

CHAPTER

32

Hazardous Materials Operations Level

Understanding the Hazards

NOTE: Content within this chapter meets the intent of **NFPA 470, 2022 Edition**, which includes chapter 7, "Professional Qualifications for Hazardous Materials/WMD Operations Level Responders (**NFPA 1072**)."

KNOWLEDGE OBJECTIVES

After studying this chapter, you will be able to:

- Identify and describe common types of hazardous materials containers.
- Describe the ways in which hazardous materials are transported.
- Identify resources that can provide technical chemical information.
- Identify different types of potential terrorist incidents and response options.

SKILLS OBJECTIVES

There are no skills objectives for operations-level responders for this chapter.

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CASE STUDY

You Are the Firefighter

Your engine company is dispatched to the scene of a leaking drum at a local lumberyard. It appears to have been hit by a forklift, causing a small tear toward the bottom, and a substance is slowly leaking and an usual odor is reported. The dirt around the drum looks wet. The foreman of the lumberyard tells you that the drum holds waste oil, and the forklift driver on duty denies hitting the drum. From a safe distance, you can tell that the drum is made of steel and has a 2-inch (51-mm) bung and a ¾-inch (19-mm) bung on the top. You can see a small red label on the side of the drum that says "flammable," with the number 3 at the bottom.

1. What type of material is most likely stored in the drum (e.g., corrosive, solvent, explosive)? Does the description of the drum provide any other useful information? If so, what?
2. What does the label on the drum signify, and does the report of an unusual odor make sense given the information you have?
3. How would you go about obtaining more information on the potential contents of the drum?

Introduction

Even the most common chemical substances and the containers they are held in can become dangerous when released or involved in an accident. For example, we tend to think of gasoline tankers and railcars as valuable components of transportation and commerce, but if they are involved in a serious accident, or are used to create harm in the hands of determined terrorists, these common modes of transport can become deadly weapons. As another example, demolition companies use explosives to bring down unneeded structures quickly and safely, but terrorists could use the same explosives to bring down an occupied building, deliberately killing many people. When it comes to hazardous materials incidents, it is the intent that distinguishes between an accident and a terrorist event, not the chemical or the container involved. This chapter therefore offers a combined overview of a wide variety of containers and their physical characteristics, the common substances found in those containers, and a broad overview of several classes of terrorism agents.

Operations-Level Container Recognition

Lots of information can be gained about an incident by knowing some basic things about containers. Some commonly encountered containers include drums, carboys, and compressed gas cylinders. This section describes several types of containers and some general characteristics of the container, such as the materials used in its construction, its shape, and its typical internal pressures. This discussion is not meant as a definitive reference for any of the container types described. Rather, it is intended to help the responder form some initial impression of the hazards and potential harm posed by the chemical and physical properties of the materials inside.

Bulk Fixed-Facility Pressure Containers

The operations-level responder may encounter very large containers at fixed facilities. **Bulk packaging**, or large-volume containers, is defined by its internal capacity based on the following measures (excluding a vessel or a barge) (NFPA 470):

- A maximum liquid capacity greater than 119 gallons (450 liters)
- A maximum net mass greater than 882 pounds (400 kg) as a receptacle for a solid
- A water capacity greater than 1001 pounds (454 kg) as a receptacle for a gas

In contrast, **nonbulk packaging** is defined as packaging that has "a liquid capacity of 119 gallons (450 liters) or less, a solids capacity of 882 pounds (400 kg) or less, or a compressed gas water capacity of 1001 pounds (454 kg) or less" (NFPA 470). Essentially, nonbulk packaging includes all types of containers other than bulk containers.

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TABLE 32-1 Common Bulk Storage Vessels, Locations, and Contents

Tank Shape	Common Locations	Hazardous Materials Commonly Stored
Underground tanks	Residential, commercial	Fuel oil, combustible liquids
Covered floating roof tanks	Bulk terminal and storage	Highly volatile flammable liquids
Cone roof tanks	Bulk terminal and storage	Combustible liquids
Open floating roof tanks	Bulk terminal and storage	Flammable and combustible liquids
Dome roof tanks	Bulk terminal and storage	Combustible liquids
Pressure horizontal tanks	Industrial storage and terminal	Flammable gases, chlorine, ammonia
Pressure spherical tanks	Industrial storage and terminal	Liquid propane gas, liquid nitrogen gas
Cryogenic liquid storage tanks	Industrial and hospital storage	Oxygen, liquid nitrogen gas

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In general, bulk storage containers are found in occupancies that rely on and need to store large quantities of a substance. Most manufacturing facilities have at least one type of bulk storage container (**TABLE 32-1**). Often these bulk storage containers are surrounded by a secondary containment system to help control an accidental release. **Secondary containment** is an engineered method to control spilled or released product if the main containment vessel fails, consisting of a device or structure, such as dikes, curbing, and double-walled tanks. A 5000-gallon (18,927-liter) vertical storage tank, for example, may be surrounded by a series of short walls commonly referred to as a **dike** or **berm** that form a catch basin around the vessel.

Secondary containment basins typically can hold the entire volume of the tank, along with a percentage of the water flowed from hose lines or sprinkler systems in the event of fire and, in the case of outdoor storage, a certain amount of rainfall. Many storage vessels, including 55-gallon (208-liter) drums, may have secondary containment systems. If facilities that use bulk storage containers in your response area have secondary containment systems, it will be easier to handle leaks when they occur, but it is important to understand their capabilities and capacities.

Bulk storage tanks are usually made of aluminum, steel, or plastic and can be either pressure or nonpressure containers. Nonpressure tanks have a working pressure between 2.65 and 4 psi and are usually made of steel or aluminum. They commonly hold flammable or combustible materials, such as gasoline, ethanol, oil, or diesel fuel, but may also hold solids. A **pressure tank** has an internal pressure of more than 15 **psig** (pounds per square inch gauge, which is a measurement of pressure inside the container shown on an attached pressure gauge in relation to atmospheric pressure). When preplanning for fixed facilities in your response area, pay attention to the types of tanks you may encounter during an incident (**FIGURE 32-1**).

Liquified Compressed Gas Cylinders

Another typical type of bulk storage vessel is the liquified compressed gas cylinder. This common type of cylinder can contain a variety of volumes, but in all cases is a nonrefrigerated, pressurized tank. The typical, high-volume, liquified compressed gas cylinder has rounded ends and large vents or pressure-relief stacks. The most common aboveground storage vessel of this type typically contains liquified propane or liquified ammonia (both are **anhydrous**, which means there is no water in the substances). Such containers can hold a few hundred gallons to several thousand gallons of product. In most cases, 10 to 15 percent of the total container capacity is vapor in the headspace above the liquid (**FIGURE 32-2**). Smaller versions of pressure containers may be found in the form of portable propane cylinders and vehicle-mounted cylinders (**FIGURE 32-3**).

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A.



B.



C.



D.

FIGURE 32-1 Examples of large-volume storage tanks. **A.** Spherical fixed-facility pressure containers. **B.** Bulk fixed-facility tanks. **C.** Bulk fixed-facility cryogenic container. **D.** A ton chlorine container after a leak.

A and B: Courtesy of Chris Hawley; **C:** © Jones & Bartlett Learning. Courtesy of Rob Schnepp; **D:** © Jones & Bartlett Learning. Courtesy of Jason Krusen.



FIGURE 32-2 In most cases, 10 to 15 percent of the total container capacity is vapor.

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Ton Containers

A **ton container** is bulk packaging that commonly holds liquified compressed gases such as chlorine and sulfur dioxide, although you may sometimes encounter refrigerant fluorocarbon gases such as trichlorofluoromethane (Freon-11) and dichlorodifluoromethane (Freon-12) stored in ton containers. Regardless of the material inside, these vessels hold approximately 2000 pounds (907 kg) of product (hence the name, *ton container*) and are approximately 8 feet (2.4 m) in length and 3 feet (1 m) in diameter. When the weight of the cylinder is added, a full ton chlorine cylinder can weigh approximately 3500 pounds (1588 kg). All ton containers, other than those containing phosphine, have a pressure relief valve called a **fusible plug**. Figure 32-1D shows a ton container after a leak. The Y

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A.



B.

FIGURE 32-3 **A.** Portable propane cylinder (nonrefrigerated liquified compressed gas) in a storage yard. **B.** Vehicle-mounted pressure container (propane) in use on a forklift.

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A.



B.

FIGURE 32-4 **A.** Portable intermodal tank. **B.** Markings on a portable intermodal tank.

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cylinder seen in Figure 32-1E is used for high-purity gases such as silane and phosphine.

Intermodal Tanks

An **intermodal tank (IM or IMO)** is a bulk packaging container that is used as both a shipping and a storage vessel. IM tanks hold between 5000 and 6300 gallons (18,927 to 23,848 liters) of product and can be either pressure or nonpressure containers. They can also be used to ship and store cryogenic liquids, such as liquid nitrogen and liquid argon. In most cases, an IM tank is shipped to a facility, where it is stored and used, and then returned to the shipper for refilling. IM tanks can be shipped by air, sea, or land (**FIGURE 32-4**).

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Typically, an IM tank is surrounded by a box-like steel framework that facilitates efficient stacking and shipping. Several types of IM tanks are available:

- IM-101 portable tanks (IMO type 1 internationally) have a 6300-gallon (23,848-liter) capacity, with internal working pressures between 25.4 pounds per square inch (psi) and 100 psi. These containers typically carry mild corrosives, food-grade products, and flammable liquids (**FIGURE 32-5**).
- IM-102 portable tanks (IMO type 2 internationally) have a 6300-gallon (23,848-liter) capacity, with internal working pressures between 14.7 psi and 25.4 psi. They primarily hold nonhazardous materials, but may also contain flammable liquids and corrosives (**FIGURE 32-6**).
- Pressure IM tanks (IMO type 5 internationally or U.S Department of Transportation [DOT] Spec 51) are high-pressure vessels with internal pressures in the range of 100–600 psi. These intermodal containers commonly hold liquefied compressed gases such as propane and butane (**FIGURE 32-7**).
- Cryogenic IM tanks (IMO type 7 internationally) are low-pressure containers in transport but can be pressurized to 600 psi. This kind of container commonly holds cryogenic materials that have temperatures less than –150°F (–101°C), such as liquefied oxygen, nitrogen, or helium (**FIGURE 32-8**).
- **Multiple element gas containers (MEGCs)** consist of several high-pressure tubes attached to a frame. The tubes are individually specified and have



FIGURE 32-5 IM-101 portable tank (IMO type 1 internationally).
Courtesy of UBH International Ltd.



FIGURE 32-7 Pressure IM tank (IMO type 5 internationally).
Courtesy of UBH International Ltd.



FIGURE 32-6 IM-102 portable tank (IMO type 2 internationally).
Courtesy of UBH International Ltd.



FIGURE 32-8 Cryogenic IM tank (IMO type 7 internationally).
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A.



B.

FIGURE 32-9 Multiple element gas containers (MEGCs) consist of several high-pressure tubes attached to a frame.

Courtesy of Bill Hand.

working pressures that range as high as 5000 psi. The products commonly carried in MEGCs include hydrogen and oxygen (**FIGURE 32-9**).

Intermediate Bulk Containers

An **intermediate bulk container (IBC)** is a bulk storage container so named because the volumes stored inside it fall between what is typically found in drums or bags and what is in cargo tanks. Their capacities are greater than 119 gallons (450 liters) but less than 793 gallons (3002 liters). IBCs are either flexible intermediate bulk containers (FIBCs) or rigid intermediate bulk containers (RIBCs). You may hear RIBCs referred to as "totes" and FIBCs called "sacks" or "super sacks." Super sacks are much larger than a normal bag and may hold solid materials weighing anywhere from 500 pounds (227 kg) to several thousand pounds (**FIGURE 32-10**). The fabric used for their construction ranges from woven cloth to polyethylene, and the IBCs may be palletized for transport. Solid materials transported and stored in super sacks may include oxidizers, corrosives, and flammable solids. Totes can be found as a high-density polyethylene tank inside a rigid stainless steel frame or perhaps a square metal tank around 4 feet (1.2 m) wide and 6 feet (1.8 m) tall. Both types have bottom-mounted discharge valves and are commonly found at fixed facilities. Totes may hold a wide variety of substances, such as solvents, corrosives, or select oxidizers.

Shipping and storing totes can create hazards. For example, these containers often are stacked atop one another and moved with a forklift. A mishap with the loading or moving process can compromise the tote (**FIGURE 32-11**). Because totes have no secondary containment system, any leak has the potential to create a large puddle. Additionally, the steel webbing around the tote makes it difficult to access and patch leaks.

Another type of unique container used for chemical storage is the flexible bladder. These vessels are typically portable and used for short-term storage and dispensing of low-hazard materials (**FIGURE 32-12**).

Transporting Hazardous Materials

Transportation of hazardous materials occurs most often on the roadway. Indeed, even when another primary mode of transport is used, roadway vehicles often transport the shipments from the rail station, airport, or dock to the point where it will be used. Responders must become familiar with all types of chemical transport vehicles they might encounter during a transportation emergency.

Roadway Transportation

Per the Code of Federal Regulations, 49 CFR 171.8(2), or local jurisdictional regulations, a **cargo tank** is bulk packaging that "is permanently attached to or forms a part of a motor vehicle or is not permanently attached to any motor vehicle and which, by reason of its size, construction, or attachment to a motor vehicle, is loaded or unloaded without being removed from the motor vehicle."

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FIGURE 32-10 Examples of flexible intermediate bulk containers (FIBCs), also known as super sacks.

Top and Bottom: © Jones & Bartlett Learning; **Middle:** © Jones & Bartlett Learning. Courtesy of Hildebrand and Noll Associates, Inc.



FIGURE 32-11 Rigid intermediate bulk containers (RIBCs), also known as totes, awaiting use at a fixed facility.

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FIGURE 32-12 Flexible bladder.

© Allen Fredrickson/Reuters

One of the most common and reliable transportation vessels is the **nonpressure liquid cargo tank**, commonly referred to as an **MC-306/DOT 406 cargo tank**. The MC designation indicates "motor carrier," and the DOT designation indicates that a cargo tank meets a certain set of specifications enforced by the U.S. DOT (**FIGURE 32-13**). These cargo tanks frequently carry liquid food-grade products, gasoline, or other flammable and combustible liquids. The oval-shaped tank is pulled by a diesel (or liquefied natural gas [LNG] or compressed natural gas [CNG]) tractor and can carry 6000 to 10,000 gallons (22,712 to 37,854 liters) of product. The **nonpressure tank** is loaded and offloaded

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FIGURE 32-13 The nonpressure liquid cargo tank (MC-306/DOT 406) typically hauls flammable and combustible liquids.

Courtesy of Polar Tank Trailer L.L.C.



FIGURE 32-15 A low-pressure liquid cargo tank, the MC-307/DOT 407 chemical hauler carries flammable liquids, mild corrosives, and poisons.

Courtesy of Polar Tank Trailer L.L.C.



FIGURE 32-14 The nonpressure liquid cargo tank (MC-306/DOT 406) has a remote emergency shut-off valve as a safety feature.

Courtesy of Glen Rudner.



FIGURE 32-16 The MC-312/DOT 412 corrosives tanker is commonly used to carry corrosives such as concentrated sulfuric acid, phosphoric acid, and sodium hydroxide.

Courtesy of National Tank Truck Carriers Association.

through valves at the bottom of the tank. These cargo tanks have several safety features, including full roll-over protection and remote emergency shut-off valves (**FIGURE 32-14**).

A vehicle that is like a low-pressure liquid cargo tank is the **low-pressure chemical cargo tank** or the **MC-307/DOT 407 chemical hauler**. It has a round or horseshoe-shaped tank and can hold 6000 to 7000 gallons (22,712 to 26,498 liters) of liquid (**FIGURE 32-15**). The MC-307/DOT 407 chemical hauler, which is a tractor-drawn tank, is used to transport flammable liquids, mild corrosives, and poisons. This type of cargo tank may be insulated (horseshoe) or uninsulated (round) and may have a higher internal working pressure than the nonpressure liquid cargo tank—in some cases, up to 35 psi. Cargo tanks that transport corrosives may have a rubber lining to prevent corrosion of the tank structure.

A chemical cargo tank, commonly referred to as an **MC-312/DOT 412** corrosive tank, is often used to carry corrosives such as concentrated sulfuric acid, phosphoric acid, and sodium hydroxide (**FIGURE 32-16**). This cargo tank has a smaller diameter than the nonpressure liquid cargo tank or low-pressure **chemical cargo tank** and is often identifiable by the presence of several heavy-duty reinforcing rings around the tank. The rings provide structural stability during transportation and in the event of a roll-over. The inside of this type of chemical cargo tank operates at approximately 15 to 25 psi and holds approximately 5000 gallons (18,927 liters). These cargo tanks have substantial roll-over protection to reduce the potential for damage to the top-mounted valves.

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A **pressure cargo tank**, commonly referred to as the MC-331, carries materials such as ammonia, propane, Freon, and butane (**FIGURE 32-17**). The liquid volume that **MC-331** tanks carry varies, from a 1000-gallon (3785-liter) delivery truck to a full-size 11,000-gallon (41,640-liter) cargo tank. The cargo tank has rounded ends, typical of a pressure vessel, and is commonly constructed of steel or stainless steel with a single tank compartment. The cargo tank operates at approximately 300 psi, with typical internal working pressures being near 250 psi. These cargo tanks are equipped with spring-loaded relief valves that traditionally operate at 110 percent of the designated maximum working pressure. A significant explosion hazard arises if fire impinges on a cargo tank, however. The nature of most materials carried in these tanks means a threat of explosion exists because of the relief valve's inability to keep up with the rapidly building internal pressure. Responders must use great care when dealing with this type of transportation emergency.

A **cryogenic liquid cargo tank**, commonly referred to as the **MC-338**, operates much like the cryogenic intermodal container described earlier and carries many of the same substances (**FIGURE 32-18**). This low-pressure tank relies on tank insulation to maintain the low temperatures required for the cryogens it carries. A box-like structure containing the tank control valves is typically attached to the rear of the tank. Special training is required to operate valves on this and any other tank. An untrained individual who attempts to operate the valves may disrupt the normal operation of the tank, thereby compromising its ability to keep the liquefied gas cold and creating a potential explosion hazard. Cryogenic cargo tanks have a relief valve near the valve control box. From time to time, small puffs of white vapor will be vented from this valve. Responders should understand that this is a normal occurrence—the valve is working to maintain the proper internal pressure. In most cases, this vapor is not indicative of an emergency.

A compressed gas **tube trailer** carries compressed gases such as hydrogen, oxygen, helium, and methane (**FIGURE 32-19**). Essentially, they are high-volume transportation vehicles that are made up of several individual cylinders banded together and affixed to a trailer. The DOT, however, does not view tube trailers as cargo tanks. The individual cylinders on the tube trailer are compressed gas cylinders. These large-volume cylinders operate at working pressures of 3000 to 5000 psi. One trailer may carry several different gases in individual tubes. Typically, a valve control box is found toward the rear of the trailer, and each individual cylinder has its own relief valve. These trailers can frequently be seen at construction sites or at facilities that use large quantities of compressed gases.



FIGURE 32-17 The MC-331 cargo tank carries materials such as ammonia, propane, Freon, and butane.

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FIGURE 32-18 The MC-338 cryogenic tank maintains the low temperatures required for the cryogens it carries.

Courtesy of Jack B. Kelly, Inc.

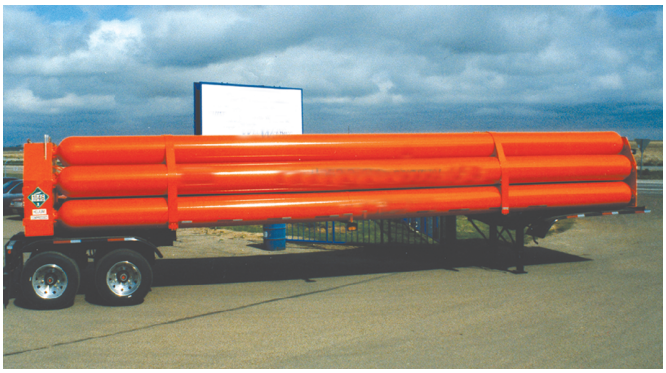


FIGURE 32-19 A compressed gas tube trailer.

Courtesy of Jack B. Kelly, Inc.

A **dry bulk cargo trailer** is commonly seen on the road. They carry dry bulk goods such as powders, pellets, fertilizers, or grain (**FIGURE 32-20**). These tanks

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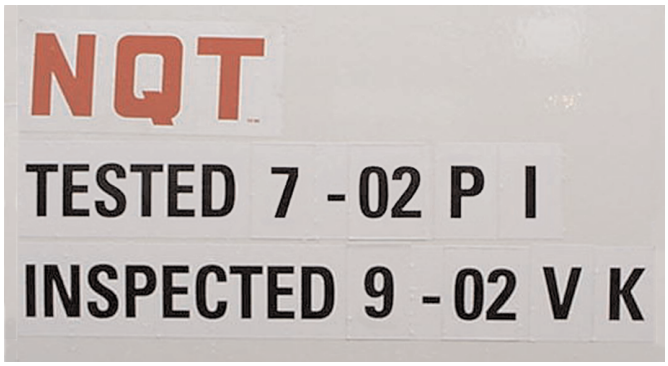


FIGURE 32-20 A dry bulk cargo tank carries dry goods such as powders, pellets, fertilizers, or grain.

Courtesy of Polar Tank Trailer L.L.C.



A.



B.

FIGURE 32-21 Cargo tank trucks. **A.** Specification plate. **B.** Inspection markings.

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are not pressurized, but may use pressure to offload the product. Dry bulk cargo tanks are generally V-shaped with rounded sides that funnel the contents to the bottom-mounted valves.

Some trailers carry more than one type of substance. Responders should always be aware of mixed-cargo trailers, as they may present multiple hazards. To understand the markings found on cargo tanks, the responder should have a basic understanding of not only the container profiles, but also written information found on the tank and tank specification plates (**FIGURE 32-21**).

Railroad Transportation

Railroads move millions of carloads of chemicals and other freight each year in the United States, with relatively few accidents. Even so, responders should recognize that when rail incidents do occur, they can create unique and significant hazards. Railcars include passenger cars, freight cars, and tank cars, some of which can carry more than 30,000 gallons (113,562 liters) of product. Hazardous materials incidents involving railroad transportation have the potential to be large-scale emergencies.

Operations-level responders should recognize the five basic types of rail tank cars:

- Nonpressure tank cars
- Pressure tank cars
- Cryogenic liquid tank cars
- Gondolas
- Boxcars

Each has a distinctive profile that can be recognized from a distance. Additionally, rail tank cars are usually labeled on both sides with, among other things, the owner of the car, the car's capacity, and the specification. With dedicated haulers, the chemical name is often clearly visible on both sides of the rail tank car.

A **nonpressure tank car** (also referred to as a **general-service rail tank car**) typically carries general industrial chemicals and consumer products such as corn syrup, flammable and combustible liquids, and mild corrosives. Many nonpressure tank cars have visible valves and piping without protective housing on top of the car and internal vapor pressures less than 25 psi (**FIGURE 32-22**). Older nonpressure tank cars, as well as many seen on today's rail system, may have a protective housing that covers the top-mounted valves and bottom outlet valves (**FIGURE 32-23**). Nonpressure tank cars may hold volumes ranging from 4000 to 40,000 gallons (15,142 to 151,416 liters).

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FIGURE 32-22 Nonpressure tank cars have visible valves and piping.

Courtesy of Chris Hawley.



FIGURE 32-23 An example of an older-style, out-of-service, nonpressure tank car.

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A **pressure tank car** transports materials such as propane, ammonia, ethylene oxide, and chlorine. These cars have internal working pressures ranging from 100 to 600 psi and are equipped with top-mounted fittings for loading and unloading. The fittings are protected by a sturdy, easily identified protective housing that sits atop the rail tank car (**FIGURE 32-24**). Unfortunately, the high volumes carried in these cars can generate long-duration, high-pressure releases that can prove difficult to control. For example, a liquid or vapor release from the valve arrangements on a chlorine tank car requires a special kit and specific training to stop the leak. Additionally, pressure rail tank cars may be insulated or uninsulated, depending on the material being transported, and chlorine and ammonia railcars have federal security alarms in protective housing to prevent chemicals from being stolen and terrorist activities from occurring.



FIGURE 32-24 Pressure tank car.

Courtesy of Chris Hawley.



FIGURE 32-25 Cryogenic liquid tank car.

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A **cryogenic liquid tank car** is the most common of the **special-use railcars** (i.e., **boxcar**, flat car, cryogenic tank car, or corrosive tank car) that emergency responders may encounter (**FIGURE 32-25**). These tank cars highlight an important concept for the emergency responder: The hazard will be unique to the railcar and its contents, and the responder will need to pay attention to the details and features of each type. Other examples of special-use railcars include the railway **gondola**, which is used to carry items such as lumber, scrap metal, coal, and pipes, and boxcars, which carry consumer goods, industrial supplies, and a multitude of boxes and palletized goods (**FIGURE 32-26**). Freight containers can be used to transport goods on trucks, ships, and railcars and may pose a challenge to a responder due to the wide variety of goods and materials that may be transported inside them (**FIGURE 32-27**).

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FIGURE 32-26 One example of a special-use railcar is the boxcar, typically used for carrying freight.

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FIGURE 32-27 Examples of freight containers in the background.

Courtesy of Chris Hawley.

The train crew will have information about all the cars on the train. This information is typically found with the conductor or with the engineer in the lead locomotive. The train crew must retain control of the paperwork at all times and will have knowledge about the availability of a specialized response team from the railroad, access to a 24/7 call center for the railroad, and information about the location and contents of the railcars; thus, they will be able to help responders understand the scope and impact of the derailment. Incidents involving hazardous materials carried on railcars can have significant effects on communities adjacent to the incident and may pose a significant risk to life, property, or the environment (**FIGURE 32-28**).

Collecting Hazard and Response Information

The responsible person for any chemical substances during transportation should maintain the source(s) of information about hazardous cargo. When encountering a chemical release on any mode of transportation, take time to find the responsible person and track down these valuable pieces of information. Additionally, the person who finds this information for you, or has it in their possession, is likely to be a great resource to connect you with subject-matter experts from the company or may have some level of knowledge about the material or the mode of transportation that may prove valuable.

CHEMTREC

The **Chemical Transportation Emergency Center (CHEMTREC)**, which is operated by the American Chemistry Council, is a clearinghouse of technical chemical information. Since 1971, this emergency call center has served as an invaluable information resource on a 24-hour basis for first responders from all disciplines who are called upon to respond to chemical incidents (NFPA 470). CHEMTREC can provide responders with technical chemical information via telephone, fax, or another electronic medium. It also offers a phone conferencing service that will put a responder in touch with thousands of shippers, subject-matter experts, and chemical manufacturers.

When calling CHEMTREC, be sure to have the following basic information ready:

- Name of the chemical(s) involved in the incident (if known)
- Name of the caller and a callback telephone number
- Location of the actual incident or problem
- Shipper or manufacturer of the chemical (if known)
- Container type
- Railcar or vehicle markings or numbers
- Shipping carrier's name
- Recipient of material
- Local conditions and exact description of the situation

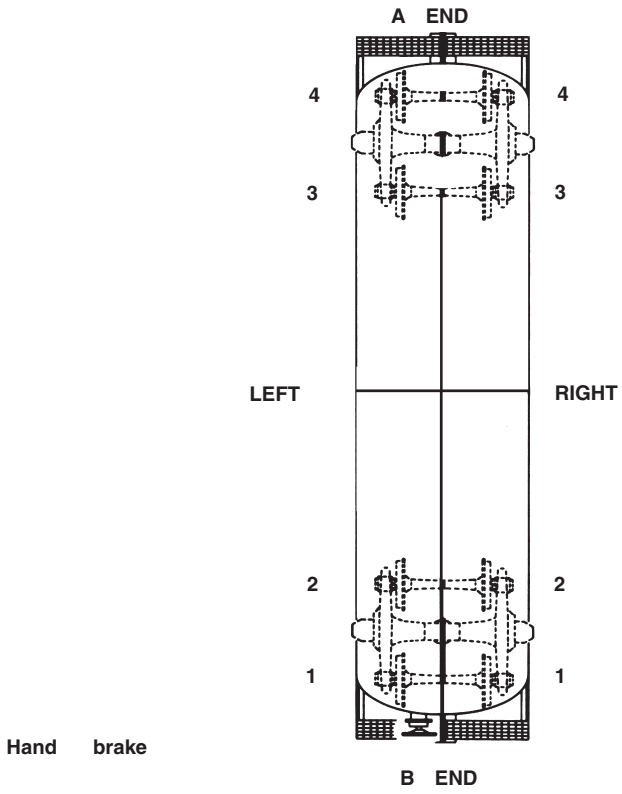
When speaking with CHEMTREC personnel, be very clear about the name of the substance and spell it out if necessary; if using a third party, such as a dispatcher, it is vital that you confirm all spellings to avoid misunderstandings. One number or letter out of place could throw off all subsequent research. When in doubt, be sure to obtain clarification. Be sure to have access

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RAILROAD TANK CARS

Railroad Tank Car Nomenclature. The railroad industry uses tank car test pressure as the criterion for differentiating between pressure and nonpressure tank cars. Non-pressure tank cars have a test pressure of 100 psig or less, while pressure tank cars have a test pressure greater than 100 psig.

When describing a tank car, the "B-end" is used as the initial reference point. The B-end is where the hand brake wheel is located; numbers 1 through 4 indicate the wheels.



Railroad Tank Car Markings. The markings on railroad tanks cars can be used to gain knowledge about the tank itself and its contents. This information would be useful in evaluating the condition of the container. These markings include the following:

- *Commodity Stencil.* Tank cars transporting anhydrous ammonia, ammonia solutions with more than 50% ammonia, a Division 2.1 material (flammable gas), or a Division 2.3 material (poison gas) must have the name of the commodity marked on both sides of the tank in 4-inch (102-mm) minimum letters.

- *Reporting Marks and Number.* Railroad cars are marked with a set of initials and a number (e.g., GATX 12345) stenciled on both sides (left end as you face the tank) and both ends of the car. Some shippers and car owners also stencil these markings on top of tank cars to assist in identification in an accident or derailment scenario. New tank cars are also stenciled on top for tank car verification during loading operations, as plant personnel can easily verify the car initial and number without climbing down from the rack.
  These markings can be used to obtain information about the contents of the car from the railroad, the shipper, or CHEMTREC. The last letter in the reporting marks has special meaning:

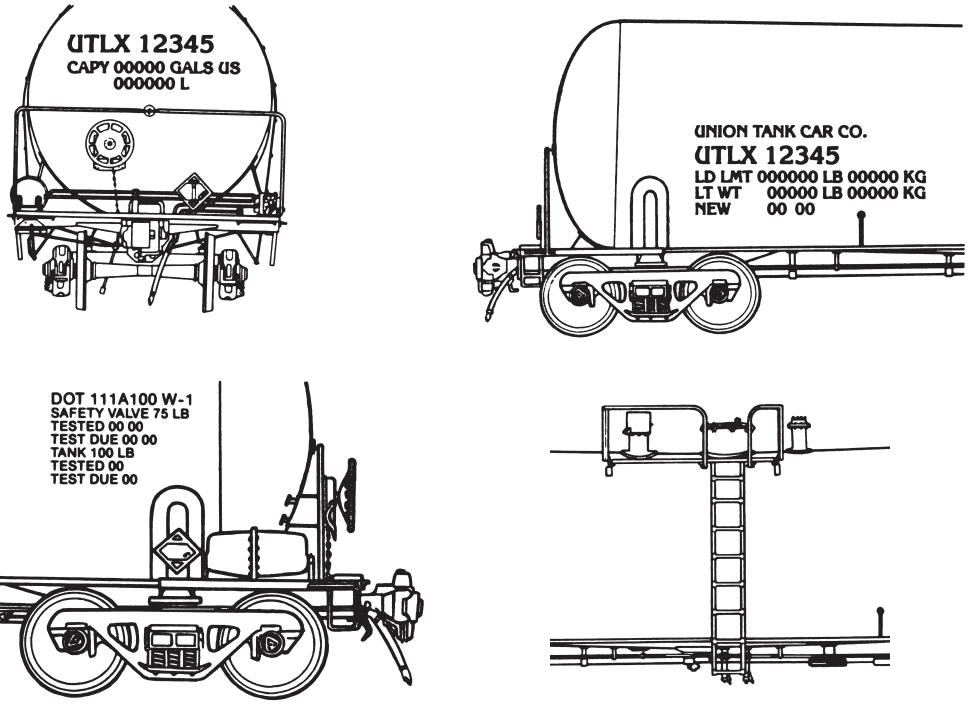
  - "X" indicates a railcar is not owned by a railroad (for a rail car, the lack of an "X" indicates railroad ownership).
  - "Z" indicates a trailer.
  - "U" indicates a container.

FIGURE 32-28 Derailments can have significant effects on communities adjacent to the incident and may pose a significant risk to life, property, or the environment. Having access to the information found stenciled on rail cars may be valuable to the responders.

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- *Capacity Stencil*. The capacity stencil shows the volume of a tank car in gallons (and sometimes liters), as well as in pounds (and sometimes kilograms). These markings are found on the ends of the car under the reporting marks. For certain tank cars (e.g., DOT-105, DOT-109, DOT-112, DOT-114, and DOT-111A100W4), the water capacity/water weight of the tank car is stenciled near the center of the car.



- *Specification Marking.* The specification marking indicates the standards to which a tank car was built. These markings will appear on both sides of the tank car (right end as you face the tank). The specification marking is also stamped into the heads of the tank, where it is not readily visible. The markings provide the following information:
  - Approving authority (e.g., DOT – Department of Transportation, AAR – Association of American Railroads, ICC – Interstate Commerce Commission [authority changed to DOT in 1966]), CTC – Canadian Transport Commission, TC – Transport Canada)
  - Class number: three numbers that follow the approving authority designation
  - Separator/delimiter character (significant in certain tank cars)
  - Tank test pressure
  - Type of material used in construction: Most tank cars are carbon steel and no designation appears. When other construction materials are used (e.g., aluminum, nickel, alloy steel), designations are used.
  - Type of weld used
  - Fittings/material/lining

- *Specification Plate.* Tank cars ordered after 2003 will have a plate on the A-end right bolster and the B-end left bolster (i.e., the structural cross-member that cradles the tank) that provides information about the tank car's characteristics. Although not designed as an emergency response tool, the plate will provide the following information:
  - Car builder's name
  - Builder's serial number
  - Certificate of construction/exemption
  - Tank specification tank shell material/head material
  - Insulation materials
  - Insulation thickness
  - Underframe/stub sill type
  - Date built

FIGURE 32-28 Continued

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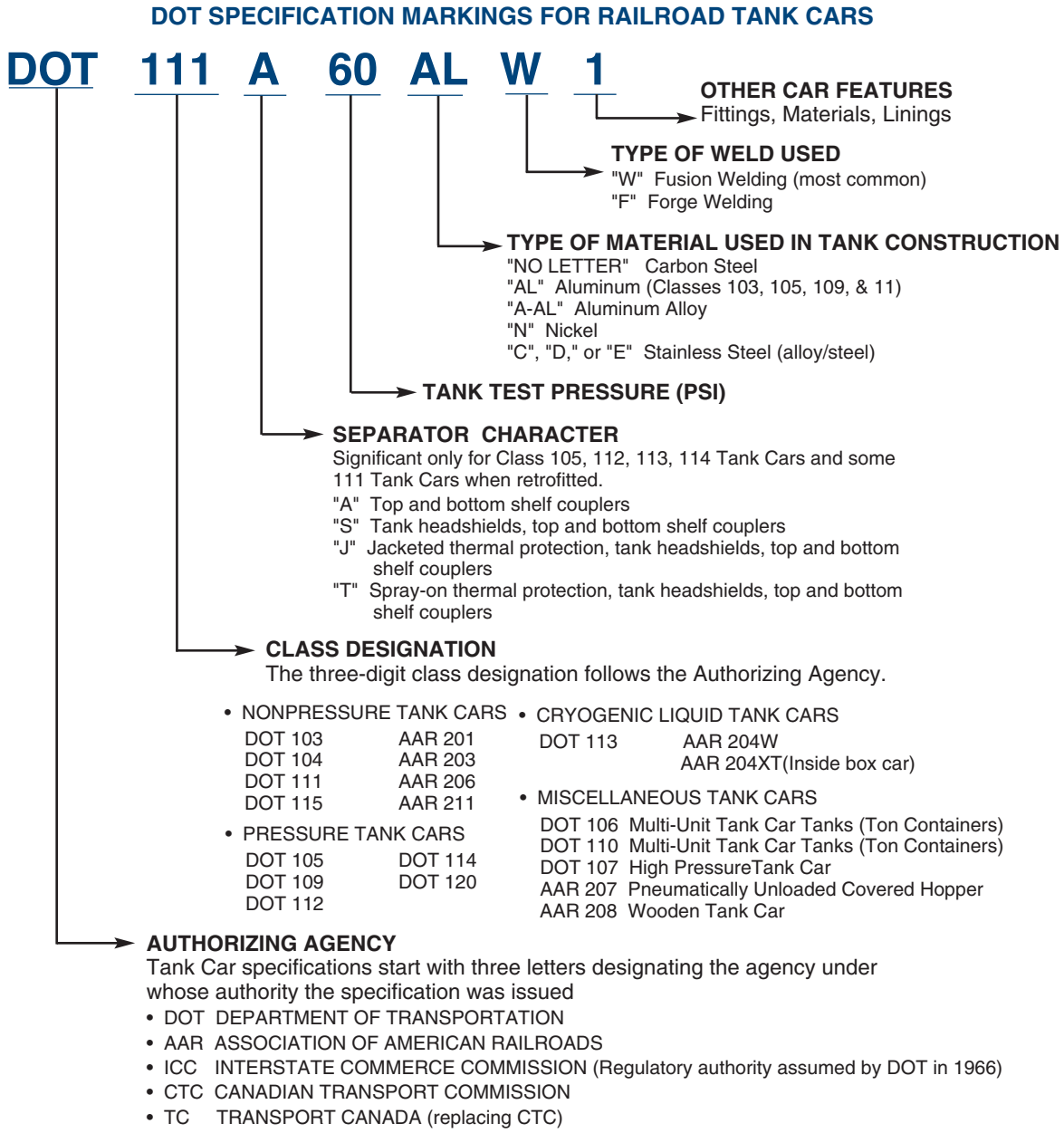


FIGURE 32-28 Continued

to a fax machine or electronic medium so that you can receive the information about the chemical sent from CHEMTREC.

The Canadian equivalent of CHEMTREC is the **Canadian Transport Emergency Centre (CANUTEC)**, which is located in Ottawa. This organization serves Canadian responders (in French and English) in much the same way that CHEMTREC serves responders in the United States. CANUTEC may be called 24 hours per day for emergency situations (NFPA 470).

The Mexican equivalent of CHEMTREC and CANUTEC is the **Emergency Transportation System for the Chemical Industry, Mexico (SETIQ)**. SETIQ also may be called 24 hours per day (NFPA 470).

Phone numbers for all three of these agencies can be found in the *Emergency Response Guidebook* (*ERG*).

National Response Center

The **National Response Center (NRC)** is a federal agency maintained and staffed by the U.S. Coast Guard. The NRC should always be notified if a hazard discharges into the environment. There are established, complex reporting requirements for different chemicals based on the reportable quantity (RQ) for each chemical. The shipper or the owner of the chemical has the ultimate legal responsibility to make this call, but

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by doing so themselves, response agencies will ensure their reporting bases are covered.

Potential Terrorist Incidents

The threat of terrorism has changed the way public safety agencies operate. In small towns and major metropolitan areas alike, the possibility exists that on any day, any agency could find itself in the eye of a storm involving intentionally released chemical substances, biological agents (disease-causing bacteria or other viruses that attack the human body), or an attack on buildings or people using explosives. No area of any country is immune to such attacks. Today, responders must recognize that they are a part of a much larger response mechanism in the United States; they must also understand that any incident involving terrorism will require the assistance and cooperation of countless local, state, and federal resources. Responders

Voice of Experience

The department that I work for provides regional response to several counties for response to hazardous material incidents. This includes covering multiple interstate highways that are critical links for infrastructure in our state.

One summer afternoon, our team was requested to assist with a motor vehicle incident on Interstate 77 near the town of Chelyan, West Virginia. The operator of a tandem tractor trailer suffered a medical emergency, which led to a crash in which the operator was ejected from the cab of his vehicle. The vehicle continued on for some distance until the rear trailer turned over on its side, dislodging and spilling the contents onto the highway.

Prior to this, our hazardous materials team members had always been warned about the potential hazards with vehicles that delivered packages from different shippers. The concern was that the shippers often send all types of different items without having any markings on the packages. The vehicle involved in this incident was, in fact, a freight truck carrying all types of packages, so our responders went in with additional concerns and cautions.

Upon arrival of our units, we surveyed the scene and performed an initial size-up. The trailers were located on a bridge 50 to 70 feet (15 to 21 m) over a small creek and local road. One trailer was upright; the other was on its side with the doors open. There was one ambulance parked in the middle of a spilled material, but no responders were near the vehicles themselves.

The incident commander (IC) advised us that the patient had already been transported, but that the transport was done by another emergency medical services (EMS) unit due to the initial unit being contaminated with the unknown material.

As with any hazardous material identification, our first request was for the bill of lading from the cab. The IC had advised that he already looked in the cab and found nothing, and with the driver not being available, they were unsure what chemical was involved.

For many years, our members have always been instructed to do a good scene survey including a 360-degree walkaround of the area, as long as they do not put themselves into any hazards. As one of our members was performing this survey, he noticed a large amount of paper in the creek below the incident.

A team member was sent down to collect this material. He returned with a wadded-up ball of paper that, when stretched out, was 20 to 30 feet (6 to 9 m) of continuous sheet feed–style paper. This was the bill of lading.

It took a small amount of time, but by comparing shipping package numbers and cross-referencing them with the bill of lading, we were able to identify that the primary hazards in this incident were xylene and ethanol. Once these chemicals were identified, we were able to provide the proper containment and decontamination for the personnel and units involved.

As a side note, further investigation into the contents of the trailer revealed the cargo included live vaccines. Again, this was proof showing that there could be anything in a freight shipment.

Robert "Les" Smith

RESA/Charleston (West Virginia) Fire Department
Charleston, West Virginia

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within every jurisdiction should think about the locations of potential targets for terrorists; the general and specific hazards posed by chemical, biological, and **radiological agents** (materials that emit radiation); possible indicators of illicit laboratories; and basic operational guidelines for dealing with explosive events and identifying the possible indicators of secondary devices. It is vital that responders continually maintain good situational awareness, but potential terrorist events require an even higher level of attention. Changing conditions or the possibility of secondary devices or additional attacks should always be considered.

Terrorists can turn the most ordinary objects into powerful weapons. For example, we tend to think of gasoline tankers and commercial airliners as valuable elements of transportation and commerce, but in the hands of determined terrorists, these devices can turn into deadly weapons. Designating an incident as an act of terrorism reflects the intent of the attacker more than the use of a certain device. For example, demolition companies use explosives to bring down unneeded structures quickly and safely; terrorists could use the same explosives to bring down an occupied building, deliberately killing many people. Again, it is the intent that separates an accident from a terrorist event.

Although bombings are the most frequently encountered terrorist acts, responders also must be aware of the threats posed by other potential weapons. Shooting into a crowd or using a vehicle to attack pedestrians in a crowded area could cause devastating carnage. The release of a **biological agent** into a subway system could cause numerous people to become ill or die, simultaneously creating a public panic response that could overload the local fire department, EMS, law enforcement, and hospitals. Given the breadth of these threats, planning should consider the full range of possibilities.

Potential targets for terrorist activities include both natural landmarks and human-made structures. These sites can be classified into three broad categories: infrastructure targets, symbolic targets, and civilian targets (**FIGURE 32-29**). The following sections will help



A.



B.



C.



D.

FIGURE 32-29 Subways **(A)**, airports **(B)**, bridges **(C)**, and hospitals **(D)** are all vulnerable to attack by terrorists who seek to interrupt a country's infrastructure.

A: © Arthur S. Aubry/Photodisc/Getty Images; **B:** © Steve Allen/Brand X Pictures/Alamy Stock Photo; **C:** © AbleStock; **D:** © Jones & Bartlett Learning. Photographed by Christine McKeen.

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you build a foundation to become a more informed responder when it comes to dealing with potential terrorist incidents.

TIP

Preincident planning at infrastructure, symbolic, and civilian targets should consider the possibility of a terrorist attack.

Responding to Terrorist Incidents

The roles of public safety responders in handling terrorist events involve many of the same functions that responders perform on a day-to-day basis. Regardless of the intent behind the incident, responders are required to make risk-based decisions about tactics and strategy, personal protective equipment (PPE), victim rescue and/or evacuation, decontamination, and information obtained during detection and monitoring activities—the entire gamut of actions required to solve the problem.

What is different during an incident with criminal intent is the landscape in which that incident is handled and the interagency cooperation that must occur. An incident with criminal intent, causing widespread destruction and/or numerous casualties, requires the involvement of many local, state, and federal law enforcement agencies; emergency management agencies; allied health agencies; and perhaps the military. It is critical that all of these agencies train together and work together in a coordinated and cooperative manner. A mass-casualty incident (MCI) involving a weapon of mass destruction (WMD) could quickly overwhelm the capabilities of your agency, neighboring agencies, and the local healthcare system, in addition to quickly becoming national and international news. Given this reality, it is important to understand which assets and capabilities of those regional agencies may be available to assist with a large-scale incident.

Additionally, preserving potential evidence is an important factor for responders to consider. This concern may be difficult to address during an active incident but should be a consideration for all responders.

In many cases, high-impact events may also require some form of after-action care for the responders in terms of mental health. This assistance will be up to the authority having jurisdiction (AHJ) to implement, but all responders should at least be aware of the need for these types of services after the incident.

In most cases, the first-responder emergency units will not be dispatched for a known WMD or terrorist incident. Rather, the initial dispatch report might cite an explosion, a possible hazardous materials incident, a single person with difficulty breathing, or multiple victims with similar symptoms. Emergency responders will rarely know that a terrorist incident has occurred until personnel on the scene begin to piece together information gained from their own observations and from interviews with witnesses.

If appropriate precautions are not taken, the initial responders may find themselves in the middle of a dangerous situation before they realize it. For this reason, initial responders should take note of any factors that suggest the possibility of a terrorist incident and immediately implement appropriate procedures. The possibility of a terrorist incident should be considered when responding to any location that has been identified as a potential terrorist target. It could be difficult to determine the true nature of the situation until a scene size-up is conducted.

Initial Actions

Responders should approach a known or potential terrorist incident just as they would a hazardous materials incident. If possible, apparatus and personnel should approach the scene from a position that is uphill and upwind. Emergency responders should don PPE, including self-contained breathing apparatus (SCBA).

The first units to arrive should establish an outer perimeter to control access to and from the scene. They should deny access to all persons except emergency responders, and they should prevent potentially contaminated individuals from leaving the area before they have been decontaminated. The perimeter must surround the affected area, with the goal being to keep people who were not initially involved from becoming additional victims. Later-arriving units should be staged an appropriate distance away from the incident.

This operation sounds quite orderly while you are reading this text, but rest assured a real-world scene would be chaotic. There will be widespread panic, and you will probably be overwhelmed. It will take some time and many more responders before you get a handle on the scene. Expect this kind of tumultuous environment if the incident is significant.

Incident command should be established in a safe location, which could be as far as 3000 feet (nearly 1 km) away from the actual incident scene. The incident command post must be set up outside the area of possible contamination and beyond the distance

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where a secondary device may be planted. The initial task should be to determine the nature of the situation, the types of hazards that could be encountered, and the magnitude of the problems that must be faced.

An initial reconnaissance (recon) team should be sent out to quickly examine the involved area and to determine how many people are involved. Proper use of PPE, including SCBA, is essential for the recon team, and the initial survey must be conducted very cautiously, albeit as rapidly as possible. The possibility that chemical, biological, or radiological agents are involved cannot be ruled out until qualified personnel with appropriate instruments and detection devices have surveyed the area. Responders should begin their reconnaissance mission from a safe distance, working inward toward the scene, while taking care not to touch any liquids or solids or to walk through pools of liquid. Emergency responders who become contaminated must not leave the area until they have been decontaminated.

A process of elimination may be required to determine the nature of the situation. Occupants and witnesses should be asked if they observed any unusual packages or detected any strange odors, mists, or sprays. The presence of many casualties with no outward signs of trauma could indicate a possible **chemical agent** exposure. In such a case, victims' symptoms might include trouble breathing, skin irritation, or seizures. A visible vapor cloud would be another strong indicator of a chemical release. Such a release could have occurred as the result of either an accident or a terrorist attack. The presence of dead or dying animals, insects, or plant life might also point to a chemical agent release as the culprit.

When approaching the scene of an explosion, responders should consider the possibility of a terrorist bombing incident and remain vigilant for secondary explosive devices. They should note any suspicious packages and notify the incident commander (IC) immediately if any such items are discovered. Responders who have not been specially trained should never approach a suspicious object. Instead, **explosive ordnance disposal (EOD) personnel**—personnel who are trained to detect, identify, evaluate, render safe, recover, and dispose of unexploded explosive devices—should examine any suspicious articles and disable them.

The guidelines presented in this section are general recommendations, of course. You must also rely on your agency's standard operating procedures, your training, and your experience to take the appropriate actions. A terrorist event may never happen in your jurisdiction—but if it does, it will require every bit of skill you have to operate safely and effectively.

Interagency Coordination

If a terrorist incident is suspected, the IC, if not already a member of a law enforcement agency, should consult immediately with local law enforcement officials. In many cases, a unified command—including law enforcement (local, state, and federal), fire department, and EMS representatives—should be established. If there are casualties, or if a mass-casualty situation is evident, the IC should notify area hospitals and activate the MCI medical plan (if one exists). Typically, local hospitals will begin to conduct an open-bed count and communicate with other hospitals about the availability of specialized medical services. Depending on the nature of the event, specialists like tactical law enforcement (i.e., special weapons and tactics [SWAT] teams) and bomb technicians may be involved in the mitigation of the event (**FIGURE 32-30**).

State emergency management officials should be notified as soon as possible, which will help ensure a quick response by both state and federal resources to a major incident. Regional emergency operation centers (REOCs) and state-level emergency operation centers (EOCs) may be established, depending on the severity of the incident. Large-scale search-and-rescue incidents could require the response of urban search and rescue (USAR) task forces activated through the Federal Emergency Management Agency (FEMA). Medical response teams, such as disaster medical assistance teams (DMATs), may be needed for incidents involving large numbers of people. The Centers for Disease



FIGURE 32-30 Tactical law enforcement teams may be required to render the area safe for fire and EMS responders to mitigate additional problems and provide patient care.

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FIGURE 32-31 An EOC is set up in a predetermined location for large-scale incidents.

© Jones & Bartlett Learning. Courtesy of MIEMSS.

Control and Prevention (CDC) may be requested to release items from the Strategic National Stockpile (SNS) when large caches of life-saving pharmaceuticals such as antidotes and medical supplies are needed.

An EOC can help coordinate the actions of all involved agencies in a large-scale incident, particularly if terrorism is involved. This center is usually set up in a predetermined remote location and is staffed by experienced command and staff personnel (**FIGURE 32-31**). The IC, who remains at the scene of the incident, should provide detailed situation reports to the EOC and request additional resources as needed.

Responders must remember that a terrorist incident is also a crime scene. To avoid destroying important evidence that could lead to a conviction of those responsible for perpetrating the attack, responders should not disturb the scene any more than is necessary. Where possible, law enforcement personnel should be consulted prior to overhaul and before the removal of any material from the scene. Responders should also realize that one or more terrorists could be among the injured. Be alert for threatening behavior, and make note of anyone who seems determined to leave the scene.

Chemical Agents

Chemical agents are toxic substances that are intended to cause harm to people or animals. Indicators of possible criminal or terrorist activity involving chemical agents may vary depending on the complexity of the operation, and there is no single indicator that may tip you off to the presence of such illicit activities. Sometimes overt indicators may be visible, such as chemical-type gloves, chemical suits, respirators, and marked or unmarked containers made of various materials in a variety of shapes and sizes. For example, glass containers are prevalent at such locations but may or may not appear to be obvious hazards or threatening in any way.

The chemicals may give off unexplained odors that are out of character for the surroundings. Residual chemicals (liquid, powder, or gas form) may also be found in the area. Chemistry books or other reference materials may be seen, as well as materials that are used to manufacture chemical weapons (e.g., scales, thermometers, or torches). The chemicals may or may not leave some type of easily identifiable signature such as an odor, liquid or solid residue, or dead insects or foliage. The main point is that you must always be on the lookout for items that may appear out of context with the setting—always pay attention to your surroundings. The routine medical or garage fire may quickly bring you up close and personal with a very dangerous situation.

Persons working around the illicit materials may themselves become exposed and exhibit symptoms of chemical exposure—for example, irritation to the eyes, nose, and throat; difficulty breathing; tightness in the chest; nausea and vomiting; dizziness; headache; blurred vision; blisters or rashes; disorientation; or even convulsions.

Chemical weapons can be disseminated in several ways. For example, intentionally releasing chlorine gas inside a building or a crowded gathering place could cause many injuries and deaths. To ensure broader distribution of a chemical agent, however, the agent might be added to an explosive device or mechanically dispersed. Crop-dusting aircraft, truck-mounted spraying units, or machine- or hand-operated pump tanks could all be used to disperse an agent.

The extent of dissemination of a toxic gas or suspended liquid particles depends on wind direction, wind speed, air temperature, and humidity at the time of the material's release. Because these factors can change quickly, it is difficult to predict the exact direction that might be taken by a chemical release cloud. Hazardous materials teams use computer models to predict the pathway of a toxic cloud. They also have the training and equipment to safely handle these situations.

Nerve Agents

A **nerve agent** is a toxic chemical agent that attacks the central nervous system. These weapons were first developed in Germany before World War II. Nerve agents resemble some pesticides (organophosphates) but are much more toxic—in some cases, 100 to 1000 times more toxic than similar pesticides. Exposure to these substances can result in injury or death within minutes.

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FIGURE 32-32 In their normal states, nerve agents are liquids.

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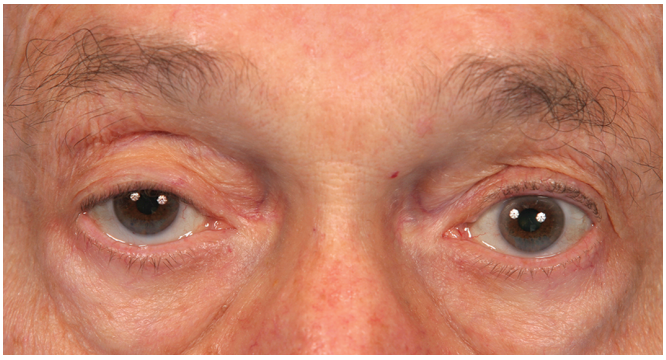
In their normal states, most nerve agents are liquids (**FIGURE 32-32**). To be an effective weapon, the liquid must either be dispersed in aerosol form or be broken down into fine droplets so that it can be inhaled or absorbed through the skin. In their pure state, liquid nerve agents are colorless. In an impure state as a result of the manufacturing process, liquid nerve agents may be yellowish to brown. Tabun, an extremely toxic substance, is reported as having a faint fruity odor.

Pouring a liquid nerve agent such as **V-agent (VX)**—an oily liquid that can persist for several weeks—onto the floor of a crowded building may not affect large numbers of people because at the ambient temperature it is not highly vaporous. A more effective method to disperse this agent would be to aerosolize it in some fashion and distribute it across the widest populated area possible. In such a scenario, the effectiveness of the agent would depend on how long it stayed in the air and how widely it became dispersed throughout the building. VX is persistent because it has a low vapor pressure and does not evaporate quickly. In contrast, **sarin**, another chemical warfare agent, is considered nonpersistent because it evaporates at about the same rate as water. Common nerve agents, their method of contamination, and specific characteristics are listed in **TABLE 32-2**.

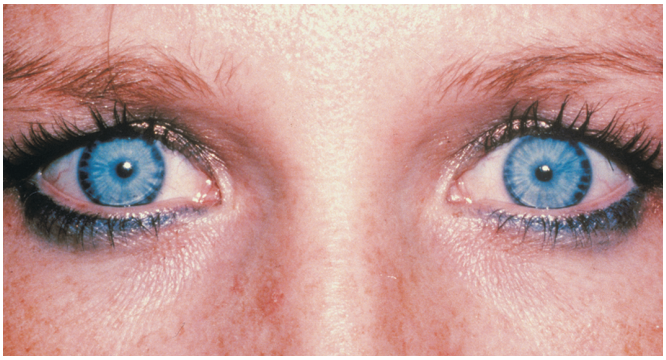
TABLE 32-2 Common Nerve Agents

Nerve Agent	Route of Exposure	Characteristics
Tabun (GA)	Skin contact Inhalation	Nonpersistent
Soman (GD)	Skin contact Inhalation	Nonpersistent
Sarin (GB)	Skin contact Inhalation	Nonpersistent
V-agent (VX)	Skin contact	Persistent

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A.



B.

FIGURE 32-33 Pupil responses. **A.** Normal. **B.** Pinpoint.

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When a person is exposed to a nerve agent, symptoms of that exposure will become evident within minutes. The symptoms may include pinpoint pupils, runny nose, drooling, difficulty breathing, tearing, twitching, diarrhea, convulsions or seizures, and loss of consciousness (**FIGURE 32-33**). The same symptoms

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are seen in individuals who have been exposed to pesticides.

Several mnemonics can help you remember the symptoms of a nerve agent exposure. The mnemonic used most often in the emergency response community is SLUDGEM:

- **S:** Salivation (drooling)
- **L:** Lacrimation (tearing)
- **U:** Urination
- **D:** Defecation
- **G:** Gastric upset (upset stomach, vomiting)
- **E:** Emesis (vomiting)
- **M:** Miosis (pinpoint pupils)

Keep in mind that such mnemonics represent a very basic and limited way to identify a nerve agent exposure. From a medical standpoint, an exposure of this type involves both the sympathetic and parasympathetic nervous systems—each of which manifests its own unique set of signs and symptoms. Advanced life support providers (paramedics, for example) should have in-depth knowledge when it comes to recognizing the signs and symptoms of a nerve agent exposure. Additionally, many Internet and print resources are available for further study on the subject.

In terms of medical treatment for a nerve agent exposure, the most common field-level treatment is DuoDote, an auto-injector that contains 2.1 mg of atropine and 600 mg of 2-PAM (2-pyridine aldoxime methyl chloride, also known as pralidoxime), delivered as a single dose through one needle (**FIGURE 32-34**). Each drug in the auto-injector has a specific target and acts independently to reverse the effects of a nerve agent exposure. Atropine, for example, reverses **muscarinic effects** such as a runny nose, salivation, sweating, bronchoconstriction, bronchial secretions, nausea, vomiting, and diarrhea; essentially, atropine is intended to deal with the SLUDGEM effects of a nerve agent exposure. Atropine dosing is guided by the patient's clinical presentation and should be given until secretions are dry or drying and ventilation becomes less labored. The other drug, 2-PAM, decreases muscle twitching, improves muscle strength, and allows the patient to breathe better.

The antidote medications can be quickly injected into a person who has been contaminated by a nerve agent. Peak atropine levels are reached approximately 5 minutes after administration; peak levels of 2-PAM are achieved in 15 to 20 minutes. For the emergency responder, this delay means that you should not expect



FIGURE 32-34 A DuoDote auto-injector.

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to administer this antidote to a person exhibiting serious signs and symptoms of a nerve agent exposure and have the patient recover right away or even at all. Auto-injectors are not an immediate cure-all. In fact, they may be ineffective if the victim has suffered a significant exposure to a nerve agent or pesticide.

DuoDote kits, which are intended for patients between 18 and 55 years of age, have been provided to many fire departments' hazardous materials teams. In addition, many law enforcement agencies and EMS units around the United States carry these antidotes on their response vehicles.

When it comes to treating victims of nerve agent exposure, emergency responders should understand that all nerve agents "age" once they are absorbed by the body. Thus, after a certain period of time (which varies depending on the agent), the administration of the DuoDote kit may be largely ineffective. Soman, for example, has an aging time of approximately 2 minutes. Sarin's aging time is approximately 3 to 4 hours. The other nerve agents have longer aging times. Follow your local protocols before administering any antidote.

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Biological Agents

Biological agents are organisms that cause disease and attack the body. They include bacteria and viruses (**TABLE 32-3**). Other toxins, such as ricin and aflatoxin, are also biological toxins. Some of these organisms, such as anthrax, can live in the ground for years; others are rendered harmless after being exposed to sunlight for only a short period of time. The effects of a biological agent depend on the specific organism, the dose, and the route of entry. Most experts believe that a biological weapon would probably be paired with a device capable of ensuring widespread dispersion of the agent.

Some of the diseases caused by biological agents, such as smallpox and pneumonic plague, are contagious and can be passed from person to person. Doctors are concerned about the use of contagious diseases as weapons because the resulting epidemic could overwhelm the healthcare system. Experts have different opinions about how difficult it would be to infect large numbers of people with one of these naturally occurring organisms. Because of their incubation period—the time between the initial infection by an organism and the development of symptoms by a victim—people would not begin to show signs of being infected until 2 to 17 days after exposure to these organisms.

People working in a lab may eventually exhibit symptoms consistent with the biological weapons with which they are working. Biological agents are associated with a delayed onset of symptoms—usually days to weeks after the initial exposure. In fact, the biggest difference between a chemical incident and a biological incident is typically the speed of onset of the health effects from the involved agents. Because most biological agents are odorless and colorless, there are usually no outward indicators that the agents have spread. Again, there may or may not be overt indicators of criminal activities at the scene—be aware and attentive!

Indicators of incidents that may potentially involve biological agents might include chemicals or production equipment such as Petri dishes, vented hoods, Bunsen burners, pipettes, microscopes, and incubators. Reference manuals, such as microbiology or biology textbooks, or handwritten research or directions—maybe in a foreign language—may be present. Containers used to transport biological agents may include metal cylindrical cans or red plastic boxes or bags, probably without specific biological hazard labels. PPE, including respirators, chemical or biological suits, and latex gloves, may be present at the scene, as well as excessive amounts of antibiotics to protect the people working with the agents (**FIGURE 32-35**). Other potential indicators may include abandoned spray devices and unscheduled or unusual sprays being disseminated (especially if outdoors at night).

Anthrax

Anthrax is an infectious disease caused by the bacterium *Bacillus anthracis*. These bacteria are typically found around farm animals such as cows and sheep. For use as a weapon, the bacteria must be cultured to develop anthrax spores. The spores, once weaponized into an ultra-fine powder, can then be dispersed in a variety of ways (**FIGURE 32-36**). Approximately 8000 to 10,000 spores are typically required to cause an anthrax infection. Spores infecting the skin cause cutaneous anthrax, ingested spores cause gastrointestinal anthrax, and inhaled spores cause inhalational anthrax. Anthrax has an **incubation period** of 2 to 6 days. The disease can be successfully treated with a variety of antibiotics if it is diagnosed early enough.

The threat posed by anthrax-related terrorism is quite real. In 2001, four letters containing anthrax were mailed to locations in New York City; Boca Raton, Florida; and Washington, D.C. Five people died after being exposed to the contents of these letters, including two

TABLE 32-3 Bacteria Versus Viruses

	Description	Dispersion	Examples
Bacteria	Single-cell microscopic organisms with a nucleus and cell wall	May form a spore	Anthrax Plague Tularemia
Viruses	Submicroscopic agents; DNA or RNA coated with protein	Require a host to live and reproduce	Smallpox Viral hemorrhagic fever (VHF)

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FIGURE 32-35 Indicators of biological agents might potentially include production or containment equipment, such as Petri dishes, vented hoods, Bunsen burners, pipettes, microscopes, and incubators.

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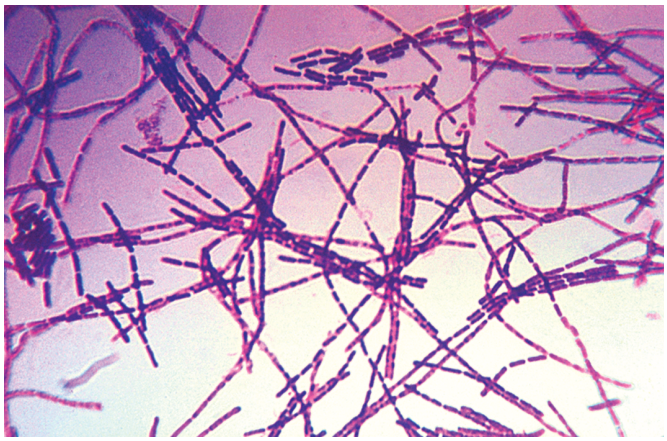


FIGURE 32-36 Anthrax spores can be dispersed in a variety of ways.

Courtesy of the Centers for Disease Control and Prevention.

postal workers who were exposed as the letters passed through postal sorting centers. Several major government buildings had to be shut down for months to be decontaminated. These incidents followed shortly after the terrorist attacks of September 11, 2001, and they caused tremendous public concern. In the wake of these incidents, emergency personnel had to respond to thousands of incidents involving suspicious packages and citizens who believed that they might have been exposed to anthrax.

Today, presumptive field tests are available that hazardous materials teams can use to determine whether the threat of anthrax or other biological agents is legitimate.



FIGURE 32-37 A bubo—one of the symptoms of the plague—consists of a swollen, painful lymph node.

Courtesy of the Centers for Disease Control and Prevention.

The gold standard to positively identify anthrax (and other biological agents), however, is not a field test. Anthrax must be cultured in a lab, by qualified microbiologists, to be positively identified. Your agency should have established procedures for handling suspicious powders and getting samples to a qualified laboratory. The local Federal Bureau of Investigation (FBI) office can provide guidance on the different types of labs available through the Laboratory Response Network and how to work with law enforcement to get a sample to the appropriate lab.

Plague

Plague is caused by *Yersinia pestis*, a bacterium that is commonly found in rodents. These bacteria are most often transmitted to humans by fleas that feed on infected animals and then bite humans.

The two main forms of plague are bubonic and pneumonic. Individuals who are bitten by fleas generally develop bubonic plague, which attacks the lymph nodes (**FIGURE 32-37**). Pneumonic plague can be contracted by inhaling the bacterium.

Yersinia pestis can survive for weeks in water, moist soil, or grains. These bacteria might also be cultured for distribution as a weapon in aerosol form. Inhalation of the aerosol form would put the target population at risk for pneumonic plague.

The incubation period for plague ranges from 2 to 6 days. This disease can be treated with antibiotics.

Smallpox

Smallpox is a highly infectious and often fatal disease caused by *Variola*, a virus; it kills approximately 30 percent of all people who become infected. Smallpox first

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presents with small red spots or as a rash in the mouth. The rash then progresses to the face, followed by the arms and legs, and then farther outward to the hands and feet. Smallpox lesions are unique in that all lesions appear to be in the same stage of development at the same time. In contrast, chickenpox lesions are observed in different stages of development across the body. Additionally, smallpox lesions can be found on the palms of the hands and the soles of the feet, whereas chickenpox lesions are seldom found on these areas.

Although smallpox was once routinely encountered throughout the world, by 1980 it had been successfully eradicated as a public health threat through the use of an extremely effective vaccine. Officially, two countries (the United States and Russia) have maintained cultures of the disease for research purposes. It is possible, however, that international terrorist groups may have acquired the virus.

The smallpox virus could potentially be dispersed over a wide area in an aerosol form; however, widespread broadcasting of this agent may not be necessary to cause a devastating outbreak. Infecting a small number of people could lead to a rapid spread of the disease throughout a targeted population, given smallpox's highly contagious nature: The disease is easily spread by direct contact, droplet, and airborne transmission. Patients are considered highly infectious and should be quarantined until the last scab has fallen off (**FIGURE 32-38**). The incubation period for smallpox is between 4 and 17 days (the average is 12 days).

Currently, there are millions of people who have never been vaccinated for smallpox. Millions more have reduced immunity because decades have passed since their last immunization.

Radiological Agents

Indicators of radiological agents may include production or containment equipment, such as lead or stainless steel containers (with or without labels), and explosives that may be used to disperse the radioactive source, along with containers (e.g., pipes), caps, fuses, gunpowder, timers, wire, and detonators. PPE present may include radiological-protective suits and respirators. Radiation monitoring equipment such as Geiger counters or radiation pagers may be present, as may similar radiation detection devices used by responders to alert them to the presence of a potential threat (**FIGURE 32-39**). As with other locations where nefarious activities may be present, responders must put the potential threat in context. There may or may not be a valid explanation for the presence of something suspicious.

A major difference between an illicit location where radioactive substances are present and a legitimate operation may be the way the substances are packaged and stored. Legitimate sources are well marked, tracked, and regulated. When radiological agents are shipped, the package type is dictated by the degree of radiation activity inside the package—that is, the labeling is driven by the *amount of radiation that can be measured outside the package*. Three varieties of labels are found on radioactive packages: White I, Yellow II, and Yellow III (**FIGURE 32-40**).

Additionally, packages with a Yellow II or Yellow III label are required to include a transport index (TI) number on the package label. This number indicates the highest amount of radiation that can be measured 1 meter (3 feet) away from the surface of the package.



FIGURE 32-38 Smallpox is a highly contagious disease with a mortality rate of approximately 30 percent.

Courtesy of the Centers for Disease Control and Prevention.



FIGURE 32-39 The personal radiation detector pictured here is capable of providing exposure rate readings as well as accumulated radiation dose.

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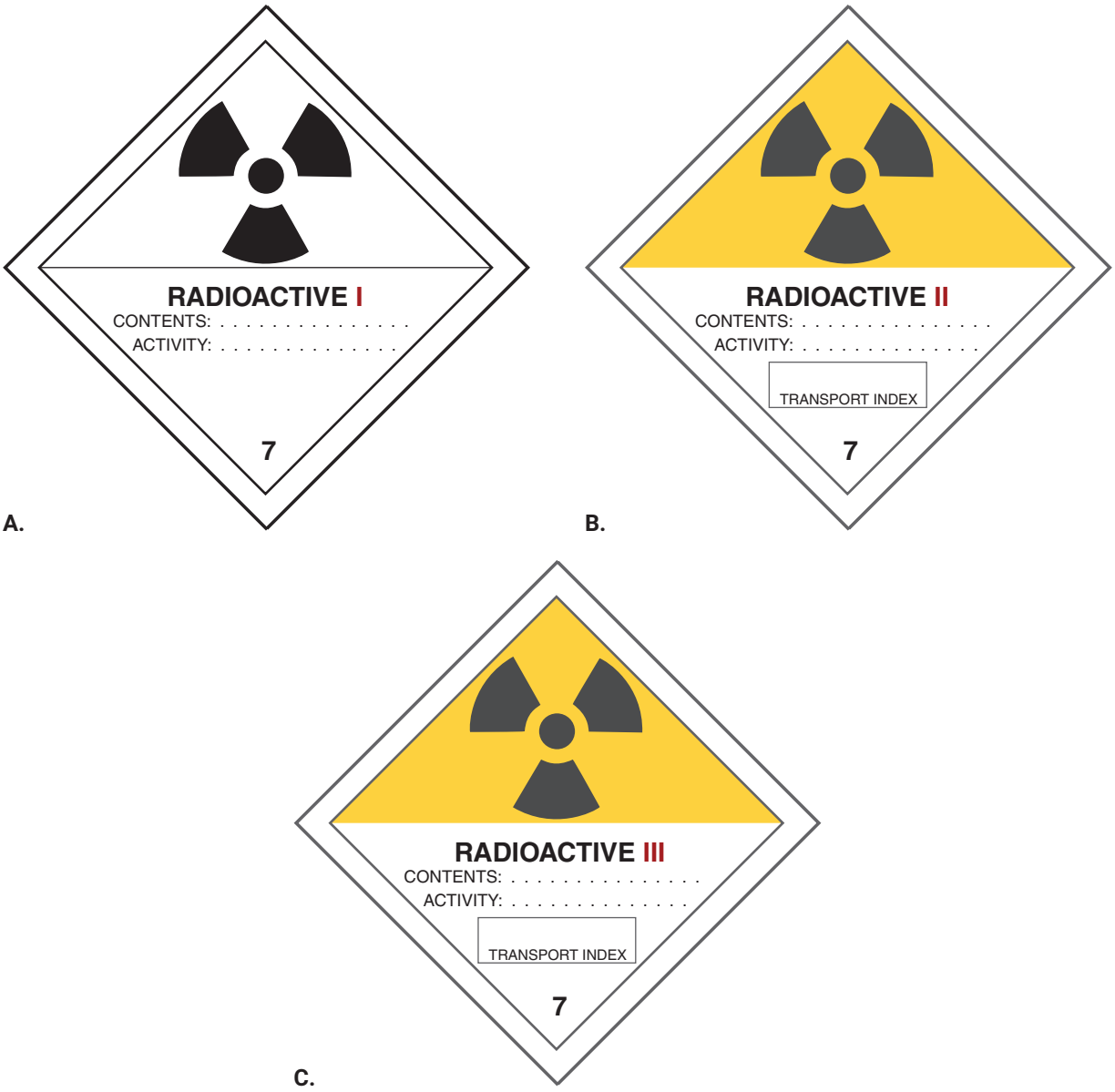


FIGURE 32-40 **A.** White I label. **B.** Yellow II label. **C.** Yellow III label.

Courtesy of the U.S. Department of Transportation.

Responders must be able to recognize situations where radioactive materials might be encountered. Industries that routinely use radioactive materials include food testing labs, hospitals, medical research centers, biotechnology facilities, construction sites, and medical laboratories. For the most part, visual indicators (signs or placards) are used at sites to indicate the presence of radioactive substances, although this is not always the case.

The key is to be able to suspect, recognize, and understand when and where you may encounter radioactive sources. If you suspect a radiation incident at a fixed facility, you should initially consult with the radiation safety officer of the facility. This person is responsible for the use, handling, and storage procedures for all radioactive materials at the site. The radiation safety officer likely will be a tremendous resource to you and will know exactly what is being used at the facility. If the incident is not at a fixed site, the presence of radiation may never be apparent. Radioactive isotopes cannot be detected by sight, smell, taste, or any of the other senses. Therefore, if you have any suspicion that the incident involves radiation, it will be necessary to call a hazardous materials team or some other resource with radiation detection capabilities.

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Significant incidents involving radiation are rare, largely due to the comprehensiveness of the regulations for using, storing, and transporting significant radioactive sources. This is not to say that these incidents will never happen; however, the regulations have helped considerably in keeping the number of incidents low. Most of the incidents you may encounter will involve low-level radioactive sources and can be handled safely. These low-level sources are typically found in Type A packaging, a packaging method that is unique to radioactive substances and is used for materials such as radiopharmaceuticals and other low-level emitters.

Radiological Packaging

The types of containers and packages most commonly used to store radioactive materials are divided into five major categories: excepted-range radioactive packaging; industrial radioactive packaging; and Type A (**FIGURE 32-41**), Type B (**FIGURE 32-42**), and Type C packaging (**FIGURE 32-43**).

Excepted packaging meets only general design requirements for any hazardous material package. Low-level radioactive substances are commonly shipped in excepted packages, which may be constructed out of heavy cardboard. Excepted packaging is authorized for limited quantities of radioactive material that would pose a very low hazard if released in an accident. Materials identified as excepted packaging include consumer goods such as smoke detectors. They are required to have the letters "UN" and the appropriate four-digit UN identification number marked on the outside of the package.

Industrial packaging is used in certain shipments usually categorized as radioactive waste. Contaminated medical equipment may serve as an example because it likely (but not always) contains a non-life-endangering amount of radioactivity. DOT regulations require that these packages allow no identifiable release of the material to the environment during normal transportation and handling. Three categories of industrial packages are distinguished: IP-1, IP-2, and IP-3, with IP-3 being the strongest. The package category will be marked on the exterior of the package.

Type A packaging is designed to protect the internal radiological contents during normal transportation and in the event of a minor accident. Such packaging is characterized by having an inner containment vessel made of glass, plastic, or metal and external packaging materials made of polyethylene, rubber, or vermiculite. Examples of materials typically shipped in Type A packages include nuclear medicines (radiopharmaceuticals),



A.



B.

FIGURE 32-41 Type A packaging.

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FIGURE 32-42 Type B packaging.

Courtesy of the U.S. Department of Energy.

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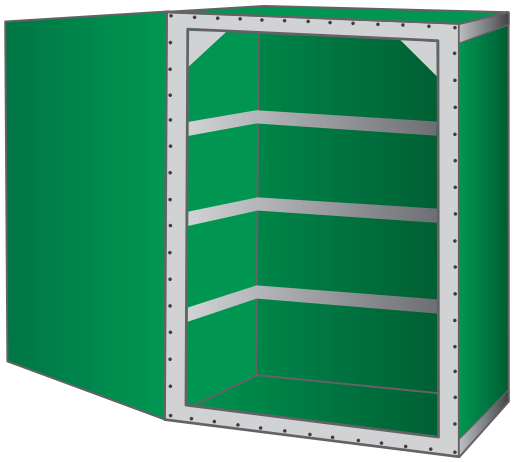


FIGURE 32-43 Type C packaging.

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radioactive waste, and radioactive sources used in industrial applications. Type A packaging and its radioactive contents must meet standard testing requirements designed to ensure that the package retains its containment integrity and shielding under normal transport conditions and may be transported by air. Type A packages must withstand moderate degrees of heat, cold, reduced air pressure, vibration, impact, water spray, drop, penetration, and stacking tests. The consequences of a release of the material in one of these packages would not be significant because the quantity of material in this package is so small.

Type B packaging is far more durable than Type A packaging and is designed to prevent a release in the case of extreme accidents during transportation. More dangerous radioactive sources might be found in Type B packaging. Some of the tests that Type B containers must undergo include heavy fire, pressure from submersion, and falls onto spikes and unyielding surfaces. Type B packages include small drums and heavily shielded casks weighing more than 100 metric tons. This type of containment vessel contains materials such as spent nuclear fuel, high-level radioactive waste, and high concentrations of other radioactive material such as cesium and cobalt. Type B packages are designed to protect their contents from greater exposure; the amount of protection is based on the potential severity of the hazard. These package designs must withstand all Type A tests and a series of tests that simulate severe or "worst-case" accident conditions. Accident conditions are simulated by performance testing and engineering analysis. Life-endangering amounts of radioactive material are required to be transported in Type B packages.

Type C packaging is intended for the transport by air of radioactive material, with no restriction on the total amount of radioactivity contained within the package. Its contents would include materials such as spent nuclear fuel. While this type of packaging does exist, there are no Type C packages currently approved for use within the United States.

Illicit Laboratories

Many indicators of possible criminal or terrorist activity involving illicit laboratories may be evident to responders. Many of the same materials used to manufacture homemade explosives are used to make illicit drugs. For example, terrorist paraphernalia may include terrorist training manuals, ideological propaganda, and documents indicating affiliation with known terrorist groups. Locations with certain characteristics are also commonly sites of illicit (clandestine) laboratories—for example, basements with unusual or multiple vents, buildings with heavy security, buildings with obscured windows, and buildings with odd or unusual odors. Personnel working in illegal laboratory settings may exhibit a certain degree of unusual or suspicious behavior; for instance, they may be nervous and have a high level of anxiety. In addition, they may be protective of the laboratory and not want to allow anyone to access the area for any reason, or they may rush people out of the area as soon as possible.

Equipment that may be present in illicit laboratory areas includes surveillance materials (e.g., photographs, maps, blueprints, or time logs of the target hazard locations), non-weapon supplies (e.g., identification badges, uniforms, and decals that would be used to allow the terrorist to access target hazards), and weapon-related supplies (e.g., timers, switches, fuses, containers, wires, projectiles, and gunpowder or fuel). Security weapons such as guns, knives, and booby trap systems may also be present.

Drug laboratories are by far the most common type of clandestine laboratory encountered by responders. These laboratories are typically very primitive and can be found in hotel rooms, in cars, and in even smaller settings. Materials used to manufacture the drugs often consist of everyday items (e.g., jars, bottles, glass cookware, coolers, and tubing) that have been modified to produce the illicit drugs (**FIGURE 32-44**).

Specific chemicals and materials found at the scene may include large quantities of cold tablets (ephedrine or pseudoephedrine), hydrochloric or sulfuric acid, paint thinner, drain cleaners, iodine crystals, table salt,

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FIGURE 32-44 Items typically found at clandestine drug laboratories often include everyday items.

© Jones & Bartlett Learning. Photographed by Glen E. Ellman.



FIGURE 32-45 Pipe bombs come in many shapes and sizes.

Courtesy of Captain David Jackson, Saginaw Township Fire Department.

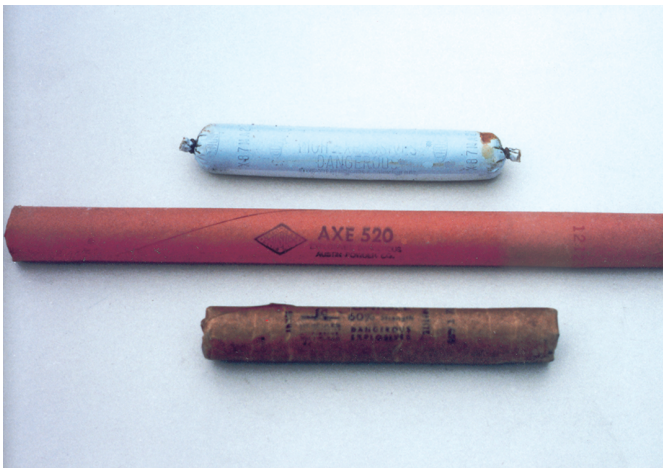


FIGURE 32-46 Every year, thousands of pounds of explosives are stolen from their rightful owners.

Courtesy of Dennis Krebs.

aluminum foil, and batteries. The strong smell of urine or unusual chemical smells such as ether, ammonia, or acetone are common indicators of clandestine drug manufacturing. Illicit drug laboratories should be considered significant hazardous materials scenes because the inexperienced chemists who run them take many shortcuts and disregard typical safety protocols to increase production.

The examples listed here are intended to give you an idea of some of the things that might tip you off to the presence of suspicious or illicit activity. It is not an exhaustive list, however, and you may encounter an illicit lab without any of these indicators. Remember, the people carrying out such activities are not interested in being obvious in their behaviors or actions.

Explosives

Indicators of possible criminal or terrorist activity involving explosives typically include materials that fit into four major categories: protective equipment, production and containment materials, explosive materials, and support materials. Protective equipment may include rubber gloves, goggles and face shields, and perhaps even fire extinguishers. Production and containment equipment may include funnels, spoons, threaded pipes, caps, fuses, timers, wires, detonators, and concealment containers such as briefcases, backpacks, or other innocuous-looking packages (**FIGURE 32-45**). Explosive materials may include gunpowder, gasoline, fertilizer, solvents, oxidizers, and similar materials (**FIGURE 32-46**). Support materials may include explosive reference manuals, Internet-based reference materials, and military information.

If you encounter an active bomb-making operation, it is important to note what you see, get yourself out of danger, secure an appropriate amount of real estate, and call for your local EOD team (**FIGURE 32-47**). This is not a situation that untrained responders should investigate (**FIGURE 32-48**).

The Dirty Bomb

In recent years, the **radiation dispersal device (RDD)**, also known as a dirty bomb, has emerged as a source of serious concern in terms of terrorism. Although not

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FIGURE 32-47 EOD personnel are trained and have the necessary tools and equipment to evaluate and disable or disrupt a device or suspected device.

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considered a WMD, an RDD has been described by the National Fire Protection Association (NFPA) as "a device designed to spread radioactive material through a detonation of conventional explosives or other [non-nuclear] means" (NFPA 470).

Packing radioactive material around a conventional explosive device could contaminate a wide area, with the size of the affected area ultimately depending on the amount of radioactive material and the power of the explosive device. Only a few radioactive sources can be used effectively in an RDD. It is also possible for a criminal to construct a nonexplosive RDD, disseminating radioactive material via pressure sprayers or air-handling systems in buildings. To limit this threat, radioactive materials, even in small amounts, are kept secure and protected. Such materials are widely used in industry and health care, and a criminal could potentially construct a **dirty bomb** with just a small quantity of stolen radioactive material.



FIGURE 32-48 The first responders who arrive at the scene of an explosion should establish a command post in a safe location and begin the process of setting up a unified command with law enforcement.

Courtesy of Captain David Jackson, Saginaw Township Fire Department.

Other types of radiological devices that may be used as weapons include improvised nuclear devices and radiation exposure devices:

- Improvised nuclear device (IND): A weapon fabricated from fissile material (highly enriched uranium or plutonium) capable of producing a nuclear explosion. A generally accepted successful yield in the 10- to 20-kiloton range—the equivalent to 10,000–20,000 tons of dynamite—in addition to high levels of radiation, would make this a very lethal device.
- Radiation exposure device (RED): Radioactive material in a sealed container located where persons nearby would receive a direct exposure. Although not considered a device that would cause widespread death or sickness, an RED could constantly impact a steady stream of persons over a given period of time. If the container failed, then contamination might occur because the material could come into contact with victims.

Secondary Devices

A **secondary device** is an explosive or incendiary device designed to harm those responders summoned to the scene for some other reason. Terrorists who want to injure responding personnel with a secondary device or attack will typically make the initial attack very dramatic to draw responders into proximity with the scene. The secondary attack usually takes

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place as the responders begin to treat victims of the initial attack.

Indicators of potential secondary devices may include "trip devices" such as timers, wires, or switches. Common concealment containers, such as briefcases, backpacks, boxes, or other common packages, may also be present; uncommon concealment containers may include pressure vessels (propane tanks) or industrial chemical containers (chlorine storage containers). Terrorists may watch the site where the primary device is placed, as part of preparing to manually activate the secondary devices.

Responders can use the EVADE mnemonic to help think critically about the presence of secondary devices:

- **E:** Evaluate the scene for likely areas where secondary devices can be placed.
- **V:** Visually scan operating areas for a secondary device before providing patient care.
- **A:** Avoid touching or moving anything that can conceal an explosive device.
- **D:** Designate and enforce scene control zones.
- **E:** Evacuate victims, other responders, and nonessential personnel as quickly and safely as possible.

CASE STUDY

You Are the Firefighter CONCLUSION

Your engine company is dispatched to the scene of a leaking drum at a local lumberyard. It appears to have been hit by a forklift, causing a small tear toward the bottom, and a substance is slowly leaking and an usual odor is reported. The dirt around the drum looks wet. The foreman of the lumberyard tells you that the drum holds waste oil, and the forklift driver on duty denies hitting the drum. From a safe distance, you can tell that the drum is made of steel and has a 2-inch (51-mm) bung and a ¾-inch (19-mm) bung on the top. You can see a small red label on the side of the drum that says "flammable," with the number 3 at the bottom.

1. **What type of material is most likely stored in the drum (e.g., corrosive, solvent, explosive)? Does the description of the drum provide any other useful information? If so, what?**

   Answer: Based on the material of construction—steel—a good first assumption to make is that the drum should or does contain a solvent-based material. The fact that is has two bungs as described indicates the material inside has a low enough viscosity to be pumped if necessary. You should always examine the exterior of the drum for additional information and markings to confirm your assumptions.

2. **What does the label on the drum signify, and does the report of an unusual odor make sense given the information you have?**

   Answer: The label signifies a flammable liquid, which would have a flash point at or below 199°F (93°C). Most oils have much higher flash points, and do not give off vapors at ambient air temperatures to create a significant odor. There appear to be some things that don't add up in the narrative. A steel drum configured as described, labeled flammable, with a perceptible odor, would likely not contain waste oil.

3. **How would you go about obtaining more information on the potential contents of the drum?**

   Answer: There may be enough inconsistency in the story that further questioning of the responsible person will not yield additional actionable information. In this case, based on the level of training of the on-scene crew, it may be reasonable to isolate and deny entry and call for hazardous materials technicians or specialists to further evaluate the drum and contents and mitigate the incident.

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WRAP-UP

SUMMARY

KNOWLEDGE OBJECTIVES

- Identify and describe common types of hazardous materials containers. (**NFPA 470: 7.2.1**, pp. 1284–1290)
  - Define bulk and nonbulk packaging parameters.
  - Identify bulk fixed-facility pressure containers, liquified compressed gas cylinders, ton containers, intermodal tanks, and intermediate bulk containers.
- Describe the ways in which hazardous materials are transported. (**NFPA 470: 7.2.1**, pp. 1290–1294)
  - Identify MC-306/DOT 406, MC-307/DOT 407, MC-312/DOT 412, MC-331, and MC-338 cargo tanks, and compressed gas tube trailers.
  - Identify the five basic types of rail tank cars: nonpressure tank cars, pressure tank cars, cryogenic liquid tank cars, gondolas, and boxcars.
- Identify resources that can provide technical chemical information. (**NFPA 470: 7.2.1**, pp. 1295–1298)
  - Understand the process to contact and utilize the resources available through CHEMTREC, CANUTEC, or SETIQ.
  - Understand the role of the National Response Center (NRC).
- Identify different types of potential terrorist incidents and response options. (**NFPA 470: 7.2.1, 7.3.1**, pp. 1299–1314)
  - Understand the need and general process for interagency coordination at a terrorist event.
  - Identify the various agents that may be used in a terrorist attack (chemical agents, biological agents, radiological agents, illicit laboratories, explosives, and secondary devices).

SKILLS OBJECTIVES

There are no skills objectives for operations-level responders for this chapter.

KEY TERMS

anhydrous Without water.

anthrax An infectious disease spread by the bacterium *Bacillus anthracis*, which is typically found around farm animals, such as cows and sheep.

berm See *dike*.

biological agent An organism that causes acute disease or long-term damage to the human body.

boxcar A railway car that carries consumer goods, industrial supplies, and a multitude of boxes and palletized goods.

bulk packaging Any packaging, including transport vehicles, having a liquid capacity of more than 119 gallons (450 liters), a solids capacity of more than 882 pounds (400 kg), or a compressed gas water capacity of more than 1001 pounds (454 kg). (NFPA 470)

Canadian Transport Emergency Centre (CANUTEC) Operated by Transport Canada, an organization that provides emergency response information and assistance on a 24-hour basis for responders to hazardous materials/weapons of mass destruction incidents. (NFPA 470)

cargo tank Bulk packaging that is permanently attached to or forms a part of a motor vehicle or is not permanently attached to any motor vehicle and which, by reason of its size, construction, or attachment to a motor vehicle, is loaded or unloaded without being removed from the motor vehicle.

chemical agent A toxic substance that is intended to cause harm to people or animals.

chemical cargo tank A tank, characterized by several heavy-duty reinforcing rings around the tank, that holds approximately 6000 gallons (22,712 liters) of product and often carries aggressive (highly reactive) acids such as concentrated sulfuric and nitric acid; also called *MC-312/DOT 412 corrosive tank*.

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KEY TERMS CONTINUED

Chemical Transportation Emergency Center (CHEMTREC) A public service of the American Chemistry Council, which provides emergency response information and assistance on a 24-hour basis for responders to hazardous materials/weapons of mass destruction incidents. (NFPA 470)

cryogenic liquid cargo tank A low-pressure tank designed to maintain the low temperature required by the cryogens it carries and that has a box-like structure containing the tank control valves typically attached to the rear of the tanker; also called *MC-338*.

cryogenic liquid tank car A low-pressure railway tank car that maintains the low temperature required by the cryogens it carries.

dike A series of short walls that form a catch basin around a container; also called *berm*.

dirty bomb See *radiation dispersal device (RDD)*.

dry bulk cargo trailer A trailer designed to carry dry bulk goods such as powders, pellets, fertilizers, or grain; it is generally V-shaped with rounded sides that funnel toward the bottom.

Emergency Transportation System for the Chemical Industry, Mexico (SETIQ) An organization in Mexico that provides emergency response information and assistance on a 24-hour basis for responders to emergencies involving hazardous materials/weapons of mass destruction. (NFPA 470)

excepted packaging Packaging, which may be constructed out of heavy cardboard, that meets only general design requirements for any hazardous material used to transport materials such as low-level radioactive substances.

explosive ordnance disposal (EOD) personnel Personnel trained to detect, identify, evaluate, render safe, recover, and dispose of unexploded explosive devices.

fusible plug A pressure relief valve on a ton container.

general-service rail tank car See *nonpressure tank car*.

gondola A railway car that carries items such as lumber, scrap metal, coal, and pipes.

incubation period The time between the initial infection by an organism and the development of symptoms in a victim.

industrial packaging Packaging used to transport materials that present a limited hazard to the public or the environment. It is classified into three categories, based on the strength of the packaging—IP-1, IP-2, or IP-3, with IP-3 being the strongest.

intermediate bulk container (IBC) A bulk storage container with a volume greater than 119 gallons (450 liters) but less than 793 gallons (3002 liters); these volumes are between the typical volume of drums or bags and the volume of cargo tanks.

intermodal tank (IM or IMO) A bulk storage container that holds between 5000 and 6000 gallons (18,927 and 22,712 liters) of product, can be either pressure or nonpressure, serves as both a shipping and storage vessel, and can be shipped by all modes of transportation—air, sea, or land.

low-pressure chemical cargo tank A rounded (uninsulated) or horseshoe-shaped (insulated) tank with an internal working pressure up to 35 psi that is capable of holding 6000 to 7000 gallons of flammable liquid, mild corrosives, and poisons; also called *MC-307/DOT 407 chemical hauler*.

MC-306/DOT 406 cargo tank See *nonpressure liquid cargo tank*.

MC-307/DOT 407 chemical hauler See *low-pressure chemical cargo tank*.

MC-312/DOT 412 corrosive tank See *chemical cargo tank*.

MC-331 See *pressure cargo tank*.

MC-338 See *cryogenic liquid cargo tank*.

multiple element gas containers (MEGCs) Several individually specified, high-pressure tubes, with working pressures that range as high as 5000 psi, that are attached to a frame and that commonly carry substances such as hydrogen and oxygen.

muscarinic effects Effects such as a runny nose, salivation, sweating, bronchoconstriction, bronchial secretions, nausea, vomiting, and diarrhea.

National Response Center (NRC) An agency maintained and staffed by the U.S. Coast Guard that should always be notified if a hazard discharges into the environment.

nerve agent A toxic chemical agent that attacks the central nervous system.

nonbulk packaging Packaging that has a liquid capacity of 119 gallons (450 liters) or less, a solids capacity of 882 pounds (400 kg) or less, or a compressed gas water capacity of 1001 pounds (454 kg) or less. (NFPA 470)

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nonpressure liquid cargo tank A nonpressure tank that typically carries between 6000 and 10,000 gallons of a product such as gasoline or other flammable and combustible liquids; also called *MC-306/DOT 406 cargo tank*.

nonpressure tank A bulk storage tank that has a working pressure between 2.65 and 4 psi and that is usually made of steel or aluminum.

nonpressure tank car A railcar that is equipped with a nonpressure tank that typically carries general industrial chemicals and consumer products such as corn syrup, flammable and combustible liquids, and mild corrosives; also called *general service rail tank car*.

plague An infectious disease caused by the bacterium *Yersinia pestis*, which is commonly found on rodents and is usually transmitted to humans by fleas.

pressure cargo tank A pressure tank with rounded ends used to transport materials such as ammonia, propane, Freon, and butane, which carries volumes from 1000 gallons (3785 liters) to 11,000 gallons (41,640 liters) cargo tank, and is commonly constructed of steel or stainless steel with a single tank compartment; also called *MC-331*.

pressure tank A bulk storage tank that has an internal pressure greater than 15 psig.

pressure tank car A railcar used to transport materials such as propane, ammonia, ethylene oxide, and chlorine; it has an internal working pressure ranging from 100 to 600 psi and is equipped with top-mounted fittings for loading and unloading that are protected by a protective housing that sits atop the tank car.

psig Pounds per square inch gauge; a measurement of pressure inside a container shown on an attached pressure gauge, in relation to atmospheric pressure.

radiation dispersal device (RDD) A device designed to spread radioactive material through a detonation of conventional explosives or other [non-nuclear] means; also called *dirty bomb*. (NFPA 470)

radiological agent A material that emits radiation, such as X-rays and radioactive isotopes, in excess of normal background radiation levels.

sarin A chemical warfare agent.

secondary containment Any device or structure that prevents environmental contamination when the primary container or its appurtenances fail.

secondary device An explosive or incendiary device designed to harm emergency responders who have responded to an initial event.

smallpox A highly infectious disease caused by the *Variola* virus, which kills approximately 30 percent of people who become infected.

soman A nerve agent that is both a contact and a vapor hazard; it has the odor of camphor.

special-use railcars Boxcars, flat cars, cryogenic tank cars, or corrosive tank cars.

tabun A nerve agent that disables the chemical connections between nerves and target organs.

ton container Bulk packaging that commonly holds compressed liquefied gases.

tube trailer A high-volume transportation vehicle made up of several individual compressed gas cylinders that operate at working pressures of 3000 to 5000 psi and are banded together and affixed to a trailer.

Type A packaging Packaging designed to protect its internal radiological contents during normal transportation and in the event of a minor accident.

Type B packaging Packaging more durable than Type A packaging, which is designed to prevent a release of a radiological hazard in the case of extreme accidents during transportation.

Type C packaging Packaging used when radioactive substances must be transported by air, with no restriction placed on the total amount of radioactivity contained within the package.

V-agent (VX) An oily liquid, contact hazard, nerve agent that can persist for several weeks.

REVIEW QUESTIONS

1. Define bulk packaging and nonbulk packaging.
2. What is the definition of cargo tank?
3. What are the five basic types of rail tank cars?
4. List at the nine basic pieces of information you should have available when calling CHEMTREC, CANUTEC, OR SETIQ.
5. Which agencies should be involved in responding to a hazardous materials incident that involves criminal intent?

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DISCUSSION QUESTIONS

1. What is a key difference between a MC-306/DOT 406 and a MC-307/DOT 407 cargo tank, and why is it important to responders?
2. What is a key benefit to calling CHEMTREC, CANUTEC or SETIQ when a chemical name is known to responders?
3. Describe how the tactics and strategies of handling an incident with criminal intent might differ from an incident without criminal intent.

APPLYING THE CONCEPTS

It is a rainy afternoon when your truck company is dispatched to a motor vehicle accident on a local freeway. Your estimated time to arrive on scene is 7 minutes. En route, your dispatch center informs you that this is a vehicle versus tanker truck with possible injuries.

1. What considerations do you have regarding the nature of the vehicles involved?
2. Does the presence of rain influence your thinking about what you may find on scene?

Upon arrival, you find that the tanker truck is a large tractor trailer rig pulling a single cargo trailer with rounded ends. The tank is painted white and appears to be a pressure vessel. There is minor damage to the rear of the cargo trailer and moderate front-end damage to a four-door passenger vehicle located behind the trailer. All occupants of the passenger vehicle self-extricated and are standing on the side of the road with what appear to be minor injuries. The driver of the truck is also out of the vehicle, speaking with an officer of the highway patrol. You have a crew of yourself (company officer) plus two firefighters, and one of the firefighters is a paramedic. All crew members are trained to the operations level.

3. Which type of cargo trailer is this likely to be?
4. Which substances would most likely be carried in the cargo tank described in the scenario?

After further investigation, you find no significant damage to the trailer and no apparent leaks. The passenger vehicle is leaking radiator fluid and brake fluid, but otherwise, there are no other leaking fluids. All patients have refused medical treatment or transport and signed the appropriate medical forms. You take this opportunity to do a walk-around of the cargo trailer to review the features of an MC-331 tank with your crew.

5. Based on the level of training of your crew and the policy and procedures of the AHJ, is cleaning up the fluids from the passenger vehicle within your scope of practice?
6. List three features that are unique to this type of cargo trailer.

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