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.
Objective

Given information from discussion, reading material, and lecture, the student will be able
to describe the key components of the hazardous materials management system and
identify the steps in the Eight-Step Process©.

Overview

• Regulatory definitions
• Laws and regulations
• Consensus standards
• The management systems approach—elements
• The Eight-Step Process©
Regulatory Definitions

• Hazardous materials pose an unreasonable risk to safety, health, and property when transported.

DOT definition

Regulatory Definitions

• Hazardous materials are capable of creating harm to people, the environment, and property.

U.S. code definition

Regulatory Definitions

• Hazardous chemicals are chemicals posing risk to employees.

OSHA definition
**Regulatory Definitions**

- Hazardous substances are designated in CWA and CERCLA as posing a risk to waterways and the environment.

EPA definition

**Regulatory Definitions**

- Extremely hazardous substances are hazardous to a community during a spill or release.

EPA definition

**Regulatory Definitions**

- Hazardous wastes are discarded materials regulated due to public health concerns.

EPA definition
Federal Laws

- Resource Conservation and Recovery Act (1976)


- Superfund Amendments and Reauthorization Act (1986)
Laws and Regulations

• Clean Air Act and Clean Air Act Amendments (1990)

Federal Laws

Laws and Regulations

• Oil Pollution Act (1990)

Federal Laws

Laws and Regulations

• Hazardous waste operations and emergency response
• Community emergency planning regulations
• Risk management programs for chemical accidental release prevention
• Hazard communication regulations

Federal Regulations
Laws and Regulations

- Hazardous waste operations and emergency response
  - Hazmat emergency response planning
  - Training requirements for responders
  - Medical surveillance
  - Post-emergency operations
  - Utilization of support personnel
  - Response requirements

HAZWOPER

Laws and Regulations

- Hazardous materials transportation regulations
- Pipeline regulations
- The National Contingency Plan (NCP)
- Facility and modal security regulations

Federal Regulations

Laws and Regulations

- Responder levels of training
  - OSHA: 1910.120
    - First Responder Awareness
    - First Responder Operation
    - Hazardous Materials Technician
    - Hazardous Materials Specialist
    - On-Scene Incident Commander
    - Specialist Employee
    - Skilled Support Personnel
Community Emergency Planning Regulations

State Emergency Response Commissions (SERCs) are responsible for developing a statewide emergency response plan.

Local Emergency Planning Committees (LEPCs) coordinate:
- Local training and planning
- Local emergency response capabilities

The LEPC membership is comprised of:
- Elected state and local officials
- The fire department
- Law enforcement
- Emergency management
- Public health officials
- Hospitals
Laws and Regulations

- Other regulations
  - Risk management programs for chemical accidental release prevention
  - Hazard communication regulations
  - Hazardous materials transportation regulations
  - Pipeline regulations
  - The National Contingency Plan (NCP)
  - Facility and modal security regulations

Most states also have regulatory authority

- The fire marshal’s office
- The department of the environment
- The occupational safety and health administration

Consensus Standards

- NFPA 1072—Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents
Consensus Standards
• NFPA 473—Competence for EMS Personnel Responding to Hazardous Material Incidents

Consensus Standards
• NFPA 475—Recommended Practice for Responding to Hazardous Materials Incidents/Weapons of Mass Destruction

Consensus Standards
• NFPA 1991—Standard on Vapor Protective Ensembles
Consensus Standards

• NFPA 1992—Standard on Liquid Splash Protection Ensembles and Clothing

Consensus Standards

• NFPA 1994—Standard on Protective Ensembles for First Responders to CBRN Terrorism Incidents

Consensus Standards

• Responder levels of training
  > NFPA 1072
    • Awareness
    • Operations—Core Competencies
    • Operations—Mission Specific Competencies
    • Hazardous Materials Technician
    • Hazardous Materials Technician with Specialty
Consensus Standards

- Responder levels of training
  - NFPA 1072
    - Incident Commander
    - Specialist Employee (C, B, A)
    - Hazardous Material Officer
    - Hazardous Material Safety Officer

Consensus Standards

- Standard of care
  - The standard of care represents the minimum accepted level of service.
  - Standard of care is established by:
    - Existing laws and regulations
    - Voluntary consensus standards and recommended practices
    - Local protocols and practices
    - Legal findings and case law precedents

The Management Systems Approach—Elements

- Elements of a hazardous materials management systems approach:
  - Planning and preparedness
  - Prevention
  - Response
  - Clean-up and recovery
The Eight-Step Process®

- The Eight-Step Process is a methodology for structuring responses to hazardous materials incidents

- Critical factors in the first hour of the incident:
  - Establishment of Command and Control
  - Ability to read "clues" to hazmat involvement
  - Ability to gain control and isolate those near the incident from the hazard

- 911 dispatchers are trained to gather critical information:
  - Location
  - Information based on reports
  - Product information
  - Unusual behavior and events
  - Casualties
  - Suspicious activities
The Eight-Step Process

• Overview of the Eight-Step Process
  ➢ Site Management and Control
  ➢ Problem Identification
  ➢ Hazard/Risk Assessment
  ➢ Selection of PPE
  ➢ Information Management and Resource Coordination
  ➢ Implementation of Response Objectives
  ➢ Decontamination and Clean-up
  ➢ Termination of Incident

Step 1: Site Management and Control

• Function
  ➢ Securing the physical location

• Goal
  ➢ Establish a safe area for response operations

Step 2: Problem Identification

• Function
  ➢ Recognition, identification, verification

• Goal
  ➢ Identify nature and severity of immediate problem
Step 3: Hazard/Risk Assessment

- **Function**: Determine if responders should intervene
- **Goal**: Develop an incident action plan based on analysis of hazards and risks

Step 4: Selection of PPE

- **Function**: Select PPE based on hazard and risk analysis
- **Goal**: Ensure personnel are protected from hazmat

Step 5: Information Management and Resource Coordination

- **Function**: Effective use of ICS to track information and resources
- **Goal**: Efficient and effective management of information and resources
Step 6: Implementation of Response Objectives

- **Function**
  - Strategies and tactics to make the problem go away
- **Goal**
  - Ensure the incident priorities are addressed in a safe, timely, and effective manner

Step 7: Decontamination and Clean-up

- **Function**
  - Removal of contaminant from personnel, equipment, and supplies
- **Goal**
  - Reduce level of contamination to safe level; prevent secondary contamination

Step 8: Termination of the Incident

- **Function**
  - Transfer of command to Post-Emergency Response Operations (PERO) entity
- **Goal**
  - Proper transfer of responsibility and completion of post-incident administrative functions
Objective
Given information from discussion, reading material, and lecture, the student will be able to describe the key components of the hazardous materials management system and identify the steps in the Eight-Step Process ©.

Review
- Regulatory definitions
- Laws and regulations
- Consensus standards
- The management systems approach—elements
- The Eight-Step Process ©
Objective
Given information from discussion, reading material, and lecture, the student will be able to describe the process of gathering and interpreting relevant hazard and response information from various sources.

Overview
• Collecting and interpreting information
• Reference manuals and guidebooks
• Hazardous materials electronic databases
• Technical information centers
• Technical information specialists
• Hazard communication documents
• Activity 1
• Monitoring instruments
Primary tasks in hazard and risk evaluation:
- Gathering hazard data and information
- Compiling data and information in a useful manner

Information on hazards of various materials is obtained from:
- Reference manuals/response guides
- Digitally stored and online databases
- Technical information centers
- Technical information specialists
- Hazard communication and right-to-know documents
- Monitoring instruments

Different texts may present information in different formats, units of measurement, etc.
- Refer to multiple sources
- Each source has advantages/limitations
Reference Manuals and Guidebooks

• Compare materials before you purchase.
• Digital versions are now commonly available.
• Personnel performing research on materials must become familiar with the resources used.

Hazmat Electronics Databases

• WISER
• CAMEO
• TOXNET
• CRW

Web-based

Hazmat Electronics Databases

• ERG
• CRW
• Downloaded programs
• Stored files/libraries

Digitally stored
Technical Information Centers

- Clearinghouses for spill notifications
- Advise on chemical hazards
- Can be private or public

Technical Information Centers

- CHEMTREC
- CANUTEC
- SETIQ
- USCG NRC
- ATSDR
- National Pesticide Information Center

Technical Information Specialists

- Establishing relationships with technical information specialists in advance
- Verifying the expertise level of specialists
  - Specialists may have narrow knowledge
  - Container design, toxicology, chemistry, weather
Hazard Communications

Documents

- Right-to-know regulations and hazard communication

Globally Harmonized System (GHS)—classification and labeling of chemicals
- Hazard communication to be inline with GHS
- Safety Data Sheets (formerly MSDS) formatted into 16 sections
- GHS fully implemented in 2015

Sections

1: Product and Company
2: Hazard Identification (per GHS)
3: Composition/Ingredients
4: First-Aid
5: Firefighting
6: Accidental Release
7: Handling/Storage
8: Exposure Control/Personal Protection
**Activity 1**

- Students will work in groups to review GHS-Safety Data Sheets assigned by the instructor.
- Students will review and compare that information for that chemical contained in the ERG and NIOSH Pocket Guide.
- A spokesperson for each group will give a 3-5 minute presentation.
Monitoring Instruments

• Direct-reading instruments
  - Corrosive monitors
  - Radiation monitors
  - Oxygen monitors
  - Combustible gas indicators
  - Colorimetric tubes
  - Toxic gas sensors
  - Photo ionization detectors
  - Flame ionization detectors
  - Infrared spectrometry

Monitoring Instruments

• Direct-reading instruments
  - Determine the presence of a chemical
  - Identify and/or classify
  - Establish appropriate PPE
  - Identify hazard control zones
  - Determine protective actions
  - Assess potential health effects
  - Determine scene safety
Monitoring Instruments

- Direct-Reading
  - Real time sampling
  - Various atmospheres

- Instrument considerations
  - User friendliness
  - Lag time (instrument response time)
  - Recovery time
  - Sensitivity/selectivity

- Instrument considerations
  - Lower detection level (LDL)
  - Calibration process
  - Correction factor (relative response curve)
  - Inherent safety
Safety considerations during monitoring
- Two-personnel teams
- Back-up teams in equal level of protection
- Protection of instruments
- Monitoring strategy
- Approaching from upwind

Priority areas
- Confined spaces
- Low-lying areas
- Areas behind barriers
- Areas where heavier-than-air vapors accumulate

To detect radiation
- Use a radiation survey monitor

Strategy for identifying and classifying unknowns
Monitoring Instruments

• To detect flammability; an oxygen enriched/deficient atmosphere
  ➢ Use a multi-gas detector

• To detect toxicity
  ➢ Use a photo-ionization detector

• To detect corrosivity
  ➢ Use pH paper
Objective

• Given information from discussion, reading material, and lecture, the student will be able to describe the process of gathering and interpreting relevant hazard and response information from various sources.

Review

• Collecting and interpreting information
• Reference manuals and guidebooks
• Hazardous materials electronic databases
• Technical information centers
• Technical information specialists
• Hazard communication documents
• Activity 1
• Monitoring instruments
Lesson 2-1: Estimating Outcomes and Area of Potential Harm

Objective
Given information from discussion, reading material, and lecture the student will be able to estimate outcomes of a hazardous materials incident, identify the area of potential harm, and obtain accurate weather information.

Overview
- Estimating potential outcomes
- Predicting the area of potential harm
- Obtaining local weather conditions
- Activity 1
- Activity 2
**Estimating Potential Outcomes**

Key factors for estimating outcomes

- Size and dimension of engulfed area
- Exposures (victims, property, systems) within engulfment area
- Concentration of substance
- Extent of hazards
- Areas of potential harm

---

**Event Response**

- **Stress**: Influence applied stress
- **Breach**: Influence breach size
- **Release**: Influence quantity released
- **Engulfment**: Influence size of danger zone
- **Impingement**: Influence exposure impingement
- **Harm**: Influence severity of injury

---

**Applied Force**

- Types
  - Thermal stress
  - Mechanical stress
  - Chemical stress
Breach Event

- The opening up of a container when the container is stressed beyond limit

Release Event

- Occurs once a container is breached.

Engulfing Event

- The travel and/or dispersal of the product and will define the primary danger zone and exposures
Impingement

- Contact of the hazard with exposures.
- May or may not cause harm.
- Harm is dose dependent.

Harm

- The effects of exposures on people, property, and systems

Factors affecting level of harm

- Timing of the release
- Size of the dispersion
- Lethality of substance
Determining the amount of product

- Shipping paper, bills of lading, etc.
- Fixed gauges
- Weight of small, non-bulk containers
- Use of infrared cameras

Determining container pressure

- Fixed gauge or inserted gauge on controlled sample line
- Temperature

Predicting the movement of airborne contaminants

- Emergency Response Guidebook
- Computer dispersion models
- Portable/fixed air monitoring systems
Obtaining Local Weather Conditions

- Dispatch centers and emergency operations centers (EOCs)
- The state’s emergency management agency
- Online weather specialists
- Weather radios
- Portable weather stations

Activity 1

- Students will determine initial isolation distances based on the incident in the scenario.
- Students will initiate site management and control steps.

Activity 2

- Students will use the GHBMO model to evaluate and determine a probable sequence of events and harm that could result at an incident.
- Students will use hazardous material references to confirm the initial isolation distances and to identify incident objectives and potential mitigation strategies.
**Objective**

Given information from discussion, reading material, and lecture, the student will be able to estimate outcomes of a hazardous materials incident, identify the area of potential harm, and obtain accurate weather information.

**Review**

- Estimating potential outcomes
- Predicting the area of potential harm
- Obtaining local weather conditions
- Activity 1
- Activity 2
Lesson 2-2: Toxicology, Health Risks, and Chemical Properties

Objective
Given information from discussion, reading material, and lecture, the student will be able to define various toxicological terms and exposure values, describe various toxicological principles and the health risks associated with exposure to chemical/biological agents, and describe various chemical properties.

Overview
- Toxicological terms and principles
- Types of harm
- Exposure values
- Radiation terms and principles
- Chemical and biological agents
- Chemical properties
Toxicology Terms and Principles
• What is toxicology?
  ➢ The study of chemical and physical properties that affect biological systems

Toxicology

Toxicology Terms and Principles
• What is toxicity?
  ➢ The ability to affect biologic tissue

Toxicity

Toxicology Terms and Principles
• Chemical Agents
  • Gases
  • Vapors
  • Dusts
  • Fumes

Chemical Agents
Physical Agents

Toxicology Terms and Principles
• Hot/Cold
• Radiation
• Noise

What is exposure?
• Exposure is contact with a chemical
  ➢ Inhalation
  ➢ Ingestion
  ➢ Injection
  ➢ Skin absorption
  ➢ Direct contact

Acute Exposure
• Results from a single, significant dose
Chronic Exposure

• Results from a small dose administered repeatedly over time
  ➢ Long-term exposure in an industrial environment
  ➢ Long-term remedial clean-up operations

Acute Effect

• An immediate biological response to:
  ➢ A small dose of a highly toxic substance
  ➢ A large dose of a less toxic substance

Chronic Effect

• A long-term health condition after exposure that persists and often worsens
• Chronic effects can result from either
  ➢ A single dose (delayed)
  ➢ Repeated doses over time
Dose = Concentration × Time

Toxicology Terms and Principles

- Dose
  - Concentration or amount over a specific period of time

Dose/Response Curve

- Magnitude of biological response
  - Concentration affects the site of action (target organ)
  - Concentration is a function of dose
  - Dose/response is a cause/effect relationship
**Toxicology Terms and Principles**

- **Local effect**
  - Effect at the point of contact

- **Systemic effect**
  - Enters the bloodstream and attacks target organs

**Measurement**

- **Airborne**
  - Parts per million (ppm) \( \text{ppm} = \frac{\text{mg/m}^3 \times \text{molecular weight}}{24.45} \)
  - Parts per billion (ppb)

- **Solid**
  - \( 1 \text{ mg/kg} = 1 \text{ ppm} \)
  - \( 1 \text{ µg/kg} = 1 \text{ ppb} \)
Toxicology Terms and Principles

- Liquid
  - 1 mg/l = 1 ppm
  - 1 µg/l = 1 ppb

Types of Harm

- Thermal
- Radiation
- Asphyxiation
- Corrosive
- Biological
- Mechanical
- Poisonous

Exposure Values

- Specified threshold amounts of given substances
- Guidelines published by various sources
- Not absolute boundaries between safe and unsafe
Exposure Values

• Can help to determine
  ➢ Isolation distances
  ➢ Hazard control zones
  ➢ Protective actions

Factors that influence toxicity

• Concentration or dose
• Rate of absorption
• Rate of detoxification
• Rate of excretion
• Miscellaneous

Measuring Toxicity

• Measuring toxicity
  ➢ Ability to injure tissue
  ➢ Extrapolation of testing on animals to humans
  ➢ Common units of measurement
    ➢ Lethal dose
    ➢ Lethal concentration
### TABLE 2-6 Health Exposure Guidelines

<table>
<thead>
<tr>
<th>Exposure Guideline</th>
<th>Target Group</th>
<th>Sponsoring Organization</th>
<th>Definition</th>
<th>Exposure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threshold Limit Value (TLV)</td>
<td>Workers</td>
<td>ACGIH</td>
<td>Occupational exposure for 8-hour time-weighted concentration</td>
<td>8 hours/day 20 to 30 years</td>
</tr>
<tr>
<td>Permissible Exposure Limit (PEL)</td>
<td>Workers</td>
<td>OSHA</td>
<td>Occupational exposure for 8-hour time-weighted concentration</td>
<td>8 hours/day 20 to 30 years</td>
</tr>
<tr>
<td>Recommended Exposure Limit (REL)</td>
<td>Workers</td>
<td>NIOSH</td>
<td>Occupational exposure for 10-hour time-weighted concentration</td>
<td>8 hours/day 20 to 30 years</td>
</tr>
<tr>
<td>Right To Know Limits</td>
<td>Workers</td>
<td>ACGIH</td>
<td>Occupational exposure for 15-minute time-weighted concentration</td>
<td>15 minutes</td>
</tr>
</tbody>
</table>

### TABLE 2-6 Health Exposure Guidelines (continued)

<table>
<thead>
<tr>
<th>Exposure Guideline</th>
<th>Target Group</th>
<th>Sponsoring Organization</th>
<th>Definition</th>
<th>Exposure Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediately Dangerous to Life or Health (IDLH)</td>
<td>Workers</td>
<td>NIOSH</td>
<td>Concentration poses a dangerous to immediate threat to life or from which escape is possible without permanent damage</td>
<td>No exposure duration</td>
</tr>
<tr>
<td>Level of Concern (LOC)</td>
<td>General public</td>
<td>EPA / FEMA</td>
<td></td>
<td>30 minutes</td>
</tr>
<tr>
<td>Emergency Response Planning (ERPG)</td>
<td>General public</td>
<td>AIHA</td>
<td>Three-tiered emergency planning guideline for emergency response estimate based on 1/10th of the published IDLH</td>
<td>1 hour</td>
</tr>
<tr>
<td>Acute Emergency Exposure Guideline (AEGL)</td>
<td>General public</td>
<td>National Research Council—Committee on Toxicology</td>
<td>Three-tiered emergency guideline for emergency response for five different exposure durations</td>
<td>10 minutes, 30 minutes, 1 hour, 4 hours, 8 hours</td>
</tr>
</tbody>
</table>

### IDLH Indicators

- Outside/open air
- Visible vapor cloud
- Release from a bulk container or pressure vessel
- Large leaks of high vapor pressure liquids or pooled liquefied gases
Indicators of an atmosphere that is likely IDLH:
- Inside/limited air
  - Below grade rescues and/or releases
  - Confined spaces
  - Leaks in areas where barriers may trap vapors/gases

Non-ionizing radiation is low-energy radiation.

Ionizing radiation creates charged particles where absorbed and has harmful effects.
Types of Radiation

- Alpha
- Beta
- Gamma
- Neutron

Alpha Particles

- Are easily shielded (paper)
- Travel 3” to 4”
- Are only harmful if ingested or inhaled

Beta Particles

- Can penetrate paper and skin, but not organs
- Can travel several yards
- Are an internal and external hazard depending on the source
- Can be shielded by glass, plastic, or foil
Radiation Terms and Principles
• Most dangerous form of common radiation
• Travel at high speed and over great distances
• Penetrate human tissue and organs
• Penetrate most materials

Gamma Rays

Radiation Terms and Principles
• Travel at high speed
• Are emitted by few natural sources
• Result from cosmic rays interacting with gas molecules

Neutron Particles

Radiation Terms and Principles
• Half-life
 ➢ The time it takes radioactive activity to decrease to one-half of its initial value through radioactive decay.
Radiation Terms and Principles

<table>
<thead>
<tr>
<th>Radioisotope</th>
<th>Half Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polonium-215</td>
<td>0.0018 seconds</td>
</tr>
<tr>
<td>Bismuth-212</td>
<td>60.5 seconds</td>
</tr>
<tr>
<td>Sodium-24</td>
<td>15 hours</td>
</tr>
<tr>
<td>Iodine-131</td>
<td>8.07 days</td>
</tr>
<tr>
<td>Cobalt-60</td>
<td>5.26 years</td>
</tr>
<tr>
<td>Sodium-226</td>
<td>1600 years</td>
</tr>
<tr>
<td>Uranium-238</td>
<td>4.5 billion years</td>
</tr>
</tbody>
</table>

Half-life of various radioactive sources

Exposure
- The receipt of radiation energy from an emitting source

Contamination
- The attachment or internalization of the emitting source to/in the body

Minimizing radiation exposure
- Time
- Distance
- Shielding
Radiation Terms and Principles

- Terms
  - Counts per minute (CPM or kCPM)
  - Dose
  - Dose equivalent

Radiation Terms and Principles

- Units of measurement
  - Rad (U.S.) and gray (International)
  - Roentgen
  - Roentgen equivalent in man (rem) (U.S.) and sievert (Sv) (International)

Chemical and Biological Agents

- Disease-producing organisms
- Bacteria
  - Anthrax
  - Cholera
  - Plague
  - E. coli
- Viruses
  - Smallpox
  - Viral hemorrhagic fever

Pathogens
Toxins

- Produced by biological sources
  - Ricin
  - Botulinum
  - T2 Mycotoxins

Chemical agents

- Designed for warfare (terrorism)
- Incapacitate and/or kill
- Categorized as
  - Nerve agents
  - Choking agents
  - Blood agents
  - Vesicants or blister agents
  - Antipersonnel agents

Nerve agents

- Organophosphate agents that affect the nervous system
- Can cause death in minutes
  - Tabun (GA)
  - Sarin (GB)
  - Soman (GD)
  - VX
**Chemical and Biological Agents**

- Damage membranes of the lungs
  - Chlorine
  - Phosgene

**Choking Agents**

- Consist of a cyanide compound
  - Hydrogen cyanide
  - Cyanogens chloride

**Blood Agents**

- Attack exposed skin and mucous membranes
  - Mustard
  - Lewisite
  - Phosgene oxime

**Vesicants/Blister Agents**
Chemical and Biological Agents

- Cause pain or burning on exposed mucous membranes and skin
  - Mace
  - Pepper spray
  - Tear gas

Persistence

- The amount of time an agent remains as a liquid
- An agent is “persistent” if it remains as liquid longer than 24 hours.
- Examples of persistent agents are
  - VX (nerve)
  - Tabun (nerve)
  - Lewisite (blister)
  - Mustard (blister)

Chemical Properties

- Define products’ characteristics
- Indicate the hazards associated
- Show responders what to look for to determine the presence of chemicals
- Can help responders identify an unknown
- Inform responders of potential reactions
- Indicate how the product will move
**Chemical Properties**

- Chemicals differ in the amount of energy required to ionize.
- A photo-ionization detector (PID) measures electron volts (eV) with a UV lamp.
- PIDs detect the most volatile organic compounds (VOCs) and some inorganic compounds.

**Ionization Potential (IP)**

**Chemical Properties**

- The ratio of the density of a substance to that of water.
- Liquids with specific gravity of more than 1.0 tend to sink in water; liquids with a specific gravity of less than 1.0 tend to float.

**Specific Gravity**

**Chemical Properties**

- Ratio of a gas's density to the density of air.
  - Vapor density over 1.0, gas tends to stay low.
  - Vapor density less than 1.0, gas tends to rise.

**Vapor Density**
Vapor Pressure

• Is the pressure of the vapor resulting from evaporation of a liquid (or solid)
• Is measured in mmHG or atm
• High vapor pressure means vapor is "jumping out at you"
• Increase as temperature increases

Vapor Pressure of Various Liquids

<table>
<thead>
<tr>
<th>Substance</th>
<th>Vapor Pressure (kPa)</th>
<th>Vapor Pressure (mmHg)</th>
<th>Temperature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tungsten</td>
<td>100 Pa</td>
<td>0.75</td>
<td>3203°C</td>
</tr>
<tr>
<td>Ethylene glycol</td>
<td>500 Pa</td>
<td>3.75</td>
<td>20°C</td>
</tr>
<tr>
<td>Water (H₂O)</td>
<td>2.3 kPa</td>
<td>0.023</td>
<td>20°C</td>
</tr>
<tr>
<td>Propane</td>
<td>2.4 kPa</td>
<td>0.024</td>
<td>30°C</td>
</tr>
<tr>
<td>Ethanol</td>
<td>5.83 kPa</td>
<td>0.046</td>
<td>38°C</td>
</tr>
<tr>
<td>Methanol</td>
<td>2.86 kPa</td>
<td>0.021</td>
<td>35°C</td>
</tr>
<tr>
<td>Acetone</td>
<td>37.9 kPa</td>
<td>0.279</td>
<td>20°C</td>
</tr>
<tr>
<td>Acetaldehyde</td>
<td>98.7 kPa</td>
<td>0.787</td>
<td>20°C</td>
</tr>
<tr>
<td>Chlorine</td>
<td>2.2 kPa</td>
<td>0.16</td>
<td>20°C</td>
</tr>
<tr>
<td>Formaldehyde</td>
<td>435.7 kPa</td>
<td>3.27</td>
<td>30°C</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>1.25 MPa</td>
<td>12.55</td>
<td>25°C</td>
</tr>
<tr>
<td>Carbon dioxide</td>
<td>5.7 MPa</td>
<td>42°C</td>
<td>25°C</td>
</tr>
</tbody>
</table>

Flammability

• Flammable range is the spectrum of mixtures of product to air at which a product will burn
  - Lower explosive limit
  - Upper explosive limit
Chemical Properties

- The lowest temperature at which a product vaporizes enough to form an ignitable mixture in air

Flash Point

Reactivity

- Oxidation ability
- Water reactivity
- Air reactivity
- Chemical reactivity
- Polymerization
- Catalyst
- Inhibitor
- SADT
- Maximum safe storage temperature
- Catalyst
- Inhibitor

 Objective

Given information from discussion, reading material, and lecture, the student will be able to define various toxicological terms and exposure values, describe various toxicological principles and the health risks associated with exposure to chemical/biological agents, and describe various chemical properties.
Review

• Toxicological terms and principles
• Types of harm
• Exposure values
• Radiation terms and principles
• Chemical and biological agents
• Chemical properties
Objective
Given information from discussion, reading material, and lecture, the student will be able to describe the importance of pre-incident planning of facilities, areas, and processes that present hazardous materials risks, and identify the safe operating practices and procedures that must be followed during responses to hazardous materials incidents, including safety precautions during search/rescue operations.

Overview
• Pre-incident planning
• Safe operating practices and procedures
• Medical surveillance
• Environmental exposure
• Activity 1
Pre-incident Planning

- Pre-incident plans identify specific problems, processes, or locations.
  - A pre-incident plan may concentrate on a particular type of tank.
- Response information is gathered prior to the incident.

Pre-incident Planning

- There are mechanisms to:
  - Gather information
  - Compile information
  - Maintain information
  - Produce that information during an emergency

Pre-incident Planning

- May need to be developed for facilities that
  - Present high risk to the community
  - Support national security
  - Are economically sensitive
  - Are in environmentally sensitive areas
  - Have poor water supplies
  - Will require large quantities of foam concentrate
  - Have restricted access or are hard to access

Special preplans
Pre-incident Planning

- Hazardous materials inventory
- The presence/amount of explosives
- Isolation and evacuation distances
- Extinguishing agents
- Drainage and secondary containment
- Special atmospheres
- The facility's emergency response plan

NFPA 1620

Pre-incident Planning

- Initial response/initial actions
- Specialized operations, processes, & hazards
- Construction
- Building features
- Management contact
- Utilities
- Elevators

NFPA 1620

Pre-incident Planning

- Security systems
- Means of egress
- Emergency response capabilities
- Water supply
- Fire protection systems

NFPA 1620
Pre-incident Planning

• Developed and funded by OSHA and the EPA
• When completed, satisfies HAZWOPER
• Is site specific

Pre-incident Planning

• A preplan should include:
  ➢ A simple plot plan
  ➢ Any special plans prepared by the facility

Preplanning
Pre-Incident Planning

Emergency Response Plans

Safe Operating Practices & Procedures

- Incident Management System (IMS)
- Site Safety Plan
- Safety Officer and Assistant Safety Officer (HM Group)
- SOP/Response Plan Checklist

Tools for the HMIC

To begin the process of assembling a site safety and control plan, the IC (or a combination of players, such as the IC and/or assistant safety officer or hazmat group supervisor, depending on your jurisdiction) will need to understand the nature of the problem in order to craft reasonable incident objectives.
The site safety and control plan
- Is prepared by the HM group supervisor (or branch director)
- Is reviewed with all HM group members
- Will be completed prior to taking action in the exclusion zone
- Specifies the nature of the problem
- Includes a map of the scene
- Identifies resources

Outlines incident objectives
- Identifies strategies
- Assigns tactical objectives
- Defines the operational period
- Includes an incident organizational chart
- Specifies safe work practices and emergency procedures
- Will be reviewed during the safety/operational briefing

Objectives
- Tasks
- Safety Issues
- Escape plans/procedures
- Signs/symptoms of exposure
- Back-up team coordination
- Decon coordination/procedures

Review the site safety plan
Site Safety and Control Checklist

- Checklist systems include:
  - Stand-alone worksheets
  - Job aids in the Field Operations Guide

Advantages of formal checklists

- Are a simple/reliable method to coordinate info
- Don't panic
- Have institutional memory
- Identify assigned tasks
- List critical activities and action items
- Prioritize actions
- Provide a framework for development of the PIA

For the checklist system to be effective, checklists must be updated on a regular basis.
Safe Operating Practices & Procedures

1. Minimizing personnel in contaminated areas
2. Contamination avoidance
3. Entry, egress, and escape routes
4. Decontamination site layout
5. Task identification
6. Communications
7. Prohibited actions

When are responders most likely to be injured?
- During initial response operations
- During the transition from emergency to clean-up/recovery operations
Three safety practices

• The buddy system
• The back-up team
• Selection and use of the correct PPE

Safety officer responsibilities

• The safety of ALL personnel
• Development of the safety plan/message (ICS Form 208)
• Coordination with the medical unit leader
• Identification and termination of any unsafe practice

Assistant safety officer responsibilities

• The safety of HM group (branch) personnel
• Coordination with the safety officer
• Identification/termination of any unsafe practice
Safe Operating Practices & Procedures

- Assignment of safety officer and safety officer-HM
- Identification of staging areas
- Identification of escape routes
- Identification of withdrawal signals
- Determination of hazard zones
- Maintenance of site security
- Use of proper PPE
- Use of an effective personnel accountability system

Medical Surveillance

- An ongoing, systematic evaluation of individuals at risk of suffering adverse effects of stress or exposure to heat, cold, or hazardous environments.
Medical Surveillance

- The success of any medical program depends on management support and employee involvement.
- NFPA 1582 is the Standard on Occupational Medical Programs for Fire Departments.

Medical Surveillance

Environmental Exposure

- The physical working environment must be constantly monitored.
  - Environmental factors
  - Responder’s susceptibility to environmental conditions
Heat Exposure

- Heat rash
- Heat cramps
- Heat exhaustion
- Heat stroke

Preventing heat emergencies

- Body temperature should be kept below 101°F.
- PPE cooling options include:
  - Air-cooled jackets and suits
  - Ice cooled vests

Exposure to cold

- Wind chill
- Water chill
- Hypothermia
**Environmental Exposure**

* Sources of noise are
  - Pressure relief devices
  - Generators
  - Pumps
  - Machinery

**Activity 1**

* Review the Emergency Response Plans for Blue County and identify the agencies/entities responsible for various functions at a hazardous materials incident.

**Objective**

Given information from discussion, reading material, and lecture, the student will be able to describe the importance of pre-incident planning of facilities, areas, and processes that present hazardous materials risks, and identify the safe operating practices and procedures that must be followed during responses to hazardous materials incidents, including safety precautions during search/rescue operations.
Review

- Pre-incident planning
- Safe operating practices and procedures
- Medical surveillance
- Environmental exposure
- Activity1
Objective
Given information from discussion, reading material, and lecture, the student will be able to describe appropriate techniques for controlling the release of hazardous materials and techniques for confining or otherwise mitigating the hazards associated with a spill/release of hazardous materials.

Overview
- Hazmat control techniques
- Flammable liquid fires
- Flammable gas fires
Hazmat Control Techniques

- Chemical treatment of a spilled substance to create a solid

Solidification

Hazmat Control Techniques

Overflow Damming

- Contaminant
- Water
- 4" pipe
- Upstream
- Downstream
Hazmat Control Techniques

Patching/Plugging

- The reduction of product flow to relieve pressure on over-pressurized containers

Hazmat Control Techniques

Overpacking

Hazmat Control Techniques

- Pressure isolation/reduction
  - The reduction of product flow to relieve pressure on over-pressurized containers
Hazmat Control Techniques

- Pressure isolation/reduction
  - Valve leaks
  - Isolation of pumps/pressure source
  - Venting
  - Scrubbing
  - Flaring
  - Hot-tapping
  - Vent and bum

Methods

Hazmat Control Techniques

- Transfer operations relying on the free flow of a liquid product by gravity, the use of pumps, or pressurization techniques to move the product

Liquid Product Transfer

Hazmat Control Techniques

- Pressure between the damaged tank and the receiving tank is first equalized and a transfer pump is then used to move the contents into the receiving tank.

Gas Transfer Method
Flammable Liquid Fires

- Lack of resources
- Nothing to save
- No exposures

Non-intervention Mode

Flammable Liquid Fires

- Protect exposures
- Allow the fire to burn

Defensive Tactics

Flammable Liquid Fires

- There must be sufficient quantities of the following for uninterrupted attack
  - Water
  - Foam
  - Personnel
  - Specialized equipment

Offensive Tactics
Flammable Liquid Fires

- Types of foam
  - Aqueous film-forming foam
  - Fluoroprotein foam
  - Alcohol-resistant aqueous film-forming foam
  - Film-forming fluoroprotein foam

Flammable Gas Fires

- Material involved
- Nature of hazard (quantity, pressure)
- Container (design, construction, stress upon)
- Area affected
- Exposures
- Resources

Dangerous nature of natural gas

- The most commonly encountered flammable gases are natural gas
  - Methane
  - Propane
  - Butane
**Flammable Gas Fires**

- Time incident started
- Time of arrival of responders
- Probability of confinement

**Important size-up information**

- Layout of the incident
  - Size/type of vessels
  - Stressed/damaged valves and piping
  - Fire protection systems
  - Exposures
- Risk evaluation

**Operational Modes**

- Non-intervention
  - Imminent BLEVE
- Defensive
  - Exposure protection only
- Offensive
  - Primary exposure cooling
  - Source isolation
  - Continuous, uninterrupted attack
Flammable Gas Fires

- Protect primary and secondary exposures
- Isolate source
- Reduce operating pressure
- Permit self-extinguishment
- Control/extinguish secondary fires

Objective

Given information from discussion, reading material, and lecture, the student will be able to describe appropriate techniques for controlling the release of hazardous materials and techniques for confining or otherwise mitigating the hazards associated with a spill/release of hazardous materials.

Review

- Hazmat control techniques
- Flammable liquid fires
- Flammable gas fires
Objective
Given information from discussion, reading material, and lecture, the student will be able to describe techniques to remove contaminants from citizens, response personnel, tools, equipment, vehicles, and structures that have come in contact with a hazardous material and identify the advantages and limitations of those techniques.

Overview
- Decontamination
- Phases and types
- Physical techniques
- Chemical techniques
**Decontamination**

- The physical removal of contaminants from personnel and equipment, preventing the spread of contamination

**Phases and Types**

- **Gross Decontamination**

**Phases and Types**

- Secondary decontamination
  - Ensures removal of contaminants to an acceptable level
  - May be comprised of multiple steps
Physical Techniques

Absorption

Physical Techniques

Adsorption

Physical Techniques

- Brushing/scraping
  - Involves the removal of powdered or solid materials
  - Generally occurs prior to additional decontamination methods
Physical Techniques

• Freezing
  ➢ Solidifying sticky liquids on equipment
Physical Techniques

- Heating
  - Removing contaminants with high-pressure steam/water jets
    - Vehicles
    - Equipment
    - Structures
  - Not used to decontaminate people

Physical Techniques

- Pressurized air
  - Blowing dust or liquid contaminants from crevices in equipment/structures
  - Aerosolization

Physical Techniques

Vacuuming
Physical Techniques
• Evaporation
  ➢ Is allowing the contaminant to “off-gas” until it is gone, particularly if its vapors do not present a hazard
  ➢ Can be used when the contaminant is a high-vapor-pressure liquid or gas

Chemical Techniques
• The use of chemicals or materials to alter the chemical structure of the contaminant
• Used to decontaminate outside surfaces
  ➢ Buildings
  ➢ Equipment
  ➢ Roads
  ➢ Vehicles

Neutralization
Chemical Techniques

- **Solidification**
  - Using commercially available products to encapsulate material
  - A liquid substance is chemically treated so that a solid material results.

Chemical Techniques

- **Disinfection**
  - Inactivating (killing) pathogenic microorganisms

Chemical Techniques

- **Sterilization**
  - Has limited field application
  - Autoclaving (steam)
  - Chemical sterilization
  - Ultraviolet light
Objective
Given information from discussion, reading material, and lecture, the student will be able to describe techniques to remove contaminants from citizens, response personnel, tools, equipment, vehicles, and structures that have come in contact with a hazardous material and identify the advantages and limitations of those techniques.

Review
• Decontamination
• Phases and types
• Physical techniques
• Chemical techniques
Lesson 4-2: Incident Action Plans and Public Protective Actions

Objective
Given information from discussion, reading material, and lecture, the student will be able to develop an incident action plan for a hazardous materials incident and identify appropriate public protective actions based on the hazards and risks presented by the incident.

Overview
• Response objectives and options
• Developing the incident action plan
• Public protective actions
• Activity 1
Response Objectives and Options

• Understanding the Problem
  • What has taken place?
  • What is currently taking place?
  • What is likely to take place in the future?
  • How can we positively influence the chain-of-events?

• Risk
  • The likelihood that something bad is going to happen, factoring in the severity of that event

• Risk Evaluation
  • Crucial for understanding incident potential
Response Objectives and Options

- Magnitude
- Occurrence
- Timing
- Effect
- Location

Motel

Response Objectives and Options

- Offensive
- Defensive
- Non-intervention

Response options

Response Objectives and Options

- Resources
- Training / capabilities
- Potential harm

Criteria for determining operational mode
What is an incident action plan?

- Incident objectives
- Time frames
- Organizational structure
- Hazards
- Assignment of mitigation efforts
- Methods of communication

Developing an Incident Action Plan

- Understand the nature of the problem
- Identify available resources
- Develop incident objectives
- Develop tactical objectives
- Identify an operational period
- Identify the ICS organization players
- Identify emergency procedures/safe work practices
- Conduct a safety and operational briefing

Site safety and control plan

- Incidents objectives
  - Statements of WHAT (not how) the responders are going to accomplish
  - Based on incident priorities
    - Life safety
    - Incident stabilization
    - Environmental/property conservation
Strategic objectives

- Are a broad game plan that specifies what actions will be taken
- Are based on incident objectives
- Must be consistent with the operational mode (offensive, defensive, non-intervention)

Tactical objectives

- Specific actions to achieve strategic goals
- Defined processes to be implemented
- Specific and measurable

Tactical decision-making

- Multiple tactics are required.
- Each tactic has advantages and disadvantages.
- Effective decision-making requires thinking ahead.
- There are fewer options as time passes.
Developing an Incident Action Plan

- Physical barriers
- Distance
- Time
- Techniques

Public Protective Actions

- Strategies used to protect the public from the hazardous material by implementing
  - Protection-in-place
  - Evacuation
  - A combination of the two

Factors in PPA decisions

- What has been released
- How much has been released
- The hazards associated with the product
- Population density
- Time of day
- Weather conditions
- Type of facility
- The availability of airtight structures
**Public Protective Actions**

- Hazardous material involved
- Populations at risk
- The timing of the release
- Meteorological conditions
- Communications capability with the general public and responders
- Responder capability in implementing, controlling, monitoring, and terminating PPA

Evacuate or protect-in-place?

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**Isolation Distances**

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**Public Protective Actions**

- Ideal when
  - Material has already been released.
  - The released material is fast-moving.
  - The leak can be rapidly controlled.

Protection-in-Place
Factors to consider when evaluating structures for protection-in-place
- Age of the building
- Prevailing wind direction
- Building height

When to utilize protection-in-place
- The hazardous material has been totally released from its container and is dissipating.
- The released material forms a “puff” or migrating plume pattern.
- There is a fast-moving toxic vapor cloud that will quickly overtake exposed people.
- Short-duration solid or liquid leaks are present.

Public Protective Actions
- The public must be provided with clear instructions.
- The public must comply with recommendations.
- Protection-in-place requires timely and effective warning.
- There must be a clear rationale between protection-in-place and evacuation.
- Prior public training and education will facilitate protection-in-place procedures during an emergency.
Public Protective Actions

• Controlled relocation of people
  ➢ Limited-scale evacuation
  ➢ Full-scale evacuation

Evacuation

Full-scale evacuations

• Full-scale evacuations involve the relocation of large populations.
• Full-scale evacuations present two major problems:
  ➢ Life safety
  ➢ Expense
• There will be no shortage of critics the day after the evacuation.

Indicators for full-scale evacuations

• Large, prolonged leaks involving flammable and/or toxic gases
• Large quantities of materials that could detonate or explode
• Leaks and releases that are difficult to control and could increase in size or duration
• Releases that cannot be controlled, and people at risk
Public Protective Actions

- Alerting and notification
- Transportation
- Relocation
- Information

Four critical issues during evacuation

World Trade Center

Fukushima, Japan
Public Protective Actions

Limited-scale evacuations

• Implemented when the incident affects 1 or 2 buildings in the vicinity of the incident
• The majority of the evacuations required at hazmat incidents affect a small number of people.
• May be the best option for the IC

Alerting and notification

• Methods will vary depending on
  ➢ Location of the emergency
  ➢ Type of PPA plan and hardware in place
  ➢ Time of day
Alerting methods

Public Protective Actions
- Door-to-door notification
- Loudspeakers/public address systems
- Tone-alert radios
- Emergency alerting system
- Personalized localized alerting network
- Weather radios
- Commercial television and radio

Community emergency response plan
- The plan should spell out who has the authority and responsibility to activate each system.
- Each system component should be tested on a regular basis.
- There should be a layered notification approach to reach the maximum number of people.
- There should be priority notification of those most at risk first.
Activity 1

- Based on the scenario presented and the information that has been gathered thus far, the student will identify incident objectives and determine the strategies that will be used to achieve those objectives.

Objective

Given information from discussion, reading material, and lecture, the student will be able to develop an incident action plan for a hazardous materials incident and identify appropriate public protective actions based on the hazards and risks presented by the incident.

Review

- Response objectives and options
- Developing the incident action plan
- Public protective actions
- Activity 1
Objective

Given information from discussion, reading material, and lecture, the student will be able to identify the levels of chemical protection, describe the processes that can compromise chemical protective clothing, describe various factors affecting personnel performance in hazardous materials garments, and describe special considerations for hazmat personnel operating in confined spaces.

Overview

- Chemical protective clothing
- Hazardous materials in confined spaces
- Activity 1
Three types of protective clothing

- Structural firefighting clothing (SFC)
- Chemical protective clothing
- High-temperature protective clothing

Selecting CPC

- Hostility of the environment
- Tasks to be performed
- Type of protective clothing required
- Capabilities of the user

Hostility of the environment

- Hazardous material involved
- Physical state of the substance
- Hazardous properties of the substance
- Harm that will result from contact
- Physical hazards
- Weather conditions
Tasks to be performed

- Response objectives
- Objectives of entry
- Potential for exposure
  - Type of exposure
  - Level of exposure
  - Duration of exposure

Type of protective clothing required

- Compatibility with chemical
- Chemical resistance
- Integrity of ensemble
- Compatibility with tasks

Capabilities of the user

- Physical stressors
  - Temperature extremes
  - Excessive noise
  - Limited visibility/light
  - Restricted mobility
- Psychological stressors
  - Experience with SCBA/CPC
  - Fear of injury, illness, or death
Chemical Protective Clothing

• Structural firefighting clothing

Choosing CPC

• Primary concerns
  ➢ Chemical resistance
  ➢ Integrity of ensemble
  ➢ Tasks to be performed

Tools to determine the proper ensemble

• Manufacturers’
  ➢ Permeation charts (suits)
  ➢ Degradation charts (boots and gloves)
Chemical Protective Clothing

- CPC should be the responders’ last line of defense

Degradation

- Degradation is physical destruction/decomposition due to
  - Chemicals
  - Use
  - Ambient conditions (e.g., exposure to sunlight)

Degradation

- Visible signs of degradation are:
  - Shrinking
  - Cracking
  - Swelling
  - Dissolving
  - Charring
Chemical Protective Clothing
- Is the flow or movement of chemicals through closures, holes, seams, etc.
- Is caused by:
  - Manufacturing defects/PPE defects
  - Physical damage to the suit (e.g., punctures, abrasions, etc.)
  - Degradation of the garment

Penetration

Chemical Protective Clothing
- Penetration is measured in terms of:
  - Breakthrough time
  - Permeation rate

Permeation

Chemical Protective Clothing
- The movement of a chemical through material at the molecular level
  - Adsorption
  - Diffusion
  - Desorption toward wearer

Permeation
Chemical Protective Clothing

Factors affecting permeation

- Temperature
- Thickness
- Mixture of chemicals
- Previous exposures
Safety Considerations

• Air management
• PPE/CPC maintenance
• Entry/back-up crew in equivalent level of CPC
• Two-in/two-out
• Rapid intervention team(s)
• Situational awareness
• Contingency plans
• Radio communication with hand-signal back-up
Chemical Protective Clothing

- Must be constantly monitored
  - Heat
  - Cold

Susceptibility to the Environment

- Fitness
- Ability to acclimate to the elements
- Age
- Level of hydration
- Weight
- Alcohol and drug use (including prescription drugs)
- Illness, infection, allergies, or disease

Hazardous Materials in Confined Spaces

- Confined space is any area that meets the following criteria:
  - There is limited or restricted means of entry or exit.
  - Employees can physically enter the space.
  - The space is not designed for occupancy.
Hazardous Materials in Confined Spaces

- Toxic
- Oxygen deficient
- Oxygen enriched
- Flammable

Four Hazardous Atmospheres

Hazardous Materials in Confined Spaces

- Limited egress
- Extensive travel distances
- Physical hazards
- Darkness
- Poor communications

Confined space hazards

Hazardous Materials in Confined Spaces

- OSHA defines permit-required confined space as having one or more of the following characteristics:
  - Contains or could contain a hazardous atmosphere
  - Contains material that has the potential for engulfing the entrant
  - Has inwardly converging walls
  - Has any other recognized safety or health hazards

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  - Has any other recognized safety or health hazards
Hazardous Atmosphere

- Any atmosphere that may expose employees to risk of death, incapacitation, impairment of ability to self-rescue, injury, or acute illness from:
  - Flammable vapor > 10% of LFL
  - Combustible dust concentration ≥ LFL
  - Oxygen concentration below 19.5% or above 23.5%
  - Potential exposure of toxic substance above PEL
  - Any other condition that creates IDLH

Flammable Atmospheres

- Rescue operations may safely be conducted in flammable atmospheres at concentrations of 10% or below (gas to air)

- Between 10% and 20% concentration, rescue teams may enter provided they have:
  - Proper PPE
  - Respiratory protection
  - Class 1, Division 2 electrical equipment

- Rescue operations in flammable gas atmospheres between LEL and UEL are too dangerous for entry.
Hazardous Materials in Confined Spaces

• Rescue attempts can be made in atmospheres above PEL/TLV if proper PPE and respiratory protection is available.

Questions to Ask Before Entry

• Can the confined space be entered safely?
• Is this operation a rescue or a body recovery?
• Do we have control of the situation and a coordinated IAP?

Activity 1

• Based on the information gathered, the student will determine the appropriate level of protection for various responders.
Objective

Given information from discussion, reading material, and lecture, the student will be able to identify the levels of chemical protection, describe the processes that can compromise chemical protective clothing, describe various factors affecting personnel performance in hazardous materials garments, and describe special considerations for hazmat personnel operating in confined spaces.

Review

• Chemical protective clothing
• Hazardous materials in confined spaces
• Activity 1
Objective
Given information from discussion, reading material, and lecture the student will be able to describe incident management concepts and various elements of the incident management system that are used to coordinate responses to hazardous materials incidents. The student will be able to identify the responsibilities of various positions within the Incident Command System and identify federal entities that have regulatory authority and/or may offer assistance at a hazardous materials incident. The student will be able to describe the steps to implement an emergency response plan.

Overview
• ICS for hazmat incidents
• Federal assistance
• Activity 1
ICS for Hazmat Incidents

- Establishment and management of an IAP
  - Development of ICS structure
  - Development of objectives, strategies, and tactics
  - Information management
  - Resource management

Role of command

ICS for Hazmat Incidents

- Multiple agencies
- Multi-jurisdictional response
- Competing missions
- Mission overlaps/gaps

Major incidents

ICS for Hazmat Incidents

- Fire
- EMS
- HMRT
- Law enforcement
- Public works
- Health department
- Military

Key players
ICS for Hazmat Incidents

- Multi-disciplinary incidents
- Incidents spanning multiple jurisdictions
- Primary agencies’ command-level representatives
  - Lead and supporting commanders
  - Single IAP
  - Resource coordination

Unified command

ICS for Hazmat Incidents

- Public information officer
- Incident safety officer
- Liaison officer

Command staff

ICS for Hazmat Incidents

- Operations section chief
- Planning section chief
- Logistics section chief
- Finance/admin chief

General staff
ICS for Hazmat Incidents

ICS underlying principles

- Unity of command
- Chain-of-command
- Modular design

Incident Safety Officer

- Monitors the safety of all personnel
- Reports to the IC
- Develops a safety plan/message
- Stops any unsafe actions

Assistant Safety Officer (HM)

- Is certified as a HM technician
- Ensures safe procedures within the HM branch/group
- Reports to the safety officer
- Advises on health and safety
- Monitors and documents times in the hot zone
- Coordinates with HM medical
- Stops unsafe actions
ICS for Hazmat Incidents

Public Information Officer (PIO)

- PIO develops/delivers information to the public.
- News media is a major means of communication.
- PIO may be providing critical information.
- IC approves the release of information.

ICS for Hazmat Incidents

Joint Information Centers (JICs)

- Incidents with expansive info requirements
- Information management specialists from multiple agencies
- JICs' mission
  - Consistent information
  - Accurate information
  - Protection of sensitive information

ICS for Hazmat Incidents

Liaison Officer

- Command staff officers
  - Liaison officer is the point of contact for
    - Assisting agencies
    - Cooperating agencies
    - Non-governmental organizations
ICS for Hazmat Incidents

• Implements the IAP
• Reports to the IC
• Is responsible for all tactics
• Assists in development of the IAP (w/IC)

Operations Section Chief

ICS for Hazmat Incidents

• Reports directly to the IC
• Maintains incident documentation
• Monitors resource status
• Tracks situation status
• Develops contingency plans
• Develops the IAP for the next operational period
• Plans and conducts meetings

Planning Section Chief

ICS for Hazmat Incidents

• Reports directly to the IC
• Acquires supplies, facilities, equipment, apparatus, etc.
• Arranges the movement of supplies to operational areas
• May divide responsibilities into a service branch and support branch

Logistics Section Chief
ICS for Hazmat Incidents

- Procurement
- Compensation
- Time documentation
- Claims
- Cost analysis

Finance/Administration Section Chief

ICS for Hazmat Incidents

- Intelligence/investigation may be a fundamental concern in some incidents.
  - Terrorism/WMD
- Intelligence may be deployed as a general staff position or at other levels of the organization.
  - Within operations
  - Within planning

Intelligence Section Chief

ICS for Hazmat Incidents

- Is responsible for all hazmat functions
  - Reports to IC or ops section chief
  - Supervises groups and divisions

Hazmat Branch Director
ICS for Hazmat Incidents

• Groups are functional
  ➢ Entry group
  ➢ Decontamination group
  ➢ Research group

Group/Division Supervisors

ICS for Hazmat Incidents

• Divisions are geographical
  ➢ Division
  ➢ East Division
  ➢ College Park Division

Group/Division Supervisors

ICS for Hazmat Incidents

• Entry team
  ➢ Reconnaissance
  ➢ Mitigation
  ➢ Offensive and defensive operations

• Back-up team
  ➢ Extraction (rescue) of entry team
**Decontamination Team**

- Development of decontamination plan
- Preparation of decontamination area
  - Management of all decon operations
  - Coordination with other teams
    - Entry
    - Medical
    - Monitoring effectiveness of decon

**Information/Research Team**

- Provides technical support
- Gathers, compiles, and analyzes technical information from both public and private agencies
- References multiple sources
- Provides information for:
  - Interpretation of environmental monitoring
  - Evaluation of Public Protective Action options
  - Selection of PPE

**Site Access Control Team**

- Sets up/monitors hazard zones
- Tracks movement in the hot zone
- Manages the safe refuge area
### Federal Assistance

- **Weapons of Mass Destruction Civil Support Teams (WMD-CST)**
  - Are assigned in each state
  - Advise on CBRNE

- **CBRNE Enhanced Response Force Package (CERFP)**
  - Search/rescue
  - Decontamination
  - Medical triage

- **WMD Civil Support Teams (CST)**
  - CBRNE
  - Homeland Response Force
  - USMC

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<thead>
<tr>
<th>Agencies with response capabilities</th>
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<tbody>
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Activity 1

A list of resources that have arrived will be presented to the student. The student will develop an organizational chart of the command and general staffs and staff each position. The student will develop an organizational chart depicting the distribution of resources within the operations section. The class will then be divided into four groups; each group will complete one of the following ICS forms: #202, #203, #204, #208.

Objective

Given information from discussion, reading material, and lecture the student will be able to describe incident management concepts and various elements of the incident management system that are used to coordinate responses to hazardous materials incidents. The student will be able to identify the responsibilities of various positions within the Incident Command System and identify federal entities that have regulatory authority and/or may offer assistance at a hazardous materials incident. The student will be able to describe the steps to implement an emergency response plan.

Review

• ICS for hazmat incidents
• Federal assistance
• Activity 1
Objective
Given information from discussion, reading material, and lecture, the student will be able to describe the methods to determine the progress of a response towards meeting the objectives stated in an incident action plan, the effectiveness of response operations, the process of transferring command of an incident, and the process of making modifications to an incident action plan.

Overview
• Determining the effectiveness of the response
• Modifying the IAP
• Transfer of command
Determining the Effectiveness of the Response

- Other texts, databases, and guides
  - WISER
  - NIOSH Pocket Guide
  - Product-specific guides

- Computer dispersion models
  - ALOHA (in CAMEO)
  - CHARM
  - Other modeling programs
Determining the Effectiveness of the Response

Monitoring conditions

- Compare actual behavior to what had previously been predicted.
  - Plume dispersal
  - Fire containment
  - Vapor concentration
  - Container deformity
  - Leak control
  - Effectiveness of containment

Evaluate the response

- Continually monitor conditions.
- Compare actual behavior to expected behavior.
- Use GHBMO to reassess potential outcomes.
- Actual versus expected behavior
  - General Hazardous Materials Behavior Model (GHBMO)—Ludwig Benner of NTSB
Determining the Effectiveness of the Response

- Size and dimension of engulfed area
- Exposures (victims, property, systems) within engulfment area
- Concentration of substance
- Extent of hazards
- Areas of potential harm

Reassess potential outcomes

Determining the Effectiveness of the Response

- Effective and according to schedule
- Effective and ahead of schedule
- Partially effective, not according to schedule
- Partially effective, not meeting tactical/strategic objectives

Analysis of strategic tactical objectives

Determining the Effectiveness of the Response

- Magnitude
- Occurrence
- Timing
- Effect
- Location

Factors influencing outcomes
Modifying the IAP

• Modification may occur at any level
  ➢ Incident goals
  ➢ Strategy
  ➢ Tactical objectives
  ➢ Tasks

Modifying the IAP

• Availability of resources drives the incident
  ➢ Non-intervention
  ➢ Defensive operations
  ➢ Offensive operations

Modifying the IAP

• Commit resources to the current highest priority.
• Continue providing resources to highest priority until sufficient.
• Move to next higher priority.

Strategies should be prioritized
Modifying the IAP

• Risks change
  ➢ Determining there is no life safety hazard
  ➢ Rescues completed
  ➢ Body recovery
  ➢ Discovery of lives at risk

Life safety

Modifying the IAP

• Risks change
  ➢ Incident has stabilized.
  ➢ Incident has worsened.
  ➢ Incident is worse than previously thought.

Incident stabilization

Modifying the IAP

• Risks change
  ➢ Property has been saved.
  ➢ Damage has already occurred.
  ➢ Property is determined to be of little value.

Property conservation
**Modifying the IAP**

• A key player in evaluating progress
  ➢ Resource status
  ➢ Situation status
  ➢ Intelligence analysis
  ➢ Documentation
  ➢ Contingency plans
  ➢ IAP for the next operational period

**Planning section**

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**Modifying the IAP**

• Modify hazard zones as conditions warrant.
  ➢ Air monitoring
  ➢ Spill containment
  ➢ Migration of product
  ➢ Radiation levels

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**Modifying the IAP**

• Assess effectiveness of decontamination.
  ➢ Sampling of run-off
  ➢ Visual indications of remaining contamination
  ➢ Air sampling
  ➢ pH
  ➢ Radiation sampling
Modifying the IAP

- Assess effectiveness of PPE.
  - Penetration
  - Degradation
  - Permeation
  - Respiratory protection
  - Post-medical screening

- Assess responders' level of training.
- Constantly monitor personnel.
  - Physical condition
  - Stress
  - Fatigue

Transfer of Command

- The assumption of responsibility by the incoming IC/IMT
- Transfer of command as a formal process
- Transfer of authority for the incident
**Transfer of Command**
- To satisfy jurisdiction/agency requirements
- To improve incident efficiency/effectiveness
- To address incident complexity
- To relieve personnel
- To replace the loss of an IC
  - Due to injury, sickness, or personal emergency
- To comply with an agency administrator's order

Why should the transfer take place?

**Conducted face-to-face**
- Situation status
- Progress during operational period
- Current objectives/strategies/tactics
- ICS organization
- Resource status
- Incident facilities
- Communications plan
- Needs
- Safety issues
- Casualties

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Review

- Determining the effectiveness of the response
- Modifying the IAP
- Transfer of command
Objective
Given information from discussion, reading material, and lecture, the student will be able to identify the steps associated with the termination of the emergency phase of the incident, including the process of debriefing, the gathering of relevant information for post-incident analysis, the critique of the incident (including identification of various critique formats), and reporting requirements.

Overview
• Termination of the emergency phase
• Incident debriefing
• Post-incident analysis
• After-action review
• Reporting and documentation
Declaring the emergency phase terminated

• Start of the post-emergency phase
  ➢ Clean-up
  ➢ Restoration
  ➢ Recovery

Termination of the Emergency Response Phase

Mission creep

• The sometimes slow transition from the emergency to post-emergency phase
• Unsafe conditions as personnel let their guard down

Termination of the Emergency Response Phase

1. Declaration that the emergency phase has been terminated
2. Transfer of command to post-emergency response organization (PERO)
3. Debriefing
4. Post-incident analysis
5. Critique/after-action review

The five termination activities
Termination of the Emergency Response Phase

- Is the incident scene dangerous?
- Is the incident scene safe?
- Does PERO require emergency response resources?
- Is the incident scene “totally” safe?
  - Mom test
  - Advice of the HM group supervisor and safety officer

Assessment

Termination of the Emergency Response Phase

- Responsibility will be formally transferred to the responsible party (RP) or PERO

Transfer of responsibility

Termination of the Emergency Response Phase

- The PERO IC briefing will include info on:
  - The nature of the incident
  - Actions taken
  - Hazardous materials involved
  - Safety procedures
  - Documentations
  - Law enforcement
  - AHJ information

Transfer of responsibility
### Incident Commander Responsibilities

- Document time of departure.
- Document contact information.
  - RP
  - Contractors
  - PERO
- Provide IC’s contact information.

### Debriefing

- Is conducted at the end of the emergency phase.
- Should last 15 to 20 minutes.
- Provides information regarding risks and hazards faced.

- Informs responders of:
  - The hazmat involved
  - Broken/damaged equipment
  - Equipment in need of decon or replacement
  - Unsafe conditions
  - The PIA coordinator assignment
  - The potential need for CISD
  - The POC for incident-related concerns
Incident Debriefing

1. Health information
2. Equipment and apparatus exposure
3. The follow-up point of contact (POC)
4. Immediate-action problems
5. A "thank you"

Post-incident Analysis

1. Command and control
2. Tactical operations
3. Resource deployment
4. Support services
5. Plans and procedures
6. Training

PIA sources

- Reports/forms
- Activity logs/incident notes
- Photographs/video/audio
- Air monitoring sampling results
- Organizational chart
- Documented interviews
- Shipping documents
- SDS
- Chemical hazard information
- Responding units/agencies/personnel
After-action Review

- The AAR is a structured, participatory discussion involving the leadership of response agencies.
  - Strengths and opportunities for improvement
  - Lessons learned

AAR format

After-action Review

- The participant-level critique
  - Key player’s review of on-scene activities

AAR format

After-action Review

- The operations-level critique
  - Is a structured review of emergency operations by section chiefs and supervisors
  - Concerns, challenges, unanticipated events, and lessons learned

AAR format
After-action Review

- The group-level critique
  - Is an open forum
  - Concerns constructive comments

Reporting and Documenting

- Incident reports
- Written IAPs
- Injury/illness reports
- Exposure reports
- Post-incident analysis
- After-action review
- Financial impact reports
- Training records
- Chain-of-custody

Types

- Critical in the following situations
  - Assessing liability in lawsuits
  - Cost recovery from responsible parties or state or federal government
  - Workers' compensation litigation
  - Accurate tracking of resources used (billing)
  - Assessment of training needs
  - Needs identification
  - Quality improvement
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