Hazardous Materials for First Responders
4th Edition

Chapter 2 — Hazardous Materials Identification
Learning Objective 1

Identify the seven clues to the presence of hazardous materials.
Risk increases when moving closer to identify hazardous materials.
Learning Objective 2

Discuss the occupancy types, locations, and pre-incident surveys that may indicate hazardous materials.
Pre-Incident Surveys

- Reduce on-site decisions for first responders
- Reduce oversights, confusion, and duplication of effort
- Identify several items
- Ongoing process; includes review and updates
- Not always accurate
DISCUSSION QUESTION

What are exposures?
What are some occupancies that are highly probable locations for hazardous materials storage?
Some occupancies are highly probable locations for hazardous materials.

Courtesy of U.S. Customs and Border Protection, photo by Charles Csavossy
Locations That May Indicate Hazardous Materials

- Roadways
- Railways
- Waterways
- Airways
- Pipelines
- Water level in rivers and tidal areas

Courtesy of Phil Linder
Identify where a potential attack can do the greatest harm.

Courtesy of U.S. Customs and Border Protection, photo by Gerald L. Nino
DISCUSSION QUESTION

What are some specific locations that may be terrorist targets?
Potential terrorist targets that should be considered.

- Mass transportation
- Critical infrastructure
- Areas of public assembly and recreation
- High profile buildings and locations
- Industrial sites
- Educational sites
- Medical and science facilities
Learning Objective 3

Describe the container shapes that may contain hazardous materials.
Categories of Containers

- Bulk and nonbulk
- Pressure and nonpressure
- Bulk-capacity fixed-facility containment systems and transportation packaging

Courtesy of Rich Mahaney
DISCUSSION QUESTION

What is bulk packaging?

What is nonbulk packaging?
There are several types of bulk-capacity fixed-facility containers.
There are several types of bulk-capacity fixed-facility containers.

- Pipelines
- Reactors
- Open piles or bins
- Storage Cabinets
Nonpressure/atmospheric storage tanks operate under little pressure.
Pressure Storage Tanks

- Hold contents under pressure
- Low-pressure storage tanks – Operating pressures from 0.5 to 15 psi (3.45 kPa to 103 kPa) {0.03 bar to 1.03 bar}
- Pressure vessels – Pressures of 15+ psi (103 kPa) {1.03 bar} or greater

(Continued)
There are a variety of bulk transportation containers.

- Railroad cars
- Vessel cargo carriers
- Intermediate bulk containers
- Cargo tanks
- Unit loading devices
- Ton containers
- Intermodal containers
Low-pressure tank cars transport materials with low vapor pressures.

Courtesy of Rich Mahaney
Pressure tank cars transport materials with higher pressures.
Cryogenic liquid tank cars carry low pressure and refrigerated liquids.

Courtesy of Rich Mahaney
Other railroad cars carry a variety of materials.

- Covered hopper cars
- Uncovered (open top) hopper cars
- Pneumatically unloaded hopper cars
- Boxcars and gondolas
Cargo tank construction features are designed to fit specific uses.
Intermodal containers may contain hazardous materials or mixed loads.
Some intermodal containers are tank containers.

Courtesy of Rich Mahaney
How can you tell if a freight container contains hazardous materials?
Low-pressure intermodal containers are the most common.
Intermodal containers can be pressurized or specialized.

Courtesy of Rich Mahaney

Courtesy of Rich Mahaney
There are a variety of vessel cargo carriers that are likely to contain hazardous materials.

- **Tanker**
  - Petroleum carrier
  - Chemical carrier
  - Liquefied flammable

- **Cargo vessel**
  - Bulk carrier
  - Break bulk carrier
  - Container vessel

- **Barge**
Unit loading devices are used to consolidate air cargo into transportable units.
Intermediate bulk containers are designed for mechanical handling.
Intermediate bulk containers can be flexible or rigid.
Ton containers require special equipment to patch.

Courtesy of Rich Mahaney

Courtesy of Rich Mahaney
Structural fire-fighting gear does not provide adequate protection against the hazardous materials commonly stored in ton containers.
What are the criteria for bulk packaging?
Nonbulk packaging is used to transport smaller quantities of hazardous materials.

- Bags
- Carboys and jerry cans
- Cylinders
- Drums
- Deward flasks
Containers for radioactive materials protect against increasing levels of hazards.
Learning Objective 4

Identify placards, labels, and markings that designate the presence of hazardous materials.
UN Recommendations on the Transport of Dangerous Goods

- Adopted by U.S., Canada, and Mexico
- Establishes minimum requirements for transport by all modes of transportation
- Facilitates trade and safe, efficient transport
- Includes standards for packaging and multimodal tanks
UN hazard classes identify substances that pose significant hazard in transportation.

- **Class 1 - Explosives**
- **Class 2 - Gases**
- **Class 3 - Flammable liquids**
- **Class 4 - Flammable solids, substances liable to spontaneous combustion, substances that emit flammable gases on contact with water**

(Cont.)
UN hazard classes identify substances that pose significant hazard in transportation.

- **Class 5** - Oxidizing substances and organic peroxides
- **Class 6** - Toxic and infectious substances
- **Class 7** - Radioactive materials
- **Class 8** - Corrosive substances
- **Class 9** - Miscellaneous dangerous substances and articles
UN identification numbers are assigned to individual materials.

Sample Displays of 4-Digit UN Identification Numbers

- FLAMMABLE
  - 3
- 1090
  - 3
- 1993
  - 3

1090
What are the nine UN hazard classes?
U.S. DOT placards are unique for each hazard class.

DOT Placard Parts

- Background Color
- Hazard Symbol
- Diamond Shape
- 4-Digit Identification Number or Hazard Class Designation
- Hazard Class Number

10.8 inches (273 mm)
What are ORM-Ds and MOTs?
U.S. DOT labels provide the same information as placards.
On DOT placards, what does the color orange indicate?
Canadian and Mexican placards, labels, and markings are based on UN recommendations.
Other North American highway vehicle identification markings will include various information.

D.O.T. specification

Design pressure

Total capacity

Number of compartments & capacity

Courtesy of Rich Mahaney
North American railroad tank car markings have a variety of styles.

(Continued)

Courtesy of Rich Mahaney
North American railroad tank car markings have a variety of styles.
North American railroad tank car markings have a variety of styles.

**Specification Marking Explanation**

- **Class Number**
- **Tank Test Pressure**
- **Type Weld Used**

**Example Marking:**

- **DOT:** 111
- **A:** 60
- **AL:** W
- **2:**

  - **Fittings/material/lining:** In this case, a bottom outlet is prohibited; numbers vary from 1 to 7
  - **Material of construction other than steel:** (in this case, aluminum)
  - **Separator or delimiter letter:** Significant in certain tank cars
  - **Approving Authority:** (in this case, the Department of Transportation)
International intermodal container/tank markings are generally on the right hand side.
Describe the other markings and colors that may indicate the presence of hazardous materials.
CAUTION

Read the container and understand all of the information provided!
NFPA® 704 System is commonly required for occupancies that contain hazardous materials.
What two hazards are authorized for use in the special hazards position?
Requires employers to:

- identify hazards in workplace and train employees how to recognize these hazards
- ensure that all containers are labeled, tagged, or marked with identity of substances contained along with appropriate hazard warnings
Canadian Workplace Hazardous Materials Information System (WHMIS) uses two types of labels.

WHMIS Label

PRODUCT IDENTIFIER
IDENTIFICATEUR du PRODUIT

RISK PHRASES
MENTIONS de RISQUES

PRECAUTIONARY MEASURES
PRÉCAUTIONS à PRENDRE

FIRST AID MEASURES
PREMIERS SOINS

SEE MATERIAL SAFETY DATA SHEET
VOIR FICHE SIGNALÉTIQUE

SUPPLIER IDENTIFIER
IDENTIFICATEUR du FOURNISSEUR
Mexican Hazard Communication System

- Equivalent to HCS
- Employers ensure that hazardous chemical substances in workplace are appropriately and adequately labeled
- Adopts NFPA® 704 and related label system as official
- Caution symbols triangular
FHSA requirements for household products labels uses a system of signal words.

CAUTION
• Minor health effects

WARNING
• Moderate hazards

DANGER
• Highest degree of hazard

POISON
• In addition to DANGER on labels of highly toxic materials

(Continued)
FHSA Requirements for Household Products Labels

- Name, business address of manufacturer, packer, distributor, or seller
- Common/chemical name of ingredients
- Principal hazard(s)
- Precautionary statements
- First-aid instructions
- Instructions for special handling or care
- *Keep out of the reach of children*
Chemical Abstract Service® (CAS ®) Numbers

• Unique numerical identifiers assigned to various products
• Can be used to search chemical databases
• Typically included on safety data sheets
This EPA sign is an example of how other symbols and signs may vary by facility.

CAUTION
CONTAINS
PCBs
(Polychlorinated Biphenyls)

A toxic environmental contaminant requiring special handling and disposal in accordance with U.S. Environmental Protection Agency Regulations 40 CFR 761 - For Disposal Information contact the nearest U.S. E.P.A. Office.

In case of accident or spill, call toll free the U.S. Coast Guard National Response Center:
800:424-8802
Dow Chemical
504-353-8888
ISO safety symbols are international safety signs used with OSHA hazard signs.

<table>
<thead>
<tr>
<th>Corrosive</th>
<th>Explosive</th>
<th>Flammable</th>
<th>Toxic/Poisonous</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Corrosive Symbol" /></td>
<td><img src="image2.png" alt="Explosive Symbol" /></td>
<td><img src="image3.png" alt="Flammable Symbol" /></td>
<td><img src="image4.png" alt="Toxic/Poisonous Symbol" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Biological Hazard</th>
<th>Radiation</th>
<th>Oxidizer</th>
<th>Irritant</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5.png" alt="Biological Hazard Symbol" /></td>
<td><img src="image6.png" alt="Radiation Symbol" /></td>
<td><img src="image7.png" alt="Oxidizer Symbol" /></td>
<td><img src="image8.png" alt="Irritant Symbol" /></td>
</tr>
</tbody>
</table>

* ISO = International Organization for Standardization. This table is not comprehensive.
Globally Harmonized System (GHS) symbols help create consistent labeling standards.

<table>
<thead>
<tr>
<th>Flammables/Fire Hazard</th>
<th>Oxidizers</th>
<th>Explosives or Explosion Hazard</th>
<th>Corrosives</th>
<th>Compressed Gases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warnings</td>
<td>Environmental Hazards</td>
<td>Poison/Toxic</td>
<td>Variety of Health Hazards</td>
<td></td>
</tr>
</tbody>
</table>
Military markings are not necessarily uniform.

Courtesy of Rich Mahaney
The military ships some hazardous materials and chemicals by common carrier. When this is done they are not required to be marked with DOT and TC transportation markings.
Pipeline markers are required where pipelines cross under or over roads, railroads, and waterways.

Courtesy of Rich Mahaney
Pesticide labels are regulated by the EPA.
Color Codes – ANSI Z535.1

- Danger or Stop
- Warning
- Caution
- Safety Equipment
- Safety Information Signage
Learning Objective 6

Explain the written resources available to indicate the presence of hazardous materials.
Shipping papers accompany hazardous materials shipments.

49 CFR SHIPPING PAPER REQUIREMENTS

MUST BE IN THIS ORDER

SHIPPING PAPER
EMERGENCY # 1-800-CAN-HELP

<table>
<thead>
<tr>
<th>NO. &amp; KIND</th>
<th>HM</th>
<th>PROPER SHIPPING NAME CLASS/DIVISION UN NO. &amp; PACKING GROUP</th>
<th>NET QTY</th>
<th>TOTAL QTY</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 Boxes</td>
<td>X</td>
<td>Bromoacetone 6.1 UN1569 PG II Poison Inhalation Hazard zone B Marine Pollutant</td>
<td>24 lbs.</td>
<td>240 lbs.</td>
</tr>
</tbody>
</table>

REPORTABLE QUANTITY (RQ) IF REQUIRED OR AN “X” MARKED FOR HAZMAT

NUMBER & KIND OF PACKAGES

EMERGENCY PHONE NUMBER

QUANTITY PER PACKAGE

PROPER SHIPPING NAME

HAZARD CLASS

IDENTIFICATION NUMBER

PACKING GROUP

POISON INHALATION HAZARD AND ZONE IF REQUIRED

MARINE POLLUTANT IF REQUIRED

A. Certification
Safety Data Sheets (SDSs) are often the best source of detailed information available.
What are the required sections of SDSs?
The *Emergency Response Guidebook (ERG)* helps quickly identify specific/generic hazards.

*Courtesy of Rich Mahaney*
Other Records That May Provide Information About Hazardous Materials

- Chemical Inventory Lists (CILs)
- Shipping and receiving documents
- Inventory records
- Risk management and hazardous communication plans
- Emergency response plans developed by the LEPC
Discuss the limitations of using the senses to determine the presence or absence of hazardous materials.
What is the safest of the five senses to use in the detection of a hazardous material?
Deliberately using the human senses to detect the presence of hazardous materials is both unreliable and dangerous.
Visual and physical chemical indicators provide evidence of the presence of hazardous materials.

Courtesy of FEMA News Photos, photo by Liz Roll
Physical signs and symptoms of chemical exposure can occur separately or in clusters.

- Difficult breathing
- Increase or decrease
- Tightness of chest
- Irritation
- Respiratory arrest

Changes in respiration

Changes in level of consciousness

- Dizziness
- Lightheadedness
- Drowsiness
- Confusion
- Fainting

Changes in level of consciousness

Abdominal distress

- Nausea
- Vomiting
- Cramping

(Continued)
Physical signs and symptoms of chemical exposure can occur separately or in clusters.

- Fatigue
- Weakness
- Stupor
- Hyperactivity
- Restlessness
- Anxiety
- Giddiness
- Faulty Judgment

Changes in activity level:

Visual disturbances:
- Double vision
- Blurred vision
- Cloudy vision
- Burning of the eyes
- Dilated or constricted pupils

Skin changes:
- Burning sensations
- Reddening
- Paleness
- Fever
- Chills

(Continued)
Physical signs and symptoms of chemical exposure can occur separately or in clusters.

- Uncontrolled tears
- Profuse sweating
- Mucus flowing from the nose
- Diarrhea
- Frequent Urination
- Bloody stool
- Intense thirst

Changes in excretion or thirst

- Headache
- Muscle ache
- Stomachache
- Chest pain
- Localized pain at sites of substance contact

Pain
What are some symptoms of chemical exposure?
Learning Objective 8

Discuss monitoring and detection devices.
Monitoring and Detection Devices

- Can be useful in determining the presence of hazardous materials and concentrations
- Can be used to determine scope of incident
- Effective use requires actual contact; outside scope for Awareness-Level personnel
Learning Objectives 9-11

Analyze scenarios to detect the presence of hazardous materials.
Interpret representative shipping papers.
Interpret a safety data sheet (SDS).

*These objectives are measured in Learning Activities 2-1 through 2-3.*
Learning Objective 12

Explain how to identify terrorist attacks and illicit laboratories.
There are several key differences between hazardous materials and terrorist incidents.

<table>
<thead>
<tr>
<th>Size and capacity</th>
<th>Number of casualties</th>
<th>Presence of extremely hazardous materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potential for armed resistance</td>
<td>Booby traps</td>
<td>Necessity of crime scene preservation</td>
</tr>
<tr>
<td>Secondary devices</td>
<td>Higher level of risk targets</td>
<td></td>
</tr>
</tbody>
</table>
Cues to Possibility of Terrorist Attack

- Report of 2 or more medical emergencies in public locations
- Unusually large number of people with similar signs and symptoms arriving at physicians’ offices or emergency rooms
- Reported explosion at public, historic, or government location
What types of agents are used in chemical attacks?
There are a variety of chemical attack indicators.

Warning/threat of attack; received intelligence

- Unexplained odors or tastes
- Hazardous materials presence or lab equipment not relevant to occupancy

- Unexplained patterns, sudden onset of similar, nontraumatic illnesses or deaths
- Intentional release

(Continued)
There are a variety of chemical attack indicators.

- Multiple individuals exhibiting skin, eye, or airway irritation
- Causalities distributed downwind or near ventilation systems
- Unexplained bomb or munition-like material
- Multiple individuals exhibiting unexplained health problems
- Unexplained vapor clouds, mists, and plumes

(Continued)
There are a variety of chemical attack indicators.

- Multiple individuals experiencing blisters and/or rashes
- Dead, discolored, abnormal trees, shrubs, bushes, crops, and/or lawns
- Abnormal number of sick or dead birds, animals, and/or fish
- Unusual security
- Surfaces exhibiting oily droplets or films; oily film on water surfaces
What types of materials are often utilized in biological attacks?
Biological attack indicators may take several days to develop.

Courtesy of CDC Public Health Image Library

Courtesy of U.S. Department of Agriculture
DISCUSSION QUESTION

What types of materials are used in radiological attacks?
Radiological attack indicators can be exhibited in a variety of ways.

Courtesy of Tom Clawson
There are a variety of nuclear attack indicators.
What are several indicators of a chemical attack?

What are several indicators of a radiological attack?
Explosive/incendiary attack indicators may be involved in the majority of terrorists attacks.
Illicit Laboratories present numerous threats.

**Exterior clues**

- Blacked out windows
- Discarded chemical containers
- Booby traps
- Hidden or disguised entrances
- Inappropriate levels of protection and security
- Excessive amounts of trash
Illicit Laboratories present numerous threats.

**Interior clues**

- Covered windows in an occupied building
- Chemical odors
- Flasks and other glassware
- Unusual heat sources
- Containers of unknown substances
- Pill packages or blister packs
- Large quantities of lithium batteries
- Propane bottles
What are some exterior clues to the presence of an illicit lab?
Secondary attacks and booby traps are always a possibility.
Protecting Against Possible Secondary Devices

- Anticipate the presence of a secondary device at any suspicious incident
- Visually search for a secondary device before moving into the incident area
- Limit number of emergency response personnel to those performing critical tasks

(Continued)
Protecting Against Possible Secondary Devices

- Avoid touching or moving anything that may conceal an explosive device
- Manage the scene with cordons, boundaries, and scene control zones
- Evacuate victims and nonessential personnel as quickly as possible
- Preserve scene as much as possible
Items that should arouse curiosity when looking for a secondary attack.

- Containers with unknown liquids or materials
- Unusual devices or containers with electronic components
- Devices containing quantities of fuses, fireworks, match heads, etc.
- Materials attached to or surrounding an item that could be use for shrapnel
- Ordnance such as blasting caps, detcord, military explosives, etc.

Any combination of these items
Summary

• Using the seven clues to the presence of hazardous materials, can help first responders take the first steps toward successful mitigation of a hazardous materials incident.

• Correctly identifying a hazardous material may be difficult and dangerous.
Summary

- First responders must be able to recognize when an incident may be the result of a terrorist attack, and to recognize the signs of illicit laboratories.