapter is designed to help you assess the hazards at a hazmat or WMD incident. It covers ways in which hazardous materials cause harm, toxicity and risk, toxicological terms, occupational exposure limits, properties of flammable liquids, and other chemical and physical properties.

How Hazardous Materials and WMDs Cause Harm

Hazardous materials and weapons of mass destruction (WMDs) can cause harm in many ways.

- **Thermal injuries** from temperature extremes (either hot or cold) can occur from any of the following:
  - Thermal burns from a chemical fire or hot materials.
  - Frostbite from contact with cryogenic materials.
  - Heat stress from inadequate heat dissipation. (Heat stress is the most common cause of injury to personnel working in chemical protective clothing.)
  - Hypothermia from working in cold environments.
- **Mechanical trauma** is physical impact (pressure) to the body, such as being struck by debris from an explosion or getting cut by a sharp object.
- **Poisons** can act on the entire body or specific target organs, such as the lungs, reproductive system, or nervous system.
- **Corrosives** can cause severe chemical burns to skin and eyes. In gas or vapor form, corrosives can also damage the respiratory system.
- **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.
- **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.
- **Etiological harm** can occur from exposure to a microorganism or its toxin, resulting in disabling diseases such as AIDS, hepatitis, and tuberculosis.
- **Carcinogens** are substances that cause cancer.
- **Mutagens** cause changes to the genetic material of cells (DNA and RNA) that can be inherited by offspring.
- **Teratogens** cause malformations in an unborn child, resulting in deformed or absent limbs or other physiological and behavioral effects.
- **Irritants** cause a reversible inflammatory effect, primarily on the respiratory system, but they can also affect the skin, eyes, and mucous membranes.
- **Sensitizers** cause allergic reactions after repeated exposure.
- **Convulsants** are poisons that cause seizures.

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.
- **Absorption** can occur through direct contact between a hazardous material 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). The eyes also have a high absorbency rate.
- **Ingestion** at a hazmat incident occurs most often because of failing to wash hands before eating, drinking, or smoking.
- **Injection** can occur through a cut, scratch, or puncture wound from a contaminated object.

Acute and Chronic Exposures

- **Acute exposures** are one-time or short-term exposures. Onset of symptoms is relatively quick (minutes, hours, or days).
- **Chronic exposures** are repeated or long-term exposures. Their effects are often not detectable for years.

Local and Systemic Effects

- **Local effects** are those that occur directly to the exposed area.
- **Systemic effects** are those that affect the entire body.

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

Toxicological Risk Factors

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.
- **Sex**. 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. 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.

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. 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.

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 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/pubs/chemlist.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 and 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.

(continued next page)

Toxicological Terms and Exposure Values (continued)

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) are established for workers without any special PPE. 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.

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.

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Workplace Environmental Exposure Limits (WEEL) (continued)

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

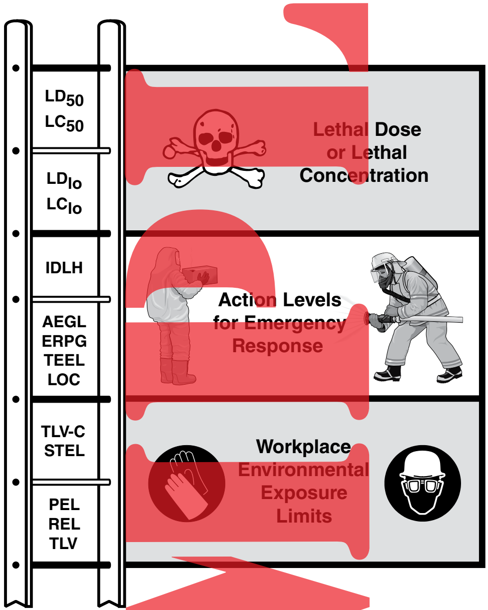
Workers can exceed the permitted or recommended exposure limits if they stay within the short-term and ceiling exposure limits explained below. Short-term and ceiling exposure limits may be either regulatory limits or recommended limits, depending on whether they're established by OSHA or another agency. (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 people 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.

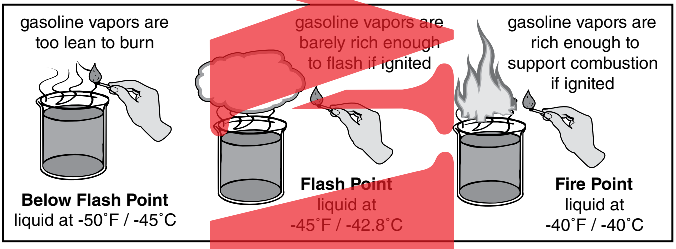
Warning: The word *inflammable* means *flammable*. It does *not* mean *nonflammable*.

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

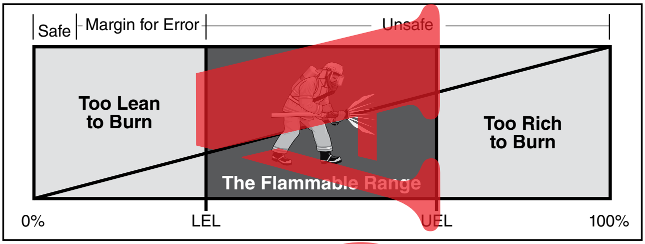
The *ignition (autoignition) temperature* of a substance is the minimum temperature required to cause self-sustained combustion, independent of an ignition source. Simply put, it's the temperature a material must reach before it will ignite. (It's also the temperature the ignition source must be.) Ignition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

- *Pilot ignition* involves an external ignition source (e.g., a lit cigarette 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.

The lower the ignition temperature, the greater the risk of ignition. Ignition temperature is sometimes difficult to measure and should be considered an approximation.

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.



Flammable Range

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Properties of Flammable Liquids (continued)

Flammable (Explosive) Range (continued)

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 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.)

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 without warning.

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 and generate heat when exposed to air. If the heat cannot dissipate fast enough, it will ignite the flammable vapors. 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. Oil-soaked rags must not be left lying in a pile.

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. *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. Assume that pyrophoric materials will also react with moisture until you've determined otherwise by checking at least three reference sources.)

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. 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. However, 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.

Chemical and Physical Change (continued)

Chemical Change ... Polymerization

Polymerization is a chemical reaction that can cause catastrophic container failure due to overpressurization. The risk is great enough that materials subject to polymerization are identified in the *Emergency Response Guidebook* by the letter "P" after the guide number. For example, you'll see 119P for ethylene oxide.

What's happening chemically is that small compounds called *monomers* react with themselves to form larger molecules called *polymers*. The polymers take up more space than monomers do, which is what overpressurizes a container.

Polymerization is not dangerous if done in a controlled manner, such as when manufacturing plastics. However, uncontrolled or runaway polymerization can spell disaster. Uncontrolled polymerization can be triggered in certain materials by:

- Elevated temperature.
- Shock or friction.
- Contamination.
- Too much of a *catalyst*—a substance added to start or speed up a chemical reaction.
- Too little of an *inhibitor*—a substance added to stop or slow a reaction. (Inhibitors have a limited shelf lives, 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, it can trigger polymerization.)

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).

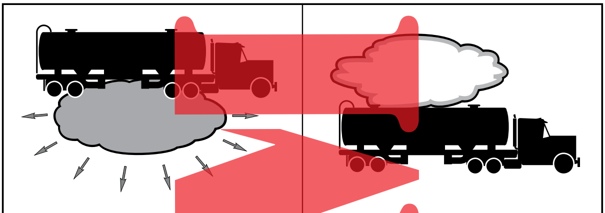
Other Chemical and Physical Properties

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.

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.



Vapors and most gases are heavier than air (vapor density greater than 1)

A handful of gases are lighter than air (vapor density less than 1)

Vapor Density of Vapors and Gases

Vapor Expansion Ratio

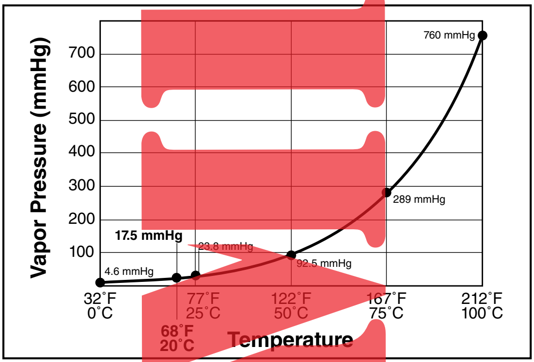
Expansion ratio is the comparison between the volume of a product in a gaseous state versus the volume of that same product in a compressed or liquefied (cryogenic) state. For example, liquefied propane (LPG) has an expansion ratio of 270 to 1. The higher the expansion ratio, the more volume a gas will occupy once released from its container.

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 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.

Vapor pressure is normally measured in *millimeters of mercury* (mmHg) at 68˚F (20˚C) at sea level. However, 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

Two other units of measurement commonly used with vapor pressure are pounds per square inch (psi) and atmospheres (atm). A vapor pressure of 760 mmHg equals 14.7 psi or 1 atm. If the vapor pressure of a substance equals or exceeds 760 mmHg (or 14.7 psi or 1 atm) at sea level, the product is a gas in its normal state.

There's no official dividing line between a "safe" vapor pressure and an "unsafe" vapor pressure, but common sense tells us that a product whose vapor pressure is less than that of water (17.5 mmHg at 68˚F/20˚C) isn't going to "reach out and touch someone" who follows the basic principles of isolating the scene and denying entry.

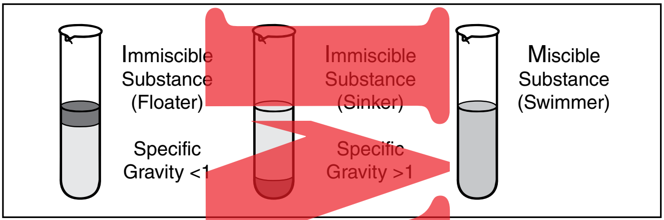
Other Chemical and Physical Properties (continued)

Specific Gravity / Miscibility / Solubility

Specific gravity is the weight of a liquid as compared to an equal volume of water. Water weighs 8.33 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.

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 can be referred to as *sinkers* and *floaters*, respectively.

Specific gravity 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. 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 can also be called *swimmers*.



Specific Gravity and Miscibility

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.

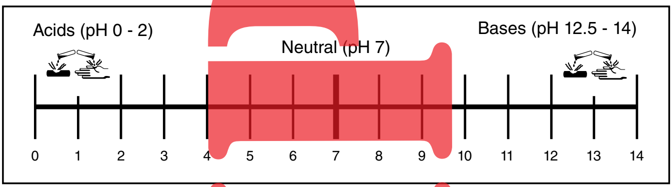
Temperature affects solubility. In general, the warmer the solvent, the greater its capacity to dissolve a substance added to it. Thus a hazardous material may be more soluble on a hot day than it is on a cold one. (Gases behave differently; the warmer they are, the less soluble they become.)

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). However, when it comes to classifying corrosives, 40 CFR 261.22 defines acids as those materials with a pH of 2 or less and bases as those with a pH of 12.5 or more.



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. 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*.

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.

Medical Management of Hazmat Exposures

This chapter provides general information on the risk of secondary contamination, patient decon guidelines, triage, EMS treatment protocols, handling the dead, and coordinating with other medical providers. Remember, however, that your standard operating procedures (SOPs) and local protocols take precedence over these guidelines.

The Role of and Risk to Awareness Level Personnel

Disclaimer

In theory, there should be no risk to you at the awareness level, because your responsibility is limited to recognizing the problem, calling for trained personnel, and securing the area.

NFPA 473, Competencies for EMS Personnel Responding to Hazardous Materials/Weapons of Mass Destruction Incidents is based on the premise that EMS personnel are trained to the *operations* level versus the awareness level. Additionally, patients should be decontaminated before they're handed off to EMS personnel at any level.

However, we don't live in an ideal world, and there are many scenarios whereby an awareness level person might end up helping a contaminated patient. Thus it's probably appropriate to begin this chapter with a disclaimer.

You can best ensure your safety ... and your protection from liability ... by not putting yourself in a position to handle contaminated patients. There's nothing wrong with insisting that patients be decontaminated before you will render care.

Do not interpret anything in this chapter as encouragement to undertake decon operations or to treat a contaminated patient. Rather, this chapter is written from the perspective that anyone—regardless of one's training or lack thereof—might be confronted with a home or workplace accident, where it's not uncommon for people to jump in and do whatever is needed until professional rescuers arrive. And, in fact, there are many common chemicals that present a low risk of secondary contamination. (See page 6-5.)

Your role at the awareness level is to protect yourself first and foremost and to call for trained responders. Should you choose to help a contaminated patient—and, again, this is not encouragement to do so—at least follow the guidelines in this book so that you can be as safe as possible under the circumstances.

Secondary Contamination

A person exposed to a hazardous material is not necessarily contaminated with it. However, if the person is contaminated (has the material on his or her body), there may be a risk of secondary contamination (or transfer) to others.

The Risk to Awareness Level Personnel Providing Patient Care

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.

However, what about those times when patients are not thoroughly decontaminated—when decon efforts are cut short because the patient is in critical condition, deteriorating rapidly, or in danger of hypothermia or because the sheer number of patients in a mass casualty incident requires responders to work more expediently?

Decon efforts shouldn't be cut short where there's a high risk of secondary contamination. (See next page.) Doing so puts everyone in danger. 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 6-6) and take precautions to protect the ambulance (page 6-7). It's also a good idea to seek advice from a toxicologist or poison control center.

Secondary Contamination (continued)

The Risk 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)

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.)
- 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.

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 6-6.)
- 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

Important: *Decon is not an awareness level function.* However, patient decon is covered in this book because it's probably unrealistic to expect people to hold off helping an injured family member, friend, or coworker, despite warnings that one should be properly trained and have proper PPE before attempting patient decon. The following should not be construed as encouragement or permission to do decon. Rather, it's provided to help keep you safe should you attempt decon. Follow your department SOPs.

General Concepts

- Ensure your safety before approaching patients.
- Wear appropriate PPE.
- 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 do 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.)
- 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.
- 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.
- Transfer patients to clean backboards or stretchers before handing them to personnel in the cold zone.
- Ensure that patients are medically evaluated after decon.
- If possible, preserve and secure evidence found during decon.
- Document the decon done for each patient.

Patient Decontamination (continued)

Decon Solutions

Water: Flushing with copious amounts of plain water works well to remove most materials from the skin and eyes. (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. 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.

Saline and **surgical irrigation solutions**: Saline solutions are good for flushing the eyes and open wounds. Surgical irrigation solutions are recommended for open wounds.

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, because hypochlorite can cause problems:

- 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.

Patient Decontamination (continued)

The following information supplements the general concepts provided on page 6-8.

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 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, arm-pits, 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.
- Dry patients promptly once decon is complete, and provide them with blankets or disposable clothing. Anticipate and treat for hypothermia early.

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 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.

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.

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 can take different forms. The entry team might 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.

Triage (continued)

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, children will experience more rapid onset and more pronounced effects than will 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.

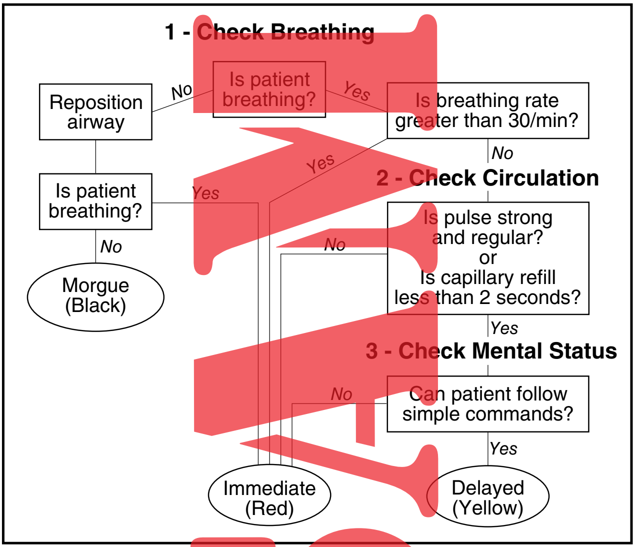
Triage (continued)

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

(continued next page)

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.

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. Rescue is not an awareness level function. If patients can walk, direct them to move to a safe refuge area. Otherwise, wait until they can be rescued by appropriate personnel.
- Make sure patients have been decontaminated as needed. (See pages 6-8 to 6-11.)
- Use universal precautions or body substance isolation procedures as appropriate. (See page 6-6.)
- 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. 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 6-8 to 6-11.

- 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.

(continued next page)

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.) 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.

Note: The following instructions are based on the assumption that responders at or above the operations level will do any decon that's needed. *Decon is not an awareness level function.*

- 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.
- Do not remove personal effects from the bodies. (If the bodies need to be decontaminated, the decon team will remove personal effects, bag and tag them, and be responsible for ensuring 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

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.

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, special safety precautions, 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 people whose lives are at stake. An intentional event, regardless of how it's labeled, poses additional risks and challenges than accidental events do.

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. Chances are, it probably isn't. 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

Listed below are both general distinctions and more specific indicators to help differentiate between chemical and biological agents. 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 medical 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 medical symptoms (usually minutes to hours following exposure).

(continued next page)

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 1-4). 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 Safety Considerations

Emergency responders must be extra diligent at possible terrorist events to ensure their 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.
- Be alert for booby traps and secondary devices.
- Avoid touching anything that might conceal an explosive device.
- Designate and enforce scene control zones.
- Evacuate victims and nonessential personnel as quickly and safely as possible.
- Maintain clear escape routes for rapid evacuation if needed.
- 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.
- Attempt to preserve evidence. Treat this as a crime scene.
- Isolate potentially exposed people or animals.
- Prevent secondary contamination.
- Arrange for critical incident stress debriefings if needed. Terrorist events can be very stressful for responders. Respect that people have their own ways of coping with stress. Provide them rest periods, time to grieve, time out to call their 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 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.

(continued next page)

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.

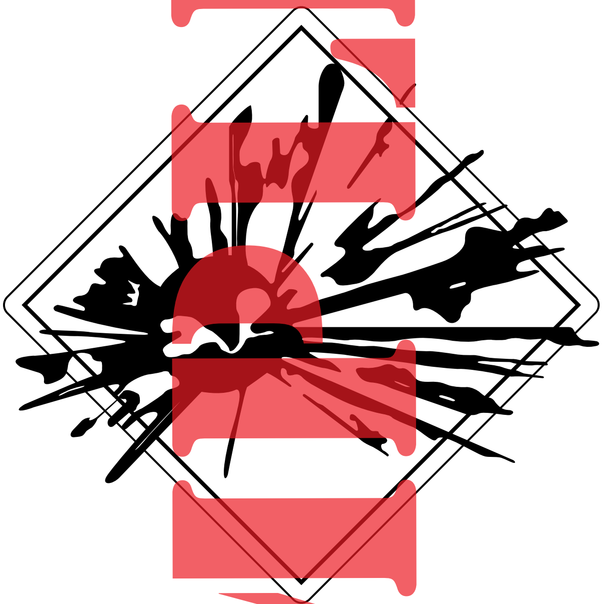
High Condition (Orange) reflects a high risk of terrorist attacks.

- 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.

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.

About Explosives and Explosions

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 results from a buildup of pressure inside a container, often due to overheating.
- A **chemical** explosion is caused by an almost instantaneous conversion of a solid or liquid explosive compound into gases with a much greater volume.
- A **nuclear** explosion involves either fission (splitting nuclei of atoms) or fusion (joining 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. 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. High explosives have more of a shattering effect. In general, high explosives must be initiated by the shock of a blasting cap.

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. Primary explosives may be referred to as *detonators* or *initiation devices* because they are often used to initiate secondary explosives. Sometimes *boosters* are used to amplify the shock wave for greater effect.
- **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. Secondary explosives are sometimes referred to as *main charge explosives*.

About Explosives and Explosions (continued)

Effects of an Explosion

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.

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.

Common Explosive Devices

Mail Bombs

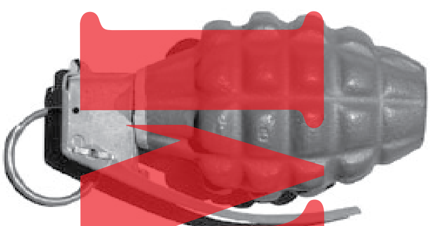
- Mail bombs can come in envelopes or boxes.
- They can be detonated in several ways, including pressure changes (such as when the package is opened), exposure to light, or immersion in water.
- They might have one or more of the following characteristics. Any one characteristic by itself may not mean 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.
- 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 emergency 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).

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.

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 emergency 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)

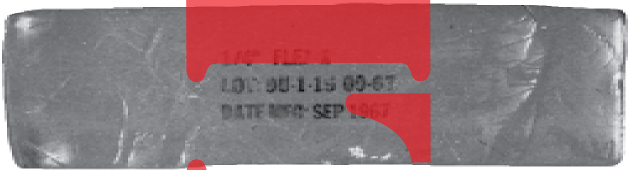
- TNT is widely used as a booster charge, bursting charge, and demolition charge.
- It is relatively insensitive to impact, heat, shock, and friction.
- TNT is most often found in cylindrical or rectangular "blocks" made of cardboard. Each block has metal ends, one of which will have a threaded blasting 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 and Smokeless Powder

Black Powder *Smokeless Powder*

- Black powder and smokeless powder are low explosives.
- Black powder is extremely sensitive to friction, heat, impact, and sparks.
- Many smokeless powders are very sensitive to friction.
- 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.
- 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.
- Black powder is generally safe when wet, but once it dries, it is just as dangerous as it was when it was first manufactured.
- Unconfined powder burns with little or no ash or smoke.

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.

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."
- Ammonium nitrate is a strong oxidizing agent.

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 very unsafe.
- 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, 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. (See also the Vehicle Bomb Evacuation Distance Table on page 8-19.)
- *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 or 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.
- 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.
- 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.
- Follow department SOPs.

Upon Discovery of an Explosive Device (continued)

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.

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.
- Call for assistance from a specially trained and equipped bomb squad. Make other notifications as appropriate.
- Be alert for secondary devices.
- Observe for evidence (e.g., unusual odors or unusual patient symptoms) that might indicate the explosive was used to disperse other hazardous materials.
- 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).
- 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.
- 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. 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 contains basic information on nerve agents, blister agents, blood agents, choking agents, and riot control agents.

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.

Recognition of Chemical Agents

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. None of the others 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.

Some of the agents have distinctive odors. However, witness descriptions may or may not be reliable. 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.

Decontamination and Patient Care

Decontamination is not an awareness level function. However, for more information, refer to the patient decon guidelines on pages 6-8 to 6-11 and the general decon guidelines on pages 2-18 and 2-19.

Follow the general treatment protocols for all chemical exposures (pages 6-17 to 6-20). A few of these chemical agents have specific antidotes. However, treatment for most chemical agents consists largely of providing supportive care for presenting signs and symptoms.

Personal Protective Equipment (PPE)

Awareness level personnel, by definition, are expected only to recognize the presence of hazardous materials or WMDs, protect themselves, call for trained personnel, and secure the area. Thus you shouldn't be in a position to need PPE. But for more information, see pages 2-16 to 2-17.

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.

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.

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.

Nerve Agents (Continued)

Patient Care

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 as soon as possible with water or soap and water.

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. Beyond that, follow the general treatment protocols on pages 6-17 to 6-20.

MARK 1 Nerve Agent Autoinjector

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.

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.

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.

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.

General Health Effects

Most blister agents produce immediate irritation to eyes, skin, and mucous membranes. With mustard, however, pain and irritation can be delayed anywhere from 2 to 24 hours, even though tissue damage begins almost immediately. (Mustard is the only chemical warfare agent that does not produce symptoms within minutes of exposure.)

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Blister Agents (Continued)

General Health Effects (continued)

Common signs and symptoms are irritation and burns to the skin, eyes, and respiratory tract. 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.

Phosgene oxime is different in that the skin lesions look more like gray wheals (hives) than blisters. Phosgene oxime also causes more severe tissue damage than do other blister agents.

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 Care

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 immediately to prevent further tissue damage.

Unfortunately, with mustard, 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.

Follow the general treatment protocols on pages 6-17 to 6-20. 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.

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 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.

General Health Effects

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.)

Patient Care

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.

Treatment consists of supportive measures for presenting signs and symptoms. Healthcare professionals may also use cyanide antidote kits if available. Beyond that, follow the general treatment protocols on pages 6-17 to 6-20.

Choking Agents

The choking agents are common industrial chemicals that attack primarily the respiratory tract.

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. 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. Chlorine smells like bleach. Phosgene smells like freshly cut grass or newly mown hay. Both gases are heavier than air.

General Health Effects

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 (fluid buildup in the lungs) can develop within 24 hours. Severe pulmonary edema can be fatal.

Patient Care

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.

Treatment consists of supportive measures for presenting signs and symptoms. Due to the risk of pulmonary edema, patients should generally be transported to a medical facility for evaluation. The only exception might be for patients exposed to chlorine who have minor or transient irritation of the eyes or throat. Beyond that, follow the general treatment protocols on pages 6-17 to 6-20.

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.

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.

Odors vary, depending on chemical composition. In general, however, tear gas and pepper spray smell like peppers. Mace has a fragrant odor, like that of apple blossoms. Adamsite is odorless.

General Health Effects

Riot control agents cause rapid onset of respiratory distress, eye irritation, and tearing that quickly incapacitate a person. Patients may also experience nausea and vomiting, although it's more common with adamsite than with other riot control agents.

Patient Care

It is often sufficient to remove patients to fresh air and to brush the powder from skin and clothing. If additional decon is needed, flush the skin with plain water, soap and water, or a weak solution of sodium bicarbonate (baking soda). Follow the general treatment protocols for all chemical exposures (pages 6-17 to 6-20).

Biological Agents

Biological agents cannot 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:

- Unusual number of sick or dying people or animals.
- Widespread reports of illness throughout a large area.
- Victims distributed in a pattern associated with a specific dispersal method.
- Delayed onset.
- Unscheduled or unusual spray being disseminated, especially if outdoors during periods of darkness.
- Abandoned spray devices.

This chapter provides only general information about biological warfare agents. Specific information about many of the biological agents and the diseases they cause can be found at the CDC's web site (www.cdc.gov).

Types of Biological Agents

There are four basic types of biological agents.

Bacteria

- Bacteria are single-celled living organisms capable of independent growth; they don't require a living host.
- Many species 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 produce extremely potent toxins inside the body.
- Examples of bacteria include anthrax, brucellosis, cholera, plague, and tularemia.

Viruses

- Viruses are also living organisms, but are much smaller than most bacteria.
- Viruses are incapable of 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

- 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

- Toxins are nonliving chemical compounds—potent poisons produced by a variety of living organisms, including bacteria, plants, and animals.
- Biological toxins produce effects similar to those caused by chemical agents.
- Biological toxins are far more toxic than most industrial chemicals are.
- Examples of toxins are botulinum toxin (botulism), ricin, saxitoxin, staphylococcal enterotoxin B (SEB), and mycotoxins.

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

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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

Exposure, Health Effects, and Patient Care

It's beyond the scope of this book to address each of the biological agents individually. Instead, this chapter provides general information that applies to most of the agents of greatest concern.

Routes of Exposure

Biological agents can enter the body through all the normal routes of entry:

- Inhalation is the primary route of exposure for most agents.
- Some agents can be transmitted by skin or eye contact, but most can't penetrate healthy, unbroken skin. (Micotoxins are an exception; they can be absorbed through intact skin.)
- Pathogens can be ingested by eating contaminated food or by eating food handled by someone whose hands are contaminated. (These are examples of ordinary food poisoning.)
- Many diseases are naturally transmitted by vectors (through bites from mosquitoes, fleas, ticks, etc.)

Some diseases can be spread through patient care activities:

- Disease can often be transmitted through needle sticks or wounds from other sharp objects.
- Some of the diseases can be transmitted through contact with blood and other body fluids (*contact transmission*).
- *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.
- A few diseases (e.g., tuberculosis, measles, and chickenpox) can be spread by *airborne transmission* (droplets containing microorganisms that remain suspended in air).

The most likely terrorist scenario involves disseminating biological agents by aerosolization (mixing the agent with a liquid and dispersing it with a spray device) or by dispersion as dry powders (possible with spores, toxins, and freeze-dried bacteria and viruses). A terrorist might contaminate food or water supplies, but it's unlikely that terrorists could successfully contaminate large municipal water supplies because dilution and chlorination would either kill the agent or greatly reduce its effectiveness.

Exposure, Health Effects, and Patient Care (continued)

"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.

Some bacteria and viruses are contagious, but many are not. (The infectious dose—the number of organisms needed to cause disease—varies based on many factors.) Toxins are not contagious.

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. Because onset of health effects is delayed, a terrorist attack will likely manifest as an unusual outbreak of disease, impacting public health authorities more so than first responders.

With toxins, onset is usually minutes to hours after exposure. 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 symptoms and circumstances of the illness is essential.

Exposure, Health Effects, and Patient Care (continued)

Health Effects

The initial effects of many bacteria and viruses resemble those of a common cold or flu. Symptoms may include fever and/or chills, weakness and fatigue, headache, nausea and vomiting, diarrhea, coughing, mild chest discomfort, and general achiness. Because these common symptoms generally aren't cause for alarm, 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.

Some diseases produce characteristic skin signs. For example:

- Cutaneous (skin) exposure to anthrax produces what starts as an itchy bump resembling an insect bite. A day or two later, the bump becomes a round, fluid-filled ulcer. A depressed, painless black scab that subsequently forms in the middle of the ulcer is a characteristic sign of cutaneous anthrax.
- Smallpox produces a rash of small red spots that progress to raised bumps filled with a thick, opaque fluid. The bumps then become pustules that are firm to the touch, feeling like there are small round objects embedded under the skin. The face and extremities are affected the most.
- Viral hemorrhagic fevers cause bleeding from mucous membranes.

Some diseases have other distinguishing signs or symptoms. However, it's often necessary for healthcare professionals to take chest x-rays, blood tests, lab cultures, or other tests to identify a specific disease.

Many of the diseases caused by biological warfare agents have high mortality rates due to complications such as respiratory distress, pneumonia, dehydration, shock, and sepsis. Prompt treatment can reduce those mortality rates. However, by the time patients realize that they have something worse than a cold or flu, their chances of survival may have dropped dramatically. That's one reason why it's so important to publicize unusual outbreaks of disease.

Health Effects (continued)

The effects of some toxins resemble those of some of the chemical agents (e.g., irritation of the skin, eyes, and mucous membranes; cough; tightness of the chest; and difficulty breathing). Symptoms occur within minutes or hours of exposure. Thus it's possible to mistakenly assume one is dealing with a chemical agent. Careful evaluation of symptoms and circumstances of the illness is essential.

EMS Response

If you've responded to a terrorist event involving possible biological agents, make sure that patients have been decontaminated before you render care. Decon is rarely needed, however, if you've responded to an EMS call for someone who is already symptomatic. Instead, treat patients based on signs and symptoms. Provide oxygen, IVs, and other treatment as appropriate.

It is beyond the scope of this book to recommend 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.

Notify the CDC and/or your local health department if it hasn't been done already. Notification is mandatory with some diseases (e.g., smallpox) and vitally important for any suspected terrorist attack involving biological agents.

Most of the time, universal precautions provide adequate protection when caring for patients. However, if the disease has not yet been identified, it may be wise to follow body substance isolation procedures. (See page 6-6.) Once you know what the disease is, follow CDC recommendations for additional protective measures.

White Powder Events

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 8-6.)

- 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 Events (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.

Handling Suspicious Mail

If the mail contains powder or a written threat or if it has other characteristics listed on the previous page, use the following guidelines.

- 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.
- Call 911 or the appropriate emergency number for your community or workplace. 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 others 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 Events (continued)

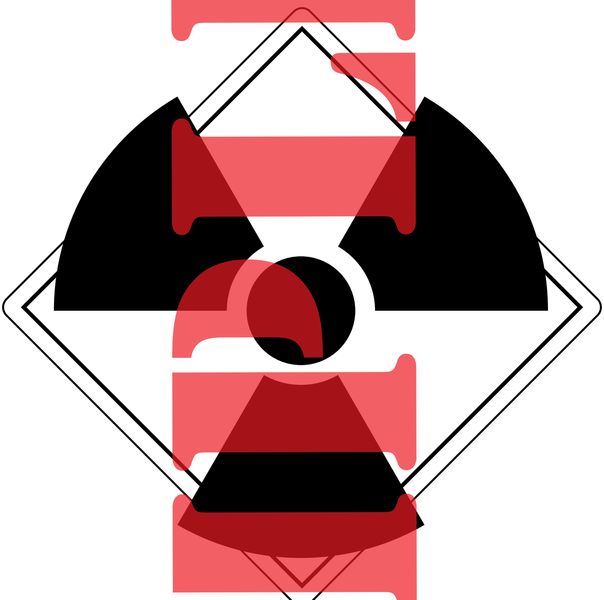
Threat Credibility Assessment

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.

Awareness level personnel can do a basic threat credibility assessment also. 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 10-10?
- 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.)?

Nuclear Events



In theory, at the awareness level, you shouldn't be involved in any hazmat incident that could expose you to radioactive materials. However, radioactive materials are common enough in some industries that it helps to have a basic understanding. Radiation incidents don't have to be as frightening as many people believe they are.

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.

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 most commonly encountered at hazmat incidents. 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.

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**.

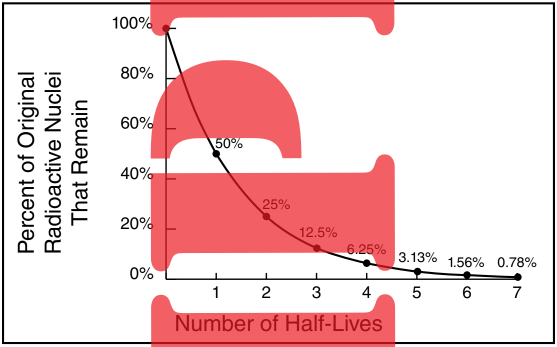
Fissile materials (uranium-233, uranium-235, plutonium-239, and plutonium-241), also known as **special nuclear materials**, are of particular concern because they can be used to create an atomic bomb. Tight restrictions govern the production and use of fissile materials.

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. (These limits are based on hour-long exposures. See next page.)

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

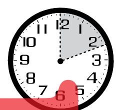
The EPA limits still leave a safety margin. Although there may be mild symptoms with doses as low as 30 rems, most people won't develop "radiation sickness" at less than 70 to 100 rems.

Time, Distance, and Shielding

The principles of time, distance, and shielding are your best defense against radiation exposure.

Time

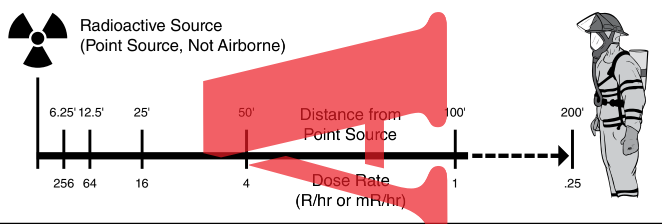
The correlation between *dose* (exposure) and *dose rate* (radiation present in the atmosphere) is directly related to time. *Dose rate* is expressed in roentgens *per hour* (R/hr), so the *dose* must be calculated by the hours, or fraction thereof, that one is exposed. If radiation is present, keep your exposure time to a minimum.

Dose Rate: 50 R/hr	Dose Rate: 50 R/hr
	
Exposure: 25 rems	Exposure: 10 rems

The Relation Between Dose Rate and Dose

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%.

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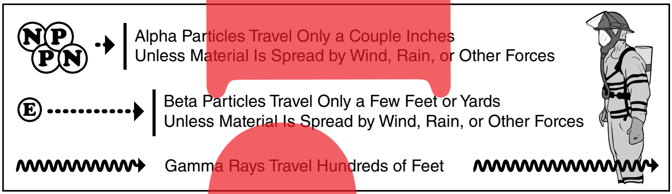
Time, Distance, and Shielding (continued)

Distance (continued)

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

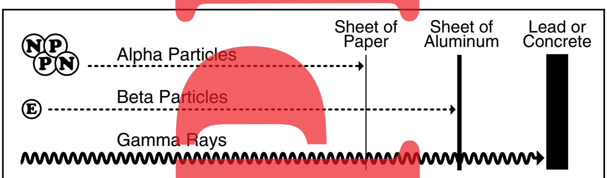
Use the current edition of the ERG to determine appropriate isolation and evacuation distances. Guides 161 through 165 in the ERG2008 recommend 75 feet (25 meters) for initial isolation, 330 feet (100 meters) for downwind evacuation on a large spill, and 1000 feet (300 meters) for initial evacuation when a large quantity of radioactive material is involved in a major fire.

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.

Time, Distance, and Shielding (continued)

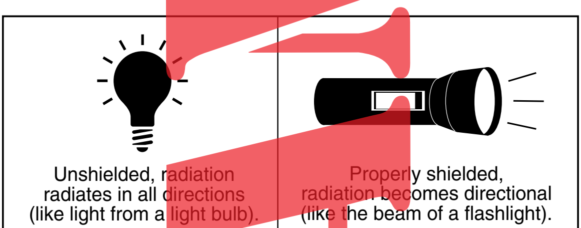
Shielding

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. (At a hazmat incident, one can take advantage of whatever shielding is present: buildings, fire engines, etc.)



The Effect of Shielding on Alpha, Beta, and Gamma Radiation

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.



The Effect of Shielding on Radiation Direction

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Shielding (continued)

Radioactive materials and wastes are placed in different types of packages based on level of radioactivity. (See page 4-12.) 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.)

Personal protective equipment (PPE) also provides some shielding. Firefighters can use structural firefighting clothing and SCBA. EMS providers, police officers, and other personnel can wear long-sleeve uniforms, gloves, hoods or hair covers, eye protection, shoe covers, and face masks (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. (Structural firefighting clothing will reduce exposure potential more so than ordinary uniforms.)

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

Important: *Decon is not an awareness level function.* However, as emphasized earlier, patient decon is covered in this book because it's probably unrealistic to expect people to hold off helping an injured family member, friend, or coworker, despite warnings that one should be properly trained and have proper PPE before attempting patient decon. The following should not be construed as encouragement or permission to do decon. Rather, it's provided to help keep you safe should you attempt decon. Follow your department SOPs.

This information supplements the general patient decon guidelines on pages 6-8 to 6-11:

- 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.
- 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.
- Contaminated clothing and other personal items should be isolated in double plastic bags labeled with each patient's name and clearly marked "Radioactive. Do Not Discard."
- Contaminated clothing should be treated as a potential radioactive source until proven otherwise.
- Radiation detectors can be used to ensure patients are adequately decontaminated. (See page 11-24)

Patient Treatment

- Follow the general treatment protocols for all chemical exposures (pages 6-17 to 6-20).
- 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.

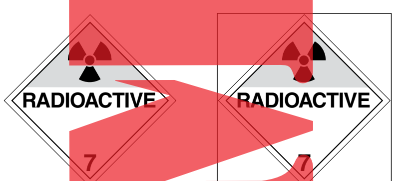
Radioactive Labels and Placards

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*.

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 used for exclusive use shipments. Thus the presence or absence of placards also provides a clue as to the degree of risk.

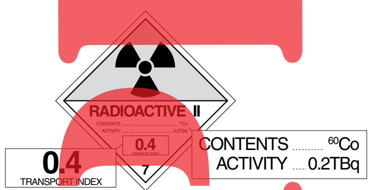


A placard on a square background means the vehicle contains a *highway route controlled quantity (HRCQ)*—a high-level radioactive material, such as spent fuel, shipped along designated routes. These designated routes (known as *preferred routes*) consist of interstate highways and bypass roads around 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.)

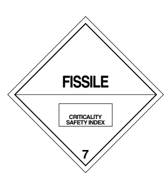


Transportation Index, Contents, and Specific Activity

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 below), 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)

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.

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.

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'd normally establish an initial perimeter.

Monitoring Essentials (continued)

Survey Meters

Most survey meters can't identify specific radioisotopes, but they will confirm that radiation is present and, subject to some limitations, 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 (high-level or low-level) they can detect.

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: one for area monitoring and one for frisking (checking patients and responders for contamination).

Understand the units of measure, and read the meter correctly. A common mistake 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 others. 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).

(continued next page)

Monitoring Essentials (continued)

Survey Meters (continued)

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.

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 pre-operational checks per the instruction manual.
- Allow adequate warm-up time.
- Establish the background radiation in a nonimpacted area.
- When using measurement equipment (e.g., to assess the scene), start from a safe distance and slowly move closer if appropriate.
- *Warning:* Don't take a survey meter into an unknown or potentially flammable atmosphere if the meter is not intrinsically safe.

(continued next page)

Monitoring Essentials (continued)

Survey Meters (continued)

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.

Background Radiation

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.

Resources for Information or Assistance

This chapter contains a brief overview of the ERG, shipping papers, and material safety data sheets. It also contains some phone numbers you may find useful.

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 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://hazmat.dot.gov/pubs/erg/gydebook.htm.

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 will have several names associated with them and vice versa. That's a red flag to 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 pure or a mixture? These factors sometimes 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.

(continued next page)

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 page 5-21 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 when in contact with water, they produce gases that are toxic by inhalation. (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 (fire/explosion hazards or health 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.

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 a single, 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.

(continued next page)

The Emergency Response Guidebook (continued)

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

Shipping papers vary with each form of transportation.

- 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 shipping papers 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 it begins with 48, it signifies 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.
- 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.
- 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 Transport of Dangerous Goods
- Occupational Safety & Health Administration (OSHA)
  http://www.osha.gov
  Follow the link: Hazard Communication

Important Phone Numbers

Local Emergency Responders and Other Resources

911 or ____________________________

- Fire Department
- Law Enforcement
- Emergency Medical Services

Emergency (911) dispatchers will often notify other resources (if needed) so that responders on scene don't have to. The following are examples of some of the resources that may be helpful:

- Public Works Department
- Public Utilities (Gas, Electric, Water)
- Sewer Department
- County Health Department
- Local Radiological Officer
- Hospitals
- Amateur Radio Operators
- Local Transportation Agency
- Industry Resources
- Licensed Waste Haulers and Other Contractors
- School District Superintendents
- Emergency Operations Center (EOC)
- Local Emergency Management Agencies (EMA)
- Disaster Relief Agencies (e.g., Red Cross, Salvation Army)

Use the space below to write in additional resources if desired.

Resource	**Phone Number**
____________________	____________________
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Important Phone Numbers (continued)

State Notification Center (Office of Emergency Services)

____

Your state notification center is the "single point of contact" at the state level. If you phone your state notification center as part of the mandatory reporting requirements, someone will notify other agencies as appropriate, including but not limited to following:

- National Guard WMD Civil Support Teams (CST)
- State Health Department
- State Radiological Officer
- State Emergency Management Agency
- State Forestry Department
- State Agricultural Department
- National Disaster Medical System (NDMS)

Use the space below to write in additional phone numbers for local offices if applicable.

Resource	Phone Number

Important Phone Numbers (continued)

National Response Center (NRC)
(800) 424-8802 or (202) 267-2675

The NRC is the "single point of contact" at the federal level. If you phone the National Response Center (NRC) as part of the mandatory reporting requirements, the NRC will notify other agencies as appropriate, including but not limited to following:

- 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)
- 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)
- Nuclear Regulatory Commission
- Federal Emergency Management Agency (FEMA)
- Federal Bureau of Investigation (FBI)
- Bureau of Alcohol, Tobacco and Firearms (ATF)
- Drug Enforcement Administration (DEA)
- U.S. Coast Guard (USCG)
- Domestic Preparedness Chemical & Biological Hotline
- Chemical Safety and Hazard Investigation Board (CSB)
- Federal Railroad Administration
- U.S. Fish & Wildlife Service
- U.S. Customs Service

Use the space below to write in additional phone numbers for local offices if applicable.

Resource	**Phone Number**
________________	________________
________________	________________
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Important Phone Numbers (continued)

Other Resources

Poison Control Center	(800) 222-1222
Centers for Disease Control (CDC)	(770) 488-7100
CHEMTREC	(800) 424-9300
Alternate Number	(703) 527-3887
Nonemergency information	(800) 262-8200
NTSB Transportation Disaster Assistance	(800) 863-9369
Alternate Number	(202) 314-6290
U.S. Postal Inspection Service	(877) 876-2455
US Army Operations Center	(703) 697-0218
Defense Logistics Agency	(800) 851-8061
National Animal Poison Control Center	(888) 426-4435
Emergency Animal Rescue Service	(800) 440-3277

Use the space below to write in additional resources if desired.

Resource	Phone Number

Important Phone Numbers (continued)

Other Resources (continued)

Use the space below to write in additional resources if desired.

Resource	Phone Number

Appendix

This chapter contains miscellaneous other information:

- Bibliography
- Index
- About the Author

Bibliography

This book is a condensed version of *The First Responder's Field Guide to Hazmat & Terrorism Emergency Response*. So that book was the primary reference source for this one. Most of the reference sources used for *The First Responder's Field Guide to Hazmat & Terrorism Emergency Response* are listed on the following pages.

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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 also produces brochures, booklets, and newsletters for fire departments and industry.

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 has been a volunteer firefighter for the Santa Clara County Fire Department (CA) since 1980. She is also a member of the Fire Associates of Santa Clara Valley, a volunteer group that provides canteen service and rehab support during major emergency incidents, fire department drills, and special events.

Other Books by Jill Meryl Levy

- The First Responder's Field Guide to Hazmat & Terrorism Emergency Response
- The First Responder's Pocket Guide to Radiation Incidents
- Hazmat Chemistry Study Guide
- The Hazmat Chemistry Mini Review
- Take Command of Your Writing
- Crimes Against the English Language

Color Reference Chart

Shown below are color renditions of some of the marking systems illustrated Chapter 3. More color illustrations are provided on the inside front cover.

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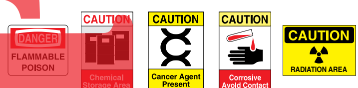

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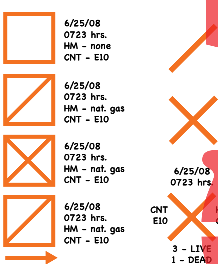

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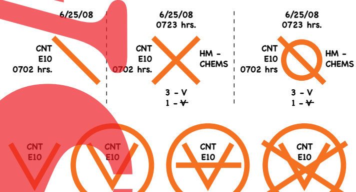

Other Search & Rescue Markings (page 3-42)

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