Welcome to the Hot Zone: An Introduction to Hazardous Materials Response

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✕ Disclosures

I have no financial disclosures to report.

✖ Learning Objectives

By the end of this lecture, you should be able to…

1. Describe the various classes of hazardous materials.
2. Utilize a hazardous material's physical, chemical, radioactive, and/or explosive properties to guide response strategies.
3. Recognize the presence of hazardous materials by the use of shipping labels and containers.
4. Identify protective actions that should be performed in the initial response to a hazardous materials incident
5. Choose the appropriate level of personal protective equipment for a known hazard.
6. Summarize the three types of decontamination and when each should be performed.
7. Cite various resources that are available to provide assistance in the case of a hazardous materials incident.

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What are the different types of hazardous materials?

02 **HAZMAT Chemistry**
How can I use physical and chemistry properties to guide my response?

03 **Recognition**
How can I use context clues to recognize HAZMAT incidents?

04 **Response Principles**
What are the principles that govern an all-hazards response?

01

Types of HAZMAT

✕ What is a hazardous material?

“A substance (solid, liquid, or gas) or energy that when released is capable of creating harm to people, the environment, and property, including weapons of mass destruction (WMD)...”

NFPA (2024)

✖ CBRNE

- **Chemical**
  - Gases, flammable liquids and solids, oxidizers, corrosives, nerve agents, blister agents, riot control agents, etc.
- **Biological**
  - Viruses, bacteria, toxins
- **Radiological**
  - Radiological exposure & dispersal devices, radiotherapy
- **Nuclear**
  - Improvised nuclear device, nuclear energy
- **Explosive**
  - IEDs, UXO, commercial explosives

02

HAZMAT Chemistry ×

✖ Physical Properties

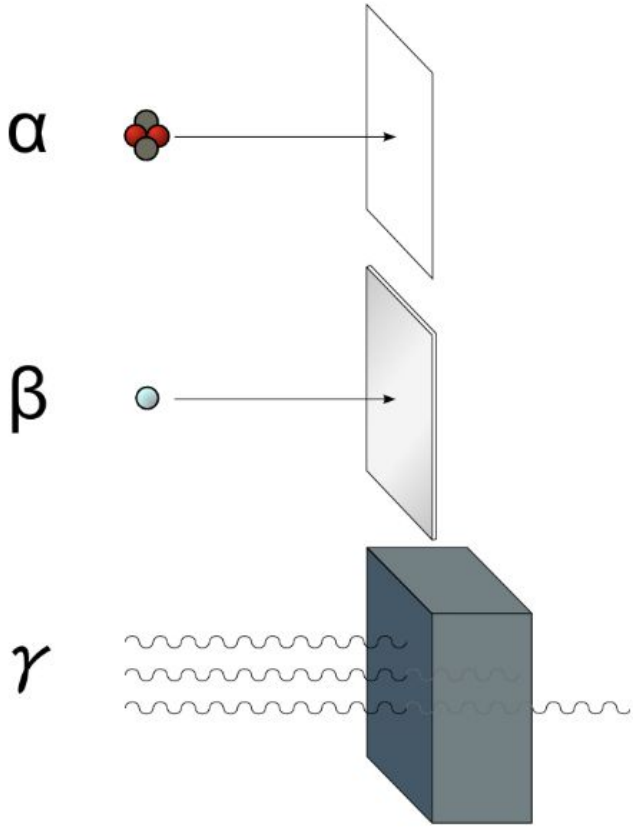
- **Vapor Pressure**
  - Pressure exerted by a vapor above the surface of a liquid
  - Used to describe the volatility of a hazardous material (i.e., its tendency to vaporize)
    - Directly proportional: Higher vapor = Higher volatility
- **Boiling Point**
  - Temperature at which a liquid transforms into a vapor or gas, or the point at which the vapor pressure of a liquid becomes equal to the pressure of the surrounding gas (air)
  - Inverse relationship with vapor pressure
- **Vapor Density**
  - Dimensionless quantity referring to the density of a vapor relative to that of hydrogen gas at the same temperature and pressure.
  - Typically used to judge the density of a hazardous material relative to that of the surrounding air
- **Evaporation Ratio**
  - Speed at which a hazardous material in the liquid phase vaporizes compared to a reference solvent
- **Expansion Ratio**
  - For liquified hazardous materials, the expansion ratio serves as a measure of the volume of gas generated when a unit volume of that material evaporates.

✖ Chemical Properties

- **Flammability**
  - Ability of a substance to burn/ignite
- **Toxicity**
  - Ability of a substance to cause biological damage
- **Acidity**
  - Ability of a substance to donate protons into solution
- **Reactivity**
  - Propensity of a substance to undergo a chemical reaction

✖ Nuclear Properties

- **Activity**
  - Measures the rate of decay of a radioactive isotope (i.e., the number of unstable nuclides decaying per second).
  - High activity = elevated levels of radioactivity
- **Half-Life**
  - Length of time that it takes for ½ of the atoms present in a sample to decay (this can vary drastically)
- **Decay**
  - Alpha
    - Radionuclides release helium nuclei (two protons and two neurons) to become more stable
  - Beta
    - Emission of an electron or positron from the nucleus of an atom
  - Gamma
    - Involves the release of very high energy electromagnetic radiation (in the form of photons)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✖ Explosive Properties

- **Velocity of Detonation**
  - Speed at which the shock wave front travels after an explosive detonates
- **Detonation Pressure**
  - Peak pressure exerted by an explosive’s shock wave
- **Autoignition Temperature**
  - Lowest temperature at which an explosive substance spontaneously ignites
- **Sensitivity**
  - How easily an explosive can be initiated by external stimuli (heat, pressure, impact, friction)
- **Brisance**
  - Shattering capability of a high explosive, depends primarily on detonation pressure

03

Recognition

Labels

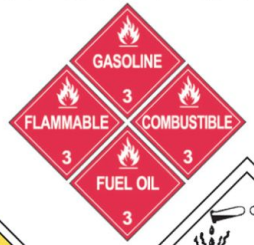
United Nations HAZMAT Classes

Nine Classes of Hazardous Materials

Class 1: Explosives
Divisions: 1.1, 1.2, 1.3, 1.4, 1.5, 1.6

Class 2: Gases
Divisions: 2.1, 2.2, 2.3

Class 3: Flammable Liquid and Combustible Liquid



Class 4: Flammable Solid, Spontaneously Combustible, and Dangerous When Wet
Divisions 4.1, 4.2, 4.3

Class 5: Oxidizer and Organic Peroxide
Divisions 5.1, 5.2

Class 6: Poison (Toxic) and Poison Inhalation Hazard

Class 7: Radioactive

Class 8: Corrosive

Class 9: Miscellaneous

Dangerous

Revised 04/13

Federal Motor Carrier Safety Administration

U.S. Department of Transportation
www.fmcsa.dot.gov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1760

GHS Classifications

Explosives

Flammable

Oxidizers

✕ GHS Classifications

Corrosives

Compressed Gas

Acute Toxicity

✕ GHS Classifications

Irritant

Carcinogen

Aquatic Toxicity

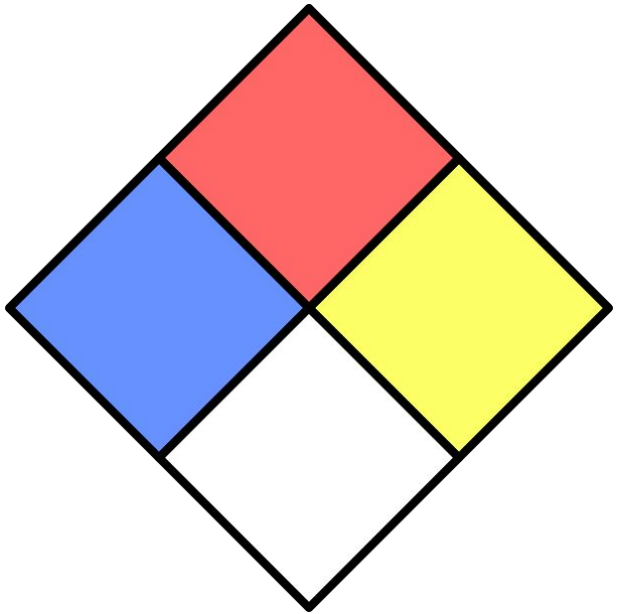
NFPA 704

Fire Hazard

4 = Will rapidly vaporize at atmospheric pressure and burn readily
3 = Ignited under almost all atmospheric conditions
2 = Moderately preheated before igniting
1 = Must be preheated before igniting
0 = Will not burn

Health Hazard

4 = Death or major residual injury
3 = Serious temporary or residual injury even if tx provided
2 = Temporary incapacitation and possible residual injury if no tx
1 = Irritation with minor residual injury if no tx
0 = No hazard



Instability Hazard

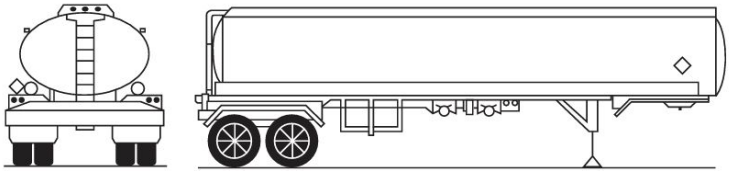
4 = Readily explosive
3 = Explosive but require strong detonation source
2 = Unstable with violent chemical changes (no detonation)
1 = Unstable at high temps or pressures
0 = Stable when exposed to heat, water

Special Hazard

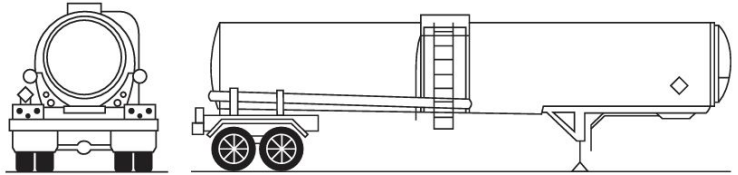
ACID = Strong acid
ALK = Strong alkali
COR = Corrosive
OX = Oxidizer
☢ = Radioactive
W = Reacts violently with water

Containers

✕ Highway

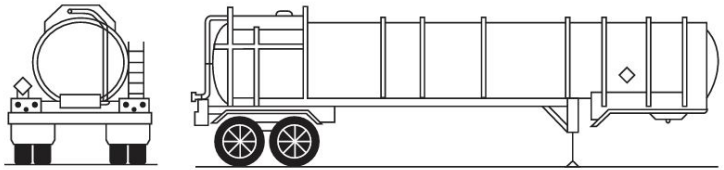


DOT406
Capacity: 1500-9500 gallons
MAWP: 3-5 psi

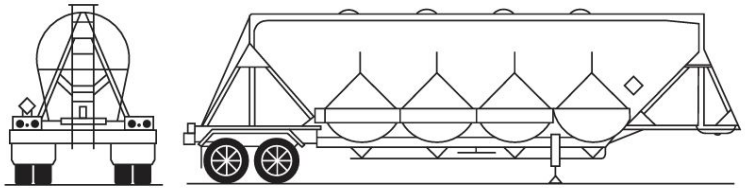


DOT407
Capacity: 5000-8000 gallons
MAWP: 25-100 psi

✕ Highway

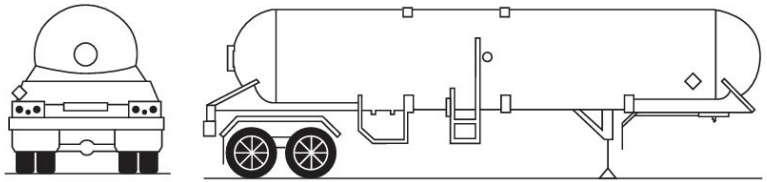


DOT412
Capacity: 3000-5000 gallons
MAWP: depends on spec. gravity of product

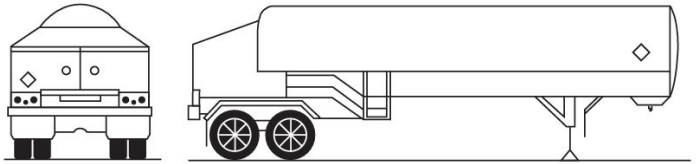


Dry Bulk Cargo Container
Capacity: Varies by substance

✕ Highway

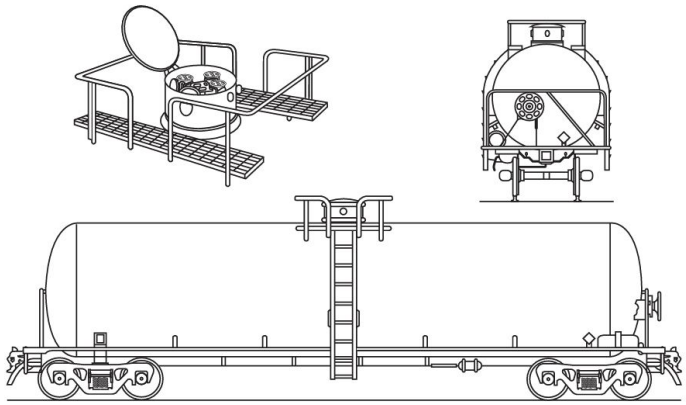


MC331
MAWP: 100-500 psi

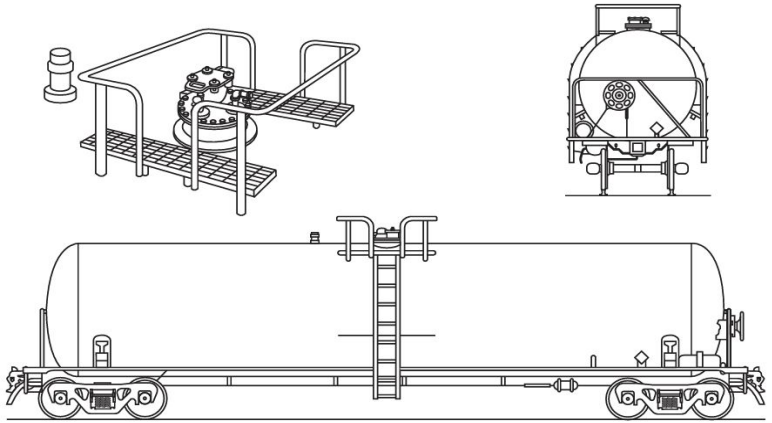


MC338
Capacity: 8000-10000 gallons
MAWP: 25.3-500 psi

✕ Rail

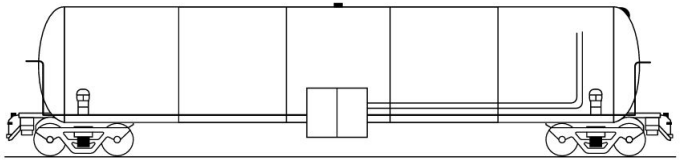


Pressure Tank Car
Capacity: 4000-45000 gallons
Pressure: >40 psi

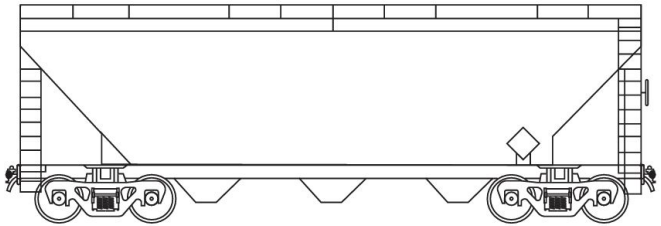


Non-/Low Pressure Tank Car
Capacity: 4000-45000 gallons
Pressure: <25 psi

✕ Rail

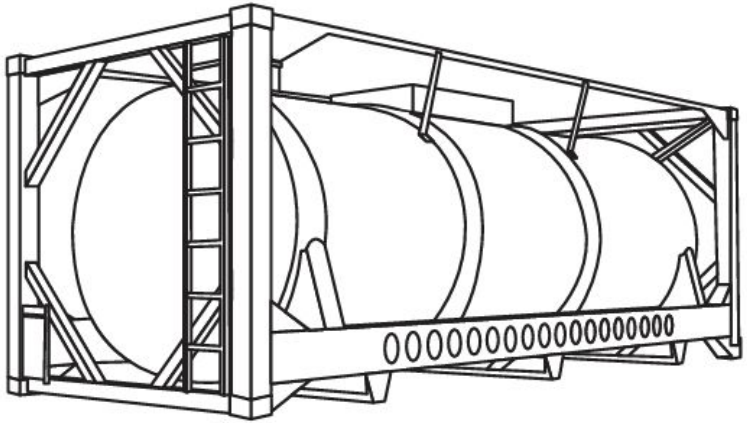


Cryogenic Tank Car
Pressure: 10-75 psi



Hopper Car
Capacity: Varies by substance

✕ Intermodal



Working Pressure: 20-500 psi
Capacity: 200-45,000 L

04

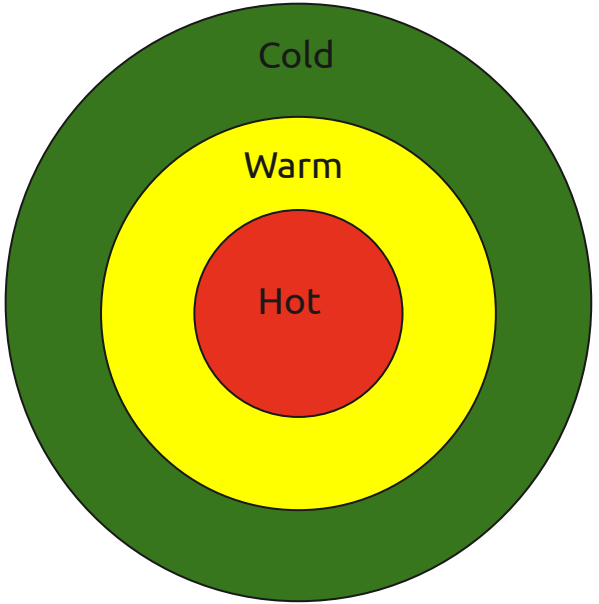
Response Principles ×

✖ Protective Actions

- **RAIN (First 30 Minutes)**
  - Recognize
    - Recognize that a HAZMAT incident has occurred.
  - Avoid
    - Avoid the area (stay upwind, uphill, upstream).
  - Isolate
    - Use the Emergency Response Guide (ERG) for initial distances.
    - For radiation, remember the inverse square law.
  - Notify
    - Notify the appropriate local resources (fire, law enforcement, etc.)

✕ Establishing Zones

- **Hot**
  - Hazard and contamination present
- **Warm**
  - Contamination control zone
  - Life-saving emergency care can occur here
- **Cold**
  - Incident command
  - Medical care and ambulance staging



✕ Personal Protective Equipment

Level A

Level B

Level C

Level D

✖ Decontamination

- Emergency
  - Rapid, gross removal of contamination from an individual unable to wait for more thorough decontamination procedures
- Technical
  - Thorough, detailed removal of contamination from responders' PPE and equipment
- Mass
  - Rapid process of removing contamination from large groups of people, usually civilians

When You Need to Phone A Friend

- **Canada**
  - CANUTEC: 1-888-CANUTEC
- **United States**
  - CHEMTREC: 1-800-424-9300
  - CHEMTEL, Inc: 1-888-255-3924
  - INFOTRAC: 1-800-535-5053
  - VERISK 3E: 1-800-451-8346
  - Radiation Emergency Assistance Center/Training Site: (865) 576-3131
    - *AVAILABLE WORLDWIDE*
- **Mexico**
  - CENACOM: 555128-0000 extensions 36428, 36422, 36469, 37807, 37810
  - CONASENUSA: 800-11-131-68

    SETIQ: 800-00-21-400

✕ Helpful Apps/Resources

- Emergency Response Guidebook (ERG)
- NIOSH Mobile Pocket Guide
- CAMEO Chemicals
- AskRail
- REAC/TS RadMed
- Mobile REMM

Case Study

You are called to the scene of a multi-vehicle collision on the interstate. As you approach the scene, you see an unknown liquid leaking onto the asphalt from the truck below:

✕ Case Study

What is this??

Case Study

What kind of container is this?

Case Study

How far should we isolate?

✕ Case Study

Which PPE would you recommend HAZMAT technicians use for this hazard?

Level A

Level B

Level C

Level D

✖ Case Study

While working to stop the leak of the hazardous material, one of the HAZMAT technicians loses consciousness and falls to the ground (it is 100 degrees Fahrenheit outside after all). He is able to be extricated to the border of the warm zone by his partner.

Which type of decontamination should be performed on the unconscious technician, and which type should be performed on the partner?

✖ Summary

- Hazardous materials (HAZMAT) are those substances that, when released, can cause harm to people, property, or the environment.
- A hazardous material's physical and chemical properties can tell us much about how it will react once released from its container and how we should structure our response.
- In the United States, there are nine classes of hazardous materials.
- Labels and shipping containers provide a wealth of information about the hazardous material contained.
- RAIN is an acronym used to remember protective actions that should be taken immediately after a hazardous materials incident has occurred.
- There are four classes of personal protective equipment: Level A, B, C, and D.

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