The Maryland Fire and Rescue Institute of the University of Maryland is the State’s comprehensive training and education system for all emergency services.

The Institute plans, researches, develops, and delivers quality programs to enhance the ability of emergency service providers to protect life, the environment, and property.
Hazardous Materials Operations
Lesson 1-1
Introduction and Paperwork

Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe the structure and requirements of this course.

Overview

- Course Structure and Introductions
- Course Requirements
Course Structure and Introductions

- Fill out paperwork
- Structure of class

Lessons
- 1-1 Introduction and Paperwork
- 1-2 Hazardous Materials Overview
- 2-1 Hazardous Materials: Properties and Effects
- 3-1 Recognizing and Identifying the Hazards
- 4-1 Estimating the Potential Harm and Planning a Response

Lessons
- 5-1 Mid-Term Exam
- 5-2 Implementing the Planned Response
- 6-1 Mission-Specific Competencies: Personal Protective Equipment
- 7-1 Mission-Specific Competencies: Product Control
- 8-1 Final Written and Practical Exam
Course Structure and Introductions
- Attendance requirement
- Safety first
- Terms
- Introductions

Course Requirements
- Skill Sheets – Must be completed prior to taking the final exam
- Final Written Exam – Student must receive a grade of 70% higher
- Final Practical Exam – Student must receive a grade of 70% or higher

Student Performance Objective
- Given information from discussion, handouts, and reading materials, describe the structure and requirements of this course.
Review

- Course Structure and Introductions
- Course Requirements
Hazardous Materials Operations
Lesson 1-2
Hazardous Materials Overview

Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe the role of first responders in dealing with a hazardous materials (HazMat) or Weapons of Mass Destruction (WMD) incident.

Overview

- Hazardous Materials Definitions
- Regulations and Standards for HazMat/WMD Response and Levels of Training
- Differences Between HazMat/WMD Incidents and Other Types of Emergencies
Hazardous Materials Definitions

- Hazard materials are substances that pose an unreasonable risk to:
  - Health
  - Safety
  - The environment
- Hazardous materials pose a risk when:
  - Transported in commerce
  - Used incorrectly
  - Not properly contained or stored

Hazardous Materials Definitions

- WMD—Criminal use of hazardous materials
  - Terror attacks
  - Illicit laboratories
  - Environmental crimes
  - Industrial sabotage

Hazardous Materials Definitions

Support Resources

- Chemical Abstracts Service (CAS)
  - Data base of 40 million substances
- Emergency Response Guide (ERG)
  - Assists responders in identifying hazardous substances and their effects
  - Identifies potential hazards, including fire, explosion and health hazards
  - Spells out recommendations for public safety and emergency response actions
Hazardous Materials Definitions
Support Resources
- OSHA—Issues regulations for workers and responders
- NFPA—Issues standards for first responders
- EPA—Issues regulations for the impact of hazardous materials on the environment

Hazardous Materials Definitions
Support Resources
- U.S. Department of Transportation (DOT)
  - Enforces laws and issues regulations governing transportation of goods by highway, rail, pipeline, air, and sometimes marine transport

Hazardous Materials Definitions
Support Resources
- LEPC—Coordinates local resources and disseminates information on HazMat
  - Gathers and disseminates information about hazardous materials to public
  - Consists of volunteers from industry, transportation, media, fire, police, public
  - Collects Material Safety Data Sheet (MSDS)
Hazardous Materials Definitions
Support Resources

- Materials Safety Data Sheet
  - Is an important resource for responders
  - Provides detailed profile of chemical/mixture
  - Is provided by manufacturer/supplier
  - Describes physical and chemical properties
  - Gives toxicology data

Hazardous Materials Definitions
Support Resources

Contains information about chemical composition, physical and chemical properties, health and safety hazards, emergency response, and waste disposal of a material.

Regulations and Standards for HazMat/WMD Response and Levels of Training

- OSHA State-Plan States
  - OSHA States adopt OSHA standards in their own organization
  - Maryland is an OSHA state
  - Maryland Occupational Safety and Health Act (MOSHA) covers workers and responders for HazMat/WMD
Regulations and Standards for HazMat/WMD Response and Levels of Training

- NFPA 472—Standard for Competence of Responders to HazMat/WMD Incidents
- NFPA 473—Standard for Competence of EMS Personnel Responding to HazMat/WMD Incidents
- Hazardous Waste Operations and Emergency Response (HAZWOPER)—OSHA regulations covering responders to HazMat/WMD

Regulations and Standards for HazMat/WMD Response and Levels of Training

- Three levels of training
  - Awareness
  - Operations
  - Technician/Specialists

Regulations and Standards for HazMat/WMD Response and Levels of Training

- Awareness-Level Personnel
  - Could encounter hazardous materials or WMDs as part of their normal duties
  - Are expected to recognize the presence of HazMat/WMD
  - Must protect themselves, call for help and secure the area
Regulations and Standards for HazMat/WMD Response and Levels of Training

- **Awareness-Level Specific Tasks**
  - Analyze incident to determine HazMat/WMD presence
  - Identify material
  - Use ERG to gather information
  - Initiate protective actions
  - Initiate notification process

Regulations and Standards for HazMat/WMD Response and Levels of Training

- **OSHA/HAZWOPER responder awareness tasks**
  - Understand what substances are involved and their risks
  - Understand potential outcomes
  - Recognize presence of HazMat
  - Identify HazMat
  - Understand role of first responder
  - Determine the need for additional resources

Regulations and Standards for HazMat/WMD Response and Levels of Training

- **Operations-Level Personnel**
  - Analyze scene to determine scope
  - Survey scene to ID containers and materials
  - Collect information from reference sources
  - Predict likely behavior of materials
  - Estimate potential harm
Regulations and Standards for HazMat/WMD Response and Levels of Training

- **Operations-Level Personnel (continued)**
  - Plan response to release, including PPE
  - Perform decontamination
  - Preserve evidence
  - Evaluate status/effectiveness of response

- **Mission-Specific Competencies**
  - Personal Protective Equipment (Lesson 6-1)
  - Technical Decontamination
  - Mass Decontamination
  - Evidence Preservation and Sampling
  - Product Control (Lesson 7-1)
  - Victim Rescue and Recovery
  - Response to Illicit Laboratories
  - Air Monitoring and Sampling

- **Technician/Specialist-Level Personnel**
  - Implement risk-based response
  - Supervise/direct operations level personnel
  - Perform specific duties
    - Implement employer’s emergency response plan
    - Classify, identify and verify materials
    - Function within ICS
Regulations and Standards for HazMat/WMD Response and Levels of Training

Technician/Specialist-Level Personnel
- Perform specific duties (continued)
  - Select/use proper PPE
  - Understand hazard and assess risk
  - Perform advanced control/contain/confine operations
  - Implement decontamination
  - Terminate incident
  - Understand chemical and toxicology behavior of hazardous materials

Safety Note – This class provides Operations Level training. Successful students will NOT be trained Technicians.
- Specialist is a HAZWOPER term not used in this class

Incident Commander
- HAZWOPER Incident Commander Requirements
  - Implement ICS
  - Implement emergency response plan
  - Understand hazards and risks of PPE
  - Understand state emergency response plan
  - Understand Federal regional response team
  - Understand decontamination
Regulations and Standards for HazMat/WMD Response and Levels of Training

■ Annual Refresher Training
  – OSHA requires annual refresher training for all levels of HazMat/WMD personnel
  – Local jurisdictions provide refresher training

■ Other Government Regulations and Organizations
  – Superfund Amendments and Reauthorization Act (SARA)
  – Emergency Planning and Community Right to Know Act (EPCRA)
  – Local Emergency Planning Committee (LEPC)
  – State Emergency Response Commission (SERC)

Differences Between HazMat/WMD Incidents and Other Types of Emergencies

■ HazMat/WMD incidents are different
  – Require a different mindset
  – Take more time
  – Have expanded role of law enforcement, presence of on-scene evidence
  – Begin with training before incident
Differences Between HazMat/WMD Incidents and Other Types of Emergencies

Factors to consider
- Chemical or hazard identification/evaluation considerations
- Time considerations
- Environmental considerations
- Law enforcement considerations

Preplanning must
- Focus on target hazards in community
- Identify threat assessment and response approach
- Coordinate planning by all agencies and departments
- Include discussion and information-sharing with LEPC
- Determine a cohesive emergency response plan, before a large-scale incident occurs

Student Performance Objective

Given information from discussion, handouts, and reading materials, describe the role of first responders in dealing with a hazardous materials (HazMat) or Weapons of Mass Destruction (WMD) incident.
Review

- Hazardous Materials Definitions
- Regulations and Standards for HazMat/WMD Response and Levels of Training
- Differences Between HazMat/WMD Incidents and Other Types of Emergencies
Hazardous Materials Operations
Lesson 2-1
Hazardous Materials: Properties and Effects

Student Performance Objective
- Given information from discussion, handouts, and reading materials, understand the chemical and physical properties of the substances involved in a hazardous material incident.

Overview
- Changes in Physical and Chemical Properties
- Critical Characteristics of Flammable Liquids
- Properties of Substances
- Relationship of Hazard, Exposure and Contamination
- Weapons of Mass Destruction
- Routes of Entry of Substances into the Body
- Chronic and Acute Health Effects of Exposure
Changes in Physical and Chemical Properties

Substances have characteristics

Responders need to understand characteristics to deal with HazMat/WMD incident

Responders need the information required to make good response decisions

Changes in Physical and Chemical Properties

- State of matter
  - Solid
  - Liquid
  - Gas

- State of matter predicts behavior
  - How did it escape?
  - Why did container fail?

- State of matter impacts durations of incident

Changes in Physical and Chemical Properties

- Other measurable characteristics
  - Vapor density
  - Flammability
  - Corrosivity
  - Water reactivity
Changes in Physical and Chemical Properties

- Physical changes to a substance
  - Temperature—heat or cold
  - Pressure—increase or decrease
  - Expansion ratio—how rapidly the volume increases
  - Chemical reactivity
    - Is also known as chemical change
    - Is the ability to transform at molecular level
    - Usually releases some form of energy

Critical Characteristics of Flammable Liquids

Flash point (1 of 2)

- Flash point is the minimum temperature at which ignition results in flash fire
  - Fire will go out once vapor fuel is consumed
- A low flash point = higher ignition temperature and vapor pressure (e.g. gasoline)
- A high flash point = lower ignition temperature and vapor pressure (e.g. diesel fuel)

Flash point (2 of 2)

- The fire point is the temperature at which sustained combustion of vapor occurs
- The fire point is usually higher than the flash point
Critical Characteristics of Flammable Liquids

- Ignition temperature
  - Also known as auto-ignition temperature
  - Is the temperature at which heated fuel ignites and continues to burn
  - Requires no external ignition source

Critical Characteristics of Flammable Liquids

- Flammable range
  - A concentration of flammable vapor and air needed for fuel/air mixture to burn
  - Defined by lower and upper limits
    - Lower explosive limit (UEL)
    - Upper explosive limit (LEL)
  - More dangerous when materials have wider ranges

Critical Characteristics of Flammable Liquids

- Vapor Pressure
  - Pertains to liquids inside a closed container
  - May be expressed in:
    - Pounds per square inch (PSI)
    - Atmospheres (ATM)
    - Torr
    - Millimeters of mercury (mm Hg)
  - Is influenced by ambient temperature
  - Causes liquid to evaporate when released
Critical Characteristics of Flammable Liquids

- Boiling Point
  - Liquid continually gives off vapors
  - Molecules must overcome downward force of atmospheric pressure
  - All liquid will turn to gas if boiling point is maintained

Critical Characteristics of Flammable Liquids

- BLEVE – Boiling liquid expanding vapor explosion
  - Results when pressurized liquefied materials inside closed vessel are exposed to high heat
  - Results in physical change from liquid to gas
  - Examples: propane, butane
- Expansion ratio: Describes the volume increase that occurs

Properties of Substances

- Vapor density
  - Is defined as weight of vapor compared to weight of air
  - Vapor density is expressed as a number, which can be found on MSDS
  - Air has a set density vapor of 1.0
  - Vapor density greater than 1.0 is heavier than air
  - Vapor density lower than 1.0 is lighter than air
  - Affects gas behavior during release
  - Causes lighter than air gases to rise and heavier than air gases to sink
Properties of Substances

- Specific gravity
  - Is a comparison of weight of liquid chemical to weight of water
  - Water has specific gravity of 1.0
  - Materials with specific gravity < 1.0 float
  - Materials with specific gravity > 1.0 sink
  - Most flammable liquids float on water

Properties of Substances

- Specific gravity

Properties of Substances

- Water solubility
  - The ability of a substance to dissolve in water
  - Important because water is most often used to extinguish fires
  - Water reacts violently with some chemicals (e.g., sulfuric acid, metallic sodium, magnesium)
Properties of Substances

Corrosivity (pH) (1 of 3)
- The ability of a material to cause damage to
  - Skin, eyes, other body parts
  - Clothing, rescue equipment
- Responders must take corrosive chemicals seriously
  - Corrosive materials require unique response tactics

Corrosivity (pH) (2 of 3)
- Corrosives consist of two types: Acids and bases
- Corrosives are measured by pH
  - Acids have pH less than 7
  - Bases have pH greater than 7
  - pH 7 is neutral
- Corrosives measuring a pH < 2.5 or pH > 12.5 are considered strong

Corrosivity (pH) (3 of 3)
Properties of Substances

- Toxic products of combustion
  - Materials decompose under heat, resulting in hazardous chemical compounds
  - *Smoke may not be just smoke!*
    - Soot, carbon monoxide, carbon dioxide, water vapor, formaldehyde, cyanide compounds, nitrogen oxides

Properties of Substances

- Radiation
  - Energy transmitted by electromagnetic waves or energetic particles
    - Sources: Sun, soil, X-rays, occupational exposures encountered in the field
  - Degree of damage determined by absorption and exposure time

Properties of Substances

- Alpha particles
  - Have weight and mass
  - Travel less than a few centimeters
  - Exposure can be lessened by:
    - Staying several feet from source
    - Using HEPA filter on simple respirator
    - Using self-contained breathing apparatus (SCBA)
Properties of Substances

- **Beta Particles**
  - Are more energetic than alpha particles
  - Pose a greater health hazard
  - May reden (erythema) and burn skin
  - May be inhaled; use SCBA
  - Can travel 10 to 15 feet in open air
  - Are considered ionizing radiation
  - Cannot pass through most solid objects

- **Ionizing Radiation**
  - Can cause changes in human cells
  - Can lead to cancer
  - Examples: X-rays, gamma rays

- **Non-ionizing Radiation**
  - Comes from electromagnetic waves
  - Does not have sufficient energy to change human cells
  - Examples: Sound waves, radio waves, microwaves
Properties of Substances

- Gamma Radiation
  - Is pure electromagnetic energy
  - Is the most energetic radiation responders may encounter
  - Can pass easily through thick, solid objects
  - Can form as a result of ionizing radiation, which can be deadly
  - Cannot be protected by SCBA
  - Can be created from neutrons

Relationship of Hazard, Exposure and Contamination

- Hazard: Material capable of causing harm
- Exposure: Process by which people, animals, the environment, and equipment come into contact with hazardous material

- Contamination
  - Is the presence of residue from released chemical
    - Decontamination: Process of residue removal
  - Can result in secondary contamination if transferred from contaminated source by direct contact
  - Can be prevented by PPE use
    - Does not enable unlimited contact
Responders should give WMD and terrorism a brief consideration when arriving at an incident.

Responders should also understand the nature of the various WMD hazards.

TRACEMP (mnemonic for types of damage from WMD)
- Thermal
- Radiological
- Asphyxiant
- Chemical
- Etiological
- Mechanical
- Psychogenic

Nerve agents
- Enter body through lungs or skin
- Disrupt central nervous system
- May cause death or serious impairment
  - Dose absorbed dictates extent of damage
- Are found in Sarin and VX
Weapons of Mass Destruction

- Nerve agents
  - Signs/symptoms: “SLUDGEM”
  - Salivation
  - Lacrimation (tearing)
  - Urination
  - Defecation
  - Gastric disturbance
  - Emesis (vomiting)
  - Miosis (constriction of the pupil)

Weapons of Mass Destruction

- Blister agents
  - Also known as vesicants
  - Cause blistering of the skin
  - Interact in harmful ways with body
  - Are found in Sulfur mustard and Lewisite

Weapons of Mass Destruction

- Blood agents
  - Disrupt oxygen transfer from blood to cells
  - Can be inhaled
  - Can be ingested or absorbed through skin
  - Are found in Cyanide compounds
    - Typical signs/symptoms: Vomiting, dizziness, watery eyes, deep and rapid breathing
Weapons of Mass Destruction

- **Choking agents**
  - Inhibit breathing and are skin irritants
  - Have an extremely irritating odor
  - Are intended to incapacitate, but may kill
    - May cause pulmonary edema ("dry drowning")
  - Are found in chlorine, phosgene and chloropicrin

- **Irritants (riot control agents)**
  - Cause pain and a burning sensation
    - Through contact with skin, eyes, mucous membranes
  - Are used to briefly incapacitate a person or group
  - Are the least toxic of the WMD groups
    - Decontaminate with water; effects are meant to wear off

- **Convulsants**
  - Cause convulsions or seizures
  - Can be fatal even in small exposures
  - Can be found in Sarin, soman, tabun and VX
    - Also organophosphate and carbamate pesticides
Routes of Entry of Substances Into the Body

- Inhalation
- Absorption
- Ingestion
- Injection

Inhalation
- Hazardous materials/WMD, corrosive materials, particles present danger
- SCBA offers excellent protection
- Infectious and contagious organisms also are inhalation hazards
  - Example: Anthrax

Inhalation
- Air-purifying respirators protect against certain airborne chemical hazards
  - More comfortable to wear, thereby permitting longer work periods
Routes of Entry of Substances Into the Body

- **Absorption**
  - Hazardous substances enter the body through the skin, eyes, nose, mouth
  - Absorption can cause asphyxiants to form, causing suffocation
  - Some agents can cause cancer
  - Aggressive solvents (e.g., paint stripper and hydrofluoric acid) pose absorption risk

- **Ingestion**
  - Chemicals enter body through GI tract
  - Exposure may occur when rotating out from emergency
  - Responders should wash before drinking/eating after hazardous work

- **Injection**
  - Occurs via cuts, abrasions, open wounds
  - Must be addressed before reporting for duty
Chronic and Acute Health Effects of Exposure

- Chronic health hazards
  - Appear after long-term exposure to hazard
  - Appear after multiple short-term exposures
  - Target organ effect
    - Example: Asbestosis

Chronic and Acute Health Effects of Exposure

- Acute health hazards
  - Occur after short, acute exposure
  - Are often seen in acid burns (sulfuric acid), breathing difficulties, and skin irritation (formaldehyde, a "sensitizer")

Chronic and Acute Health Effects of Exposure

- Toxicity—the degree to which something is toxic or poisonous and the effects of exposure to a substance
- OSHA definitions
  - Lethal dose (LD)
  - Lethal concentration (LC)
  - Calculation of LD and LC
Student Performance Objective

- Given information from discussion, handouts, and reading materials, understand the chemical and physical properties of the substances involved in a hazardous material incident.

Review

- Changes in Physical and Chemical Properties
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- Chronic and Acute Health Effects of Exposure
Hazardous Materials Operations
Lesson 3-1
Recognizing and Identifying the Hazards

Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe how to recognize and identify hazardous materials and WMDs at an emergency incident.

Overview

- Recognizing a Hazardous Materials/WMD Incident
- Hazardous Materials Containers
- Transportation of Hazardous Materials
- Transportation and Facility Markings
- Chemical References
- Other Reference Materials
- Potential Terrorist Incidents
Recognizing a Hazardous Materials/WMD Incident

_scene size-up_
- “Read” the scene.
- Truly understand what you see.
- Think before you act.

Hazmat incidents differ from other emergency incidents because
- They move more slowly
- Actions taken are largely dictated by chemicals or materials
- Responders must be conscious of the law enforcement aspects of the incident

Occupancy and Location
- Indicate possible presence of hazardous material
- House known hazardous materials
- Indicate the presence of facility safety personnel
Recognizing a Hazardous Materials/WMD Incident

- Senses
  - Initially, stay distant from incident.
  - Look.
  - Listen.
  - Do not "lead with your nose."

Hazardous Materials Containers

- Containers:
  - Are vessels or receptacles that hold material
  - Provide clues about the substance inside

Hazardous Materials Containers

- Drums
  - Are barrel-like non-bulk storage vessels
  - Store a wide variety of substances
  - Commonly have a 55-gallon capacity
  - Are made of cardboard, polyethylene, stainless steel, and other materials
Hazardous Materials Containers

The drum shown here is made of polyethylene.

Hazardous Materials Containers

Dewar Containers
- Hold cold liquids
- Are designed to preserve temperature of liquid

Hazardous Materials Containers

A series of Dewar containers stored adjacent to a compressed gas cylinder.
Hazardous Materials Containers

- **Bulk Storage Containers**
  - Hold over 119 gallons (liquid)
  - Contain more than 882 pounds (bulk)
  - Include:
    - Fixed tanks
    - Highway cargo tanks
    - Rail tank cars
    - Totes

Hazardous Materials Containers

- **Secondary Containment**
  - Helps contain spilled or released product
  - Forms a catch basin around the container
  - Normally holds contents of full container

Hazardous Materials Containers

- **Large-Volume Horizontal Tanks**
  - Can be
    - Above-ground storage tanks (ASTs)
    - Underground storage tanks (USTs)
  - May contain millions of gallons
Hazardous Materials Containers

- **Totes**
  - Are intermediate bulk containers (IBCs)
  - Have capacity from 119 to 703 gallons
  - Are hazardous to ship and store

Hazardous Materials Containers

A tote is a commonly encountered bulk storage vessel.

Hazardous Materials Containers

- **Intermodal Tanks**
  - Are used for both shipping and storage
  - Hold between 5000 and 6000 gallons
  - Can be pressurized or non-pressurized
  - Can contain liquefied gases (cryogenic liquids)
IM-101 portable tank (IMO type 1 internationally).

IM-102 portable tank (IMO type 2 internationally).

Pressure intermodal tank (IMO type 5 internationally).
Hazardous Materials Containers

- **Intermodal Tanks**
  - Other types of IM tanks
    - Cryogenic intermodal tanks (IMO type 7 internationally)
    - Tube modules

Hazardous Materials Containers

- **Non-bulk Storage Vessels**
  - Contain up to 119 gallons
  - Include:
    - Drums
    - Bags
    - Compressed gas cylinders
    - Cryogenic containers

Hazardous Materials Containers

A bung wrench is used to operate the openings on the top of a closed-head drum.
Hazardous Materials
Containers

An open-head drum has a lid that is fastened with a ring that is tightened with a clasp or a nut-and-bolt assembly.

Hazardous Materials
Containers

A pesticide bag must be labeled with the appropriate information.

Hazardous Materials
Containers

A carboy is used to transport and store corrosive chemicals.
Hazardous Materials Containers

A small cryogenic Dewar container.

Transportation of Hazardous Materials

- Transported by air, sea, and land
- Most commonly transported by roadway
- Transported by cargo tanks (bulk packaging) either
  - Permanently attached to or part of a vehicle
  - Not permanently part of the vehicle but unloaded without being removed from vehicle

Transportation of Hazardous Materials

- MC-306/DOT 406 Flammable Liquid Tankers
  - Hold
    - Liquid food-grade products
    - Gasoline
    - Other flammable and combustible liquids
  - Contain 6000 to 10,000 gallons
  - Are non-pressurized
  - Have remote emergency shut-off valves
Transportation of Hazardous Materials

The MC-306/DOT 406 flammable liquid tanker typically hauls flammable and combustible liquids.

Transportation of Hazardous Materials

MC-307/DOT 407 Chemical Hauler
- Carries
  - Flammable liquids
  - Mild corrosives
  - Poisons
- Contains 6000 to 7000 gallons

Transportation of Hazardous Materials

The MC-307/DOT 407 chemical hauler carries flammable liquids, mild corrosives, and poisons.
Transportation of Hazardous Materials

**MC-312/DOT 412 Corrosives Tanker**
- Is smaller in diameter than MC-306/DOT 406 or MC-307/DOT 407
- Has a capacity of approximately 6000 gallons
- Carries corrosives such as:
  - Concentrated sulfuric acid
  - Phosphoric acid
  - Sodium hydroxide

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

**MC-331 Pressure Cargo Tanker**
- Carries materials such as ammonia, propane, Freon, and butane
- Contains 1,000 to 11,000 gallons
- Presents an explosion threat
  - Spring-loaded relief valves unable to keep up with rapidly building internal pressure
Transportation of Hazardous Materials

The MC-331 pressure cargo tanker carries materials such as ammonia, propane, Freon, and butane.

Transportation of Hazardous Materials

- MC-338 Cryogenic Tanker
  - Maintains low temperatures for cryogens
  - Vents puffs of white vapor (normal)
  - Presents an explosion hazard with incorrect valve operation

Transportation of Hazardous Materials

The MC-338 cryogenic tanker maintains the low temperatures required for the cryogens it carries.
Transportation of Hazardous Materials

- Tube Trailer
  - Carries compressed gases such as:
    - Hydrogen
    - Oxygen
    - Helium
    - Methane

Transportation of Hazardous Materials

A tube trailer is made up of several individual cylinders banded together and affixed to a trailer.

Transportation of Hazardous Materials

- Dry Bulk Cargo Tank can contain
  - Powders
  - Pellets
  - Fertilizers
  - Grain
Transportation of Hazardous Materials

A dry bulk cargo tank is not pressurized but pressure can be used to empty contents.

Transportation of Hazardous Materials

- Railroad Transportation
  - Presents relatively few hazardous materials incidents
  - Can cause large-scale emergencies
- Rail contents can be identified with information from conductor/engineer or from tank labels

Transportation of Hazardous Materials

- Non-pressurized (General-Service) Rail Tank Car
  - Carries general industrial chemicals
    - Corn syrup
    - Flammable and combustible liquids
    - Mild corrosives
  - Contains 4,000 to 40,000 gallons
Transportation of Hazardous Materials

A non-pressurized rail tank has visible valves and piping.

Transportation of Hazardous Materials

Pressurized Rail Tank Car
- Carries pressurized industrial chemicals
  - Propane
  - Ammonia
  - Ethylene oxide
  - Chlorine
- Has potential for high-pressure leaks

Transportation of Hazardous Materials

Pressurized rail tank cars have top mounted fittings for loading and unloading.
Transportation of Hazardous Materials

- Special-Use Rail Tank Car
  - Hazard will be unique to the particular railcar and its contents
  - Boxcar
  - Flat car
  - Cryogenic tank car
  - Corrosive tank car

Special-use rail tank cars include boxcars, flat cars, cryogenic and corrosive tank cars. Tube cars are no longer in service.

Transportation of Hazardous Materials

- Pipelines
  - Are rarely involved in emergencies
  - Involve complicated emergency response that requires specially trained responders
  - Are used to transport natural gas, gasoline, and diesel fuel
  - Are maintained by pipeline/right-of-way owners
A pipeline warning sign provides information about the pipe’s contents, the owner’s name, and contact information.

Transportation and Facility Markings

- Department of Transportation (DOT) Marking System
  - Required, depending on substance being transported and quantity:
    - Placards (10 ¾” diamond-shaped)
    - Labels (4” diamond-shaped)
    - Markings
  - Will not be found on all shipments

The DOT uses labels, placards, and markings (such as these found in the ERG) to give responders a general idea of the hazard inside a particular container or cargo tank.
Transportation and Facility Markings

- NFPA 704 Marking System
  - Diamond-shaped (any size)
  - Blue diamond = health hazard
  - Red diamond = flammability
  - Yellow diamond = reactivity
  - White diamond = special information

The NFPA 704 hazard identification system is designed for fixed-facility use. Each color used in the diamond represents a particular property or characteristic.

Transportation and Facility Markings

- Hazardous Materials Information System (HMIS)
  - Helps employers comply with OSHA Hazard Communication Standard
  - Is a voluntary labeling system
  - Is meant for employees at a facility
    - Gives necessary information to work safely around chemicals
The HMIS uses a numerical hazard rating, colored horizontal columns, letters, and icons to describe the hazards posed by a particular substance and provide guidance about choosing PPE.

Military Hazardous Materials/WMD Markings
- Marking system of U.S. military
- Division 1: Mass detonation hazards
- Division 2: Explosion-with-fragment hazards
- Division 3: Mass fire hazards
- Division 4: Moderate fire hazards

Military Hazardous Materials/WMD Markings
A. Mass detonation hazards
B. Explosion-with-fragment hazards
C. Mass fire hazards
D. Moderate fire hazards
Transportation and Facility Markings

- Military Hazardous Materials/WMD Markings
  - Pictograms identify specific PPE
  - Colors depict chemical hazards
    - Red: Toxic agents
    - Yellow: Harassing agents
    - White: White phosphorous

Chemical References

- Emergency Response Guidebook (ERG)
- Fire Fighter's Handbook of Hazardous Materials
- Information on 4000+ chemicals
  - Not for long-term action plans
  - Inappropriate to use beyond the first 15 minutes
Chemical References

- Emergency Response Guidebook (ERG)
  - Index list of dangerous goods in numerical order of ID number – Yellow
  - Index list of dangerous goods in alphabetical order of material name – Blue
  - Safety recommendations – Orange
  - Initial isolation and protective distances and water reactivity – Green

Chemical References

- ERG safety recommendations – Orange
- Three sections
  1. Potential hazard
     - Fire or explosion
     - Health
  2. Public safety
     - Protective clothing
     - Evacuation

Chemical References

- ERG safety recommendations – Orange
- 3. Emergency response
  - Fire
  - Spill or leak
  - First aid
Chemical References

- Fire Fighter's Handbook of Hazardous Materials
  - Information on about 13,000 chemicals
  - First responders are primary audience
Other Reference Sources

- Material safety data sheet (MSDS)
  - Chemical makeup, potential hazards, first aid in the event of exposure
- Shipping papers
  - Names, addresses of shipper and recipient
  - Quantity of chemical, weight of shipment

Other Reference Sources

A bill of lading or freight bill: Shipping papers for road and highway transportation, located in the cab of the vehicle.

Other Reference Sources

A waybill (pictured): Shipping papers for railroad transportation. Consist of a list of the contents of every car on the train.
Other Reference Sources

A dangerous cargo manifest: Shipping papers on a marine vessel, kept in the custody of the captain or master.

Other Reference Sources

An air bill: Shipping paper for air transport, kept in the cockpit.

Other Reference Sources

- CHEMTREC (Chemical Transportation Emergency Center)
  - Toll free number 1-800-262-8200
- CANUTEC (Canadian Transport Emergency Centre)
- SETIQ (Emergency Transportation System for the Chemical Industry, Mexico)
Other Reference Sources

- National Response Center (NRC)
  - Responders should notify the NRC of significant hazardous materials incidents
  - The NRC
    - Is operated by the U.S. Coast Guard
    - Alerts the appropriate state/federal agencies
    - Toll-free number is 1-800-424-8802

Potential Terrorist Incidents

- Responders should be familiar with the locations of potential targets in their area.
  - Infrastructure targets
  - Symbolic targets
  - Civilian targets

Potential Terrorist Incidents

- Chemical and Biological Agents
  - Chemical agent clues may include
    - Rubber gloves, glass containers, residual chemicals, odor, dead insects or foliage
  - Biological agent clues may include
    - Lab equipment, reference manuals
  - Personnel may show signs of exposure.
Potential Terrorist Incidents

- Radiological Agents
  - Clues may include
    - Stainless steel containers, detonators, radiological protective suits, Geiger counters
  - Personnel may exhibit exposure symptoms such as burns or difficulty breathing.

Radioactive shipment labels.

A. White I label.
B. Yellow II label.
C. Yellow III label.

Radioactive packaging.

A. Type A package.
B. Type B package.
C. Type C package.
Potential Terrorist Incidents

Illicit Laboratories
- Items found at illicit laboratories include
  - Terrorist training manuals, basement locations with multiple vents, obscured windows
  - The most common type of illicit laboratory is a drug laboratory
  - Drug labs use everyday items such as jars, bottles, glass cookware, tubing

Explosives
- Indicator of criminal or terrorist activity
- Clues may include
  - Protective equipment, production and containment materials, explosive materials, reference materials

Secondary Devices
- Are explosive or incendiary devices designed to harm responders at the incident scene as responders treat victims of the initial attack
- Are indicated by clues such as
  - Timers, wires, switches, concealment containers, backpacks, propane tanks
Student Performance Objective

Given information from discussion, handouts, and reading materials, describe how to recognize and identify hazardous materials and WMDs at an emergency incident.

Review

- Recognizing a Hazardous Materials/WMD Incident
- Hazardous Materials Containers
- Transportation of Hazardous Materials
- Transportation and Facility Markings
- Chemical References
- Other Reference Materials
- Potential Terrorist Incidents
Hazardous Materials
Operations
Lesson 4-1
Estimating Potential Harm and Planning a Response

Student Performance Objective

■ Given information from discussion, handouts, and reading materials, describe how to protect yourself and others by estimating the potential harm or severity of an emergency incident.

Overview

1 of 2

■ Estimate the Potential Harm or Severity of an Incident
■ Identify and Protect Exposures
■ Plan Initial Response
■ Determine Need for Personal Protective Equipment
Overview
2 of 2
- Use HazMat-Specific Personal Protective Equipment
- Identify Ratings of Chemical-Protective Clothing
- Use Respiratory Protection
- Conduct Decontamination

Estimate the Potential Harm or Severity of an Incident
- Priorities for responders
  - Ensure your own safety
  - Determine correct and safe actions necessary to protect the life safety of people affected by the incident

Estimate the Potential Harm or Severity of an Incident
- Protection of life and property
  - Life safety considerations
  - Material considerations
  - Threshold Limit Value (TLV)
  - Threshold Limit Value/Short-Term Exposure Limit (TLV/STEL)
### Estimate the Potential Harm or Severity of an Incident

**Protection of life and property**
- Threshold Limit Value/Time-Weighted Average (TLV/TWA)
- Threshold Limit Value/Ceiling (TVL/C)
- Threshold Limit Value Skin

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### Estimate the Potential Harm or Severity of an Incident

**Protection of life and property**
- Permissible Exposure Limit (PEL)
- Recommended Exposure Level (REL)
- Immediately Dangerous to Life and Health (IDLH)

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### Estimate the Potential Harm or Severity of an Incident

**Hazardous materials toxicology data sources**
- Occupational Safety and Health Administration (OSHA)
  - Permissible exposure limit concept
- American Conference of Governmental Industrial Hygienists (ACGIH)
  - Threshold limit value concept
Estimate the Potential Harm or Severity of an Incident

- Resources for determining incident size
  - ERG
  - Evacuation information based on the size of the release
  - Basic action plans
  - Computer programs
    - For example, vapor cloud projection software

Estimate the Potential Harm or Severity of an Incident

- Initial Isolation Protective Action Distances from ERG

Identify and Protect Exposures

- Types of Exposures – Three Considerations
  - People
  - Property
  - Environment
Identify and Protect Exposures

- Initial actions
  - Isolating the hazard area
  - Denial of entry
  - Evacuation
  - Sheltering in place

Identify and Protect Exposures

- Reporting size and scope of incident
- Determining the concentration and pH of released materials
- Skin contact hazards
  - Absorption of toxins
  - Chemical damage

Identify and Protect Exposures

- Litmus paper used to determine pH
Plan Initial Response

- Approach incident cautiously

Plan Initial Response

- Response depends on material state

Plan Initial Response

- Response objectives
  - Measurable
  - Flexible
  - Time sensitive
Plan Initial Response

- Secondary attacks and devices
  - Should be acknowledged in response objectives
  - Should use EVADE mnemonic
    - Evaluate scene for likely placement
    - Visually scan operating area
    - Avoid touching or moving anything
    - Designate and enforce scene control
    - Evacuate victims, responders and others

Plan Initial Response

- Defensive actions
  - Physical control of released products (damming, diking)
  - Physical control at the source (shutting off valves, plugging holes)
  - Suppression or disbursement of vapors

Determine Need for Personal Protective Equipment

- Selection based on:
  - Hazardous material involved
  - Specific hazards present
  - Physical state of material
Determine Need for Personal Protective Equipment

- Performance standards for PPE
  - OSHA HAZWOPER Appendix B

- Maintaining PPE
  - Cleaning
  - Disinfecting
  - Storing
  - Inspecting
  - Manufacturer documentation

Use HazMat-Specific Personal Protective Equipment

- Street clothing and work uniforms
  - Offers the least amount of protection
  - Are worn only away from contaminated areas
  - Nomex jumpsuit

Use HazMat-Specific Personal Protective Equipment

- Structural firefighting protective clothing
  - Not chemical-protective
  - Suitable for support functions
Use HazMat-Specific Personal Protective Equipment

- High temperature-protective clothing and equipment
  - Offers a level above structural firefighting gear
  - Affords short-term high-temperature protection
  - Does not protect from hazardous materials/WMD

Use HazMat-Specific Personal Protective Equipment

- Chemical-protective clothing and equipment
  - Is designed to resist passage of chemicals
    - Permeation
    - Penetration
    - Degradation
  - Cannot protect from everything

Use HazMat-Specific Personal Protective Equipment

- Vapor-protective clothing
  - Provides full body protection
  - Requires supplied-air respiratory protection devices
  - Increases possibility of heat-related emergencies
Use HazMat-Specific Personal Protective Equipment

- Liquid splash-protective clothing
  - Protects from chemical splashes
  - Does not protect from gases or vapors

Identify Ratings of Chemical-Protective Clothing

- Level A ensemble, vapor-protective
  - Fully encapsulating garment
  - SCBA or SAR
  - Vapor-protective chemical-resistant suit
  - Chemical-resistant gloves
  - Chemical-resistant safety boots/shoes
  - Two-way radio

Identify Ratings of Chemical-Protective Clothing

- Level A ensemble
Identify Ratings of Chemical-Protective Clothing

- Level B ensemble
  - Chemical-protective:
    - Clothing
    - Boots
    - Gloves
  - SCBA or SAR
  - Two-way radio

Identify Ratings of Chemical-Protective Clothing

- Level C ensemble
  - Full-face APR
  - Chemical-resistant:
    - Clothing
    - Gloves
    - Boots/shoes
  - Two-way radio

Identify Ratings of Chemical-Protective Clothing

- Level D ensemble
  - Minimally protective and includes
    - Coveralls
    - Safety boots/shoes
    - Safety or chemical-splash goggles
    - Hard hat
Use Respiratory Protection

- Physical capability requirements
  - Medical surveillance (pre-incident)
    - Medical pre-screening
    - Yearly medical examination
  - On-scene medical monitoring
    (incident-related)

Use Respiratory Protection

- Positive-pressure self-contained breathing apparatus (SCBA)
  - Prevents both inhalation and ingestion exposure
  - Impacts time to complete tasks, due to limited air supply

Use Respiratory Protection

- Supplied-air respirators (SARs)
  - Provide external air source
  - Connect by hose to facepiece
  - Provide air for about 5 minutes with use of escape cylinder
  - Limit movement due to length of hose
  - Can be damaged if the hazardous material comes in contact with the hose
Use Respiratory Protection

- Closed-circuit self-contained breathing apparatus
  - Is commonly called "rebreather"
  - Uses exhaled air that is:
    - Scrubbed free of carbon dioxide
    - Supplemented with oxygen
    - Rebreathed
  - Allows for long work periods

Use Respiratory Protection

- Air-purifying respirators (APRs)
  - Filter particulates, vapors, and contaminants
  - Are used only when there is sufficient oxygen in atmosphere

Use Respiratory Protection

- Powered air-purifying respirators (PAPRs)
  - Are like APRs, but include small fan
  - Diminish work of breathing
  - Reduce fogging in the mask
  - Provide flow of cool air across face
Conduct Decontamination

- Emergency decontamination
  - Removing most contamination as quickly as possible
  - Remove clothing
  - Apply large quantities of water
  - Perform without decontamination corridor
  - Control runoff as much as possible

Conduct Decontamination

- Immediate removal of contaminated clothing

Conduct Decontamination

- Decontamination corridor
  - Designated area for decontamination
  - Located in warm zone
  - Requires formal and detailed process
Conduct Decontamination

- Secondary contamination
  - Is also called cross-contamination
  - Results from
    - Contact with a contaminated person or object
    - Re-entry into hot zone after decontamination

Conduct Decontamination

- Control Zones
  - Hot—area around the release
  - Warm—transition area between hot and cold
  - Cold—safe area for command, staging, EMS
  - Established as part of implementing the planned response, helps prevent secondary contamination

Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe how to protect yourself and others by estimating the potential harm or severity of an emergency incident.
Review

- Estimate the Potential Harm or Severity of an Incident
- Identify and Protect Exposures
- Plan Initial Response
- Determine Need for Personal Protective Equipment

Review

- Use HazMat-Specific Personal Protective Equipment
- Identify Ratings of Chemical-Protective Clothing
- Use Respiratory Protection
- Conduct Decontamination
Hazardous Materials Operations
Lesson 5-2
Implementing the Planned Response

Student Performance Objective
- Given information from discussion, handouts, and reading materials, describe how to control the scene of a HazMat/WMD incident and take initial response actions.

Overview
- Initial HazMat Operational Steps
- Response Safety Procedures
- Protective Actions for HazMat Incidents
- The Incident Command System
Initial HazMat Operational Steps

- Scene control
  - Important at all emergencies
  - Paramount at hazardous materials incidents

- Incident Size-up
  - Rapidly conduct mental evaluation
  - Use visual indicators of incident
  - Process the information
  - Draw conclusion to help form plan of action

Initial HazMat Operational Steps

- Incident size-up determines posture
  - Aggressive, offensive posture
    - Attack the problem
  - Defensive posture
    - Isolate the scene and protect exposures
    - Allow incident to stabilize

Initial HazMat Operational Steps

- Initial actions set tone for response and are critical to success of effort (SIN process)
  - Safety
  - Isolation
  - Notification
Initial HazMat Operational Steps

■ Safety
  – Ensure your own safety
  – Obtain briefing from those involved
  – Understand nature of problem
  – Attempt to identify released substance

Initial HazMat Operational Steps

■ Isolation
  – Isolate and deny entry to scene
  – Separate the people from the problem
  – Establish command post
  – Formulate incident action plan
  – Begin assigning tasks

Initial HazMat Operational Steps

■ Notification
  – Decide if anyone should be notified:
    ■ Specialized responders
    ■ Law enforcement
    ■ Technical experts
    ■ Regulatory agencies
Initial HazMat Operational Steps

- DECIDE decision-making algorithm

Response Safety Procedures

- Isolate release area
- Establish control zones
- Consult Emergency Response Guidebook (ERG)
- Evacuate others
- Determine sheltering-in-place strategy
- Provide emergency medical care at safe location

Response Safety Procedures

- Ignition sources
  - Identify and secure
  - Use only intrinsically safe devices so as not to create unintentional ignition source
  - Confirm intrinsically safe radios and batteries (as marked by the factory with a specific label denoting them as such)
Response Safety Procedures

- Establish control zones
  - Hot Zone—area around the release
  - Warm Zone—transition area between hot and cold
  - Cold Zone—safe area for command, staging, EMS
  - Control Zones—Established as part of implementing the planned response; help prevent secondary contamination

Response Safety Procedures

- Adjusting control zones—make control zones the right size based on the incident

Response Safety Procedures

- Performing emergency decontamination
  - Use appropriate PPE
  - Stay clear of product
  - Direct victims to suitable decontamination location
  - Instruct/assist victims in removing contaminated clothing
  - Rinse the victim with water
  - Provide or obtain medical care
Protective Actions for HazMat Incidents

First priority is to evaluate threat to life
- If no threat to life exist, severity of incident is diminished

If needed, perform life-safety actions:
- Ensuring your own safety
- Conducting search and rescue

Buddy system
- Never allow responders to operate alone
- Always have two or more responders enter contaminated area
- Follow OSHA HAZWOPER regulation on entry requirements

Back-up team
- Wears same level of protection as entry team
- Is required by OSHA HAZWOPER regulation
- Is a team of at least two
- Is ready for immediate deployment
Protective Actions for HazMat Incidents

Evacuation
- Incident commander (IC) determines need
  - May be assisted by:
    - Fire fighters
    - Law enforcement personnel
- Must find safe area
- Must arrange for transportation
- Must consult ERG for evacuation distances

Sheltering-in-place
- Sheltering-in-place is normally accomplished inside a structure with windows and doors closed and ventilation off
- Local emergency plans should identify available facilities
- Responder must make an evacuate vs. shelter-in-place decision, considering chemical released, time available to avoid exposure

Search and rescue
- Safety is first priority
- Released substance must be known
- IC determines need/feasibility
- Victims are removed to warm zone
Protective Actions for HazMat Incidents

**Safety briefing**
- Written site safety plan should be completed
  - Written plan may have to abandon if rescue required
- Verbal safety briefing is performed
  - May be brief

**Protective Actions for HazMat Incidents**

Safety briefing informs all responders of:
- Health hazards
- Incident objectives
- Emergency medical procedures
- Radio frequencies and emergency signals
- Description of site
- PPE to be worn

**Protective Actions for HazMat Incidents**

Excessive-heat disorders
- Heat exhaustion
  - Is a mild form of shock
  - Dictates the use of tepid water to drink and cool skin
- Heat stroke
  - Is severe and potentially fatal
  - Requires immediate transport to a medical facility
Protective Actions for HazMat Incidents

- Cold-temperature exposures
  - Can be caused by released materials
  - Can be caused by environment
  - Can be prevented by keeping clothing next to skin dry

Protective Actions for HazMat Incidents

- Personal protective equipment: physical capabilities requirements
  - Pre-entry health screening
  - On-scene medical monitoring

The Incident Command System

- HAZWOPER OSHA regulation requires use of ICS
- ICS has the advantages of:
  - Common terminology
  - Consistent organizational structure
  - Consistent position titles
  - Common incident facilities
The Incident Command System

- Command
  - Manages response
  - Determines incident strategy
  - Creates action plan
  - Manages resources
  - Tracks progress
  - Implements safety plan

Unified command
- Used with multiple agencies

Incident command post
- Located at or near scene of emergency
- Houses command and all direct support staff

Command staff
- Incident Safety Officer (ISO)
- Liaison Officer
- Public Information Officer (PIO)

General staff functions
- Operations
  - Led by Operations Section Chief
  - Responsible for all tactical operations
    - Group: Working on same task or objective
    - Division: Working in same geographic location
The Incident Command System

- General staff functions
  - Hazardous materials branch
  - Assistant safety officer
  - Entry team
  - Decontamination team
  - Backup team
  - Technical reference team

The Incident Command System

- General staff functions—other
  - Planning
  - Logistics
  - Finance

The Incident Command System

- Role of the Operations Level Responder
  - To be an integral component of response plan
    - Implements or supports actions to protect people, property, and the environment
    - Performs mission-specific duties as determined by AHJ
  - To be familiar with emergency response plans
  - To know different levels of response
The Incident Command System

- Response levels

Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe how to control the scene of a HazMat/WMD incident and take initial response actions.

Review

- Initial HazMat Operational Steps
- Response Safety Procedures
- Protective Actions for HazMat Incidents
- The Incident Command System
Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe and demonstrate the proper use of personal protective equipment for HazMat incidents.

Overview

- Specific Personal Protective Equipment/Practical Exercises
- Safety
- Reporting and Documenting the Incident
Specific Personal Protective Equipment/Practical Exercises

- Selection is based on:
  - Hazardous material involved
  - Specific hazards present
  - Physical state of material
- Use risk-based approach in selecting

Specific Personal Protective Equipment/Practical Exercises

- Performance standards for PPE
  - OSHA HAZWOPER Appendix B
- Maintaining PPE
  - Cleaning
  - Disinfecting
  - Storing
  - Inspecting
  - Following manufacturer documentation

Specific Personal Protective Equipment/Practical Exercises

- Types of Personal Protective Clothing
  - Street clothing/work uniforms
  - Structural firefighting protective clothing
  - High-temperature protective clothing and equipment
  - Chemical-protective clothing and equipment
    - Vapor-protective clothing
    - Liquid splash-protective
Specific Personal Protective Equipment/Practical Exercises

- Respiratory protection
  - Physical capability requirement
    - Medical surveillance (pre-incident)
      - Medical pre-screening
      - Yearly medical examination
    - On-scene medical monitoring (incident-related)

Specific Personal Protective Equipment/Practical Exercises

- Types of respiratory protection
  - Positive-pressure, self-contained breathing apparatus (SCBA)
  - Supplied-air respirators
  - Closed circuit SCBA (Rebreather)
  - Air-purifying respirators (APRs)
  - Power air-purifying respirators (PAPRs)

Specific Personal Protective Equipment/Practical Exercises

- Chemical-Protective Ensembles – Level A ensemble, vapor-protective
  - Fully encapsulating garment
    - Encloses wearer and the respiratory protection
    - Protects against only brief flash fire
    - Affords alpha radiation protection
Specific Personal Protective Equipment/Practical Exercises

- Chemical-Protective Ensembles – Level B ensemble, chemical-protective
  - Chemical-protective:
    - Clothing
    - Boots
    - Gloves
  - SCBA or SAR
  - Two-way radio

Specific Personal Protective Equipment/Practical Exercises

- 7-3 Donning a Level B ensemble
- 7-4 Doffing a Level B ensemble

Specific Personal Protective Equipment/Practical Exercises

- Chemical-Protective Ensembles – Level C ensemble, chemical resistant
  - Full-face APR
  - Chemical-resistant:
    - Clothing
    - Gloves
    - Boots/shoes
  - Two-way radio
Specific Personal Protective Equipment/Practical Exercises

- Chemical-Protective Ensembles – Level D ensemble
  - Minimally protective – including:
    - Coveralls
    - Safety boots/shoes
    - Safety or chemical-splash goggles
    - Hard hat

Safety

- Equipment performance requirements
  - Testing PPE
  - Using manufacturer specifications and recommended procedures
  - Understanding limits of HazMat operations-level personnel at HazMat incidents

Safety

- Responder Safety
  - PPE-related safety issues
    - Incident hazards (materials and environment)
    - Heat-related dangers
      - Dehydration resulting in heat exhaustion/stroke
    - Vision issues
      - Facepiece can fog up, resulting in slips and falls
    - Mobility and dexterity issues
      - Bulky PPE inhibits mobility
      - Gloves become slippery
Safety

Responder Safety
- Mitigation of PPE issues
  - Pre-entry medical monitoring
  - Use of buddy system
  - Radio communication
  - Hand signals

Safety

Responder Safety
- Heat exchange units
  - Forced-air cooling systems
  - Ice-cooled or gel-packed vests
  - Fluid-chilled systems
  - Phase-change cooling technology

Safety

Responder Safety
- Forced-Air Cooling Systems
  - Force pre-chilled air through a system of hoses worn close to the body
  - Provide lightweight, long-term cooling benefits
  - Inhibit mobility (attached to external, fixed compressor)
Responder Safety
- Ice-Cooled or Gel-Packed Vests
  - Low cost
  - Portable
  - Rechargeable (refrozen)
  - Bulky
  - Problematic—may fool body into retaining heat

Responder Safety
- Fluid-Chilled Systems
  - Pump ice-chilled liquid through tubes
  - Limit mobility
  - Increase workload and generate more heat because of weight

Responder Safety
- Phase-Change Cooling Technology
  - Temperature of material is chilled to 60°F
  - Fabric wicks away perspiration
  - System "recharges" more quickly than gel-packed vest
Reporting and Documenting the Incident

- AHJ reporting requirements
- Exposure reporting
  - Creates a history of exposures
  - Is critical if there is a subsequent medical issue

Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe and demonstrate the proper use of personal protective equipment for HazMat incidents.

Review

- Specific Personal Protective Equipment Practical Exercises
- Safety
- Reporting and Documenting the Incident
Hazardous Materials Operations
Lesson 7-1
Mission Specific Competencies: Product Control

Student Performance Objective
- Given information from discussion, handouts, and reading materials, describe and demonstrate the proper use of confinement and containment techniques for released hazardous materials.

Overview
- Product Control Options/Practical Exercises
- Incident Recovery Phase
Product Control Options/Practical Exercises

Absorption
- Absorbent material soaks up liquid release
  - Vermiculite
  - Clay
  - Peat moss
  - Spill pads
- Absorption is effective only on flat surfaces
- Disposal of used material is necessary
- Responders must be close to spill

Product Control Options/Practical Exercises

Absorption
- Materials add volume to spill
- Materials sometimes repel water while absorbing spilled liquid
- Absorption is useful to contain oil spill on body of water
- Spill booms can be used on water or land
- Skill drill 11-1: absorption/adsorption

Product Control Options/Practical Exercises

Absorption
- Pads and booms can confine liquids

[Image of spill response exercises]
Product Control Options/Practical Exercises

- Adsorption
  - Contaminant adheres to surface of material
    - Silica
    - Activated carbon
  - Adsorption can generate heat
  - Adsorption functions like Velcro—sticks to product

Product Control Options/Practical Exercises

- Damming
  - Is used when liquid flows in channel
  - Stops progress by blocking channel
  - Consists of three kinds of dams
    - Complete dam
    - Overflow dam
    - Underflow dam

Product Control Options/Practical Exercises

- Complete Dam
  - Is placed across small stream or ditch
  - Completely stops flow of material
  - Is used for
    - Basically dry streams or ditches
    - Small amounts of hazardous materials
Product Control Options/ Practical Exercises

- **Overflow Dam**
  - Is used when materials are heavier than water
  - Allows water flow above containment
  - Skill drill 11-2: overflow dam

- **Underflow Dam**
  - Is used when materials are lighter than water
  - Allows water flow below containment
  - Skill drill 11-3: underflow dam

- **Diking**
  - Keeps hazardous material in place
  - Uses various materials
    - Sand
    - Dirt
    - Loose absorbent
    - Concrete
  - Skill drill 11-4: dike
Product Control Options/Practical Exercises

- Dilution
  - Is accomplished by adding water or other substances
  - Weakens strength of hazardous material
  - Is typically used for corrosives
  - Increases the volume of contaminated materials
    - May overwhelm containment measures
  - Skill drill 11-5: dilution

Product Control Options/Practical Exercises

- Diversion
  - Redirects flow from endangered area
    - Existing curbs
    - Curvature of roadway
    - Dirt berms
    - Spill booms
    - Plastic tarps filled with sand, dirt, or clay

Product Control Options/Practical Exercises

- Diversion
  - Diversion methods are not as "permanent" as a dike; can be constructed fairly quickly.
  - Skill drill 11-6: diversion
Product Control Options/Practical Exercises

- **Retention**
  - Creates a defined area to hold material
  - Allows material to collect or pool (e.g., digging a hole)
  - Skill drill 11-7: retention

Product Control Options/Practical Exercises

- **Remote Valve Shut-off**
  - Is a pre-existing shutdown device in system
  - Can be founds in:
    - Chemical processes
    - Piped systems that carry chemicals
    - Cargo tanks

Product Control Options/Practical Exercises

- **MC-306/DOT-406 Cargo Tank**
  - Carries flammable liquids, explosives, poisons
  - Has various safety features
  - Has remote shut-off valve
The remote shut-off valve is typically found near the front of the cab, adjacent to the driver’s door, or at the rear of an MC-306/DOT-406 cargo tank.

Product Control Options/Practical Exercises

MC-307/DOT-407 Cargo Tank
- Carries low-pressure chemicals
  - Flammables
  - Combustible liquids
  - Mild corrosives
  - Poisons
- Has remote shut-off valve

The remote shut-off valve is typically found near the front of the cab, adjacent to the driver’s door, or at the rear of an MC-307/DOT-407 cargo tank.
Product Control Options/Practical Exercises

- MC-331 Cargo Tank
  - Carries compressed liquefied gases
  - Anhydrous ammonia
  - Propane
  - Butane
  - Liquefied petroleum gas (LPG)
  - Has remote shut-off valves

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Product Control Options/Practical Exercises

- The MC-331 cargo tank has remote shut-off valves at both ends of the tank, internal shut-off valves, a rotary gauge depicting product pressure, and two top-mounted vents.

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Product Control Options/Practical Exercises

- Vapor Dispersion
  - Spreads out vapors
  - Lowers concentration
  - Is accomplished by using:
    - Hose streams
    - Fans
    - Other ventilation systems
  - Skill drill 11-8: vapor dispersion
Product Control Options/Practical Exercises

- Vapor Suppression
  - Foams used
    - Aqueous film-forming foam (AFFF)
    - Alcohol-resistant concentrates
    - Fluoroprotein foam
    - Protein foam
    - High-expansion foam
  - Skill drill 11-9: vapor suppression

Product Control Options/Practical Exercises

- Vapor Suppression
  - Applying Foam—Several methods
    - Bounce-off method
    - Rain-down method
    - Roll-in method

Product Control Options/Practical Exercises

- Skill drill 11-10: rain-down foam
Product Control Options/Practical Exercises

- Skill drill 11-11: roll-in foam

Product Control Options/Practical Exercises

- Skill drill 11-12: bounce-off foam

Incident Recovery Phase

- Is the transition to the recovery phase
  - Imminent danger has passed
  - Clean-up starts
  - Responsibility for the clean up is assigned
  - Command is handed off to clean-up personnel

- Can involve the fire service
  - May remain on scene during clean up operations
  - If supporting clean-up, must focus on safety
Student Performance Objective

- Given information from discussion, handouts, and reading materials, describe and demonstrate the proper use of confinement and containment techniques for released hazardous materials.

Review

- Product Control Options/Practical Exercises
- Incident Recovery Phase