Hazardous Materials Operational

Objectives

Implementing the Response

Given situations involving a hazardous materials release in facility or transportation situations, the operational level first responder shall implement the determined response plan and evaluate its effectiveness.

Defensive Options

- Determine the defensive operations available to accomplish a given response objective.
Defensive Options

OBJECTIVES

➢ Identify the purpose, procedures, equipment and safety precautions necessary for the following techniques
  ▪ Absorption
  ▪ Confinement (dike, dam, diversion & retention)
  ▪ Dilution
  ▪ Vapor dispersion
  ▪ Vapor suppression
  ▪ Remote valve shutoffs

Defensive Control Methods

Defensive Operations

➢ Methods used to contain or confine a spill

➢ All personal must be wearing proper PPE for the hazard

➢ These actions should only be undertaken if it can be done without contacting the product

Defensive Control Methods

Defensive Operations

➢ Confinement
  ▪ Diking
  ▪ Damming
  ▪ Diverting
  ▪ Retention

➢ Absorption
  ▪ Dilution
  ▪ Vapor dispersion
  ▪ Vapor suppression
  ▪ Remote valve shutoffs
Confinement - Diking

Defensive Operations

- Physical confinement of a product using barriers to control its movement

Confinement - Diking

Defensive Operations

- Constructed by forming an embankment
- Begin construction at the farthest point away from the spill and work back to the spill

Confinement - Diking

Defensive Operations

- Used to control releases of a product on land
  - Slow moving or heavy materials can be contained using a circle dike
  - Faster moving materials necessitate a “V” shaped dike
**Confinement - Diking**

- Diking materials:
  - Dirt
  - Boards
  - Roof ladders
  - Pike poles
  - Salvage covers

**Confinement - Damming**

- Barriers built to stop the downstream movement of the material
- Typically built in ditches, streams or creeks

**Confinement - Damming**

- Overflow dams
  - Allows clean water to flow over the top of the dam while collecting the contaminant at the base

- Underflow dams
  - Allows clean water to flow through the bottom of the dam and collects the contaminant on the surface
**Confinement - Overflow Damming**

- For materials with a specific gravity greater than 1
- These materials sink in water

**Confinement - Underflow Damming**

- For materials with a specific gravity less than 1
- These materials float on water
Confinement - Damming Materials

Defensive Operations

- Dirt or sand
- Pipes
  - Should be at least 4” in diameter
  - Larger water flows require larger pipes
  - Multiple pipes may be necessary
  - Place enough pipes to cover two-thirds of the waterway
  - Hard suction can be used in an emergency

Confinement - Diverting

Defensive Operations

- Channeling spilled materials into a containment area or away from exposures
- Can be used on land and water

Confinement - Diverting

Defensive Operations

- Allows the product to be directed to an area where the effects will produce less harm
  - Examples include preventing a product from flowing down a storm drain
- Consider the angle and speed of the flow when constructing a diversion barrier
**Confinement - Retention**

- Temporary containment of a material so that it can be absorbed, neutralized or picked up

**Absorption**

- The process of absorbing or “picking up” a liquid product spill
- Most effective on spills less than 55 gallons
- Booms and pads may be used to absorb materials on the water's surface
Absorption

Defensive Operations

➢ Spread the absorbent material on top of the product or in the direction of its travel

Absorption

Defensive Operations

➢ Absorbent materials include:
  q Dirt
  q Sawdust
  q Absorbent pads
  q Socks
  q Booms
  q Speedy dry

Absorption

Defensive Operations

➢ Consider the compatibility of the absorbent to the spilled product

➢ Understand the types of materials that your absorbents will pick up

➢ Ensure that the absorbent material and the product is disposed of properly
**Dilution**

- Reduces the concentration of the material to a non-hazardous or less hazardous state

**Defensive Operations**

- This method has few practical applications at a hazmat incident, especially for first responders
- It is more likely to increase the volume of the product and create a runoff problem

**Dilution**

- May weaken the original product but not eliminate the hazard
- Fuels, oils and other hydrocarbons are not water soluble and cannot be diluted with water
Vapor Dispersion

Defensive Operations

- Using water spray to direct hazardous vapors away from a certain area

The turbulence created by the stream mixes up the air and reduces the material's concentration

In order to be effective, the material must be water soluble or the vapor cloud must be moveable

Usually used to remove gases that are heavier than air from low lying or enclosed areas

Not a recommended practice unless a life safety hazard situation is present

It is important to determine the identity of the product prior to using this tactic
Vapor Suppression

Defensive Operations

- Reduction or elimination of vapors produced by a spilled hazardous material

Vapor Suppression

Defensive Operations

- Firefighting foams are effective when used on flammable or combustible liquids
- This method significantly reduces the hazards associated with uncontrolled vapors

Vapor Suppression - Selection of Foam

Defensive Operations

- Selection of the proper foam is important for vapor suppression
  - Protein
  - Fluoroprotein
  - Aqueous film forming foam (AFFF)
  - High expansion foam
  - Hazardous materials concentrates
**Vapor Suppression - AFFF**

**Defensive Operations**

- Forms a thin layer which "floats" on the surface of the fuel
- Synthetically produced, detergent based foam

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**Vapor Suppression - AFFF**

**Defensive Operations**

- Self-healing after being disrupted
- Good viscosity at low temperatures
- Can be purchased in alcohol resistant mixtures

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**Vapor Suppression - AFFF**

**Defensive Operations**

- Comes in concentrations of 1% to 6%
  - Polar spills require a 6% mixture
  - Non-polar spills require a 3% mixture
Vapor Suppression - Polar vs Non-Polar

Defensive Operations

- Polar Substances
  - Organic Acids
  - Alcohols
  - Esters
  - Aldehydes
  - Ketones

- Non-Polar Substances
  - Hydrocarbons
  - Amines
  - Nitros
  - Ethers

Vapor Suppression - Protein Foams

Defensive Operations

- Consists of broken down animal proteins
- Not commonly used today
- Produces dense, viscous foam

Vapor Suppression - Protein Foams

Defensive Operations

- Designed to be used only on hydrocarbon fires
- High stability and heat resistance
- Good resistance to burnback
- Non-toxic and biodegradable
Hazardous Materials Operational

**Vapor Suppression - Fluoroprotein Foams**

- Defensive Operations
  - Designed to be used on hydrocarbon fires
  - Can be applied from a distance using the plunge technique

**Vapor Suppression - Fluoroprotein Foams**

- Defensive Operations
  - Utilized in subsurface injection systems
  - Good vapor suppression capabilities and burnback resistance
  - Compatible with dry chemical extinguishing agents
  - Non-toxic and biodegradable

**Vapor Suppression - Hazmat Foams**

- Defensive Operations
  - Detergent based
  - Designed to be used on unignited hazmat spills
**Vapor Suppression - Hazmat Foams**

- Not effective for firefighting applications
- Concentrates were available for acid or alkaline materials
- No longer commercially available

**Vapor Suppression - Med & High Expansion**

- Special purpose foams with a detergent base
- Low water content

**Vapor Suppression - Med & High Expansion**

- Used on pesticide fires, suppression of fuming acid vapors, and firefighting operations in concealed spaces
- Not affected by freezing and thawing
- Poor heat resistance
Vapor Suppression - Med & High Expansion

Defensive Operations

- Prolonged contact with metals should be avoided because concentrate may attack galvanized and raw steel
- Not recommended for the outdoors because the foam blanket can be blown off by a breeze

Vapor Suppression - Application

Defensive Operations

- Whenever possible, use air aspirating nozzles instead of water fog nozzles
- Review your department’s SOPs on foam equipment and application methods

Vapor Suppression - Application Methods

Defensive Operations

- Bounce-off technique
  - Protein foam
  - Fluoroprotein foam
  - Alcohol foam
  - Hazmat foam
**Vapor Suppression - Application Methods**

- Roll-on technique
  - Protein foam
  - Fluoroprotein foam
  - Alcohol foam
  - Hazmat foam

- Rainfall Technique
  - AFFF on hydrocarbon products

**Remote Valve Shutoffs**

- Not typically a tactic used by first responders
- For a limited number of situations this may be the best method of controlling the spill
- Should only be conducted if it does not place the operational level responder in the hot zone
Emergency Shutoffs - Transportation

- Mechanical valves
  - Closes all internal valves within 30 seconds of activation
  - Constructed with corrosion resistant cables and handles

- Hydraulic valves
  - Closes all internal valves when a loss of hydraulic pressure occurs
  - Typically runs off the tractor’s system via a “pig-tail”

- Pneumatic valves
  - Closes all internal valve when a loss of pneumatic pressure occurs
  - Typically runs off the tractor’s system via a “pig-tail”
Emergency Shutoffs - Transportation

Defensive Operations

- Typical locations for shutoffs
  - Behind the driver’s side of the cab
  - Near the control valves

Emergency Shutoffs - MC-306 (DOT-407)

Defensive Operations

Rear Shutoff

Forward Shutoff

Emergency Shutoffs - MC-331

Defensive Operations

Rear Shutoff

Forward Shutoff
Remote Valve Shutoffs - Fixed Facilities

Defensive Operations

- Generally found in facilities with loading and unloading areas

Evaluating Progress

OBJECTIVES

- Understand the methods used to determine the effectiveness of an incident
- Identify the method by which the status of a response should be communicated at an incident
Is the Response Effective?

Evaluating Progress

Two questions to ask:

- Is the incident beginning to stabilize?
  - Continue with operations as implemented

- Is the incident becoming worse?
  - Review the action plan and determine an alternate approach to the situation

Is the Response Effective?

Evaluating Progress

- This question should be addressed throughout the emergency response

- Changing conditions can require a change in tactics to mitigate the incident
  - Leak becomes larger
  - Weather conditions deteriorate
  - Injuries to personnel

Withdrawing from an Incident

Evaluating Progress

- It may be necessary to remove personnel from the incident area if conditions are too dangerous
  - Incident is beyond an operational level response
  - Imminent danger of explosion or BLEVE
  - Potential for massive container failure exists
Communicating Progress

- Follow predetermined communications protocols
- Use the chain of command to relay information
- Keep your dispatch center appraised of the situation

Communicating Emergency Situations

- Review your organization's SOPs
  - Emergency communications message or tones
  - Blasts on the apparatus air horns
  - Other predetermined methods
- All personnel must be familiar with emergency communications procedures

- Emergency communications do not need to follow the chain of command
  - Any delay in notifying the Incident Commander must be avoided
Decontamination

OBJECTIVES

★ Identify ways in which personnel and equipment can become contaminated

★ List the steps involved with a basic decon setup and where it should be located

★ Identify the purpose, advantages and disadvantages of emergency decontamination

Decontamination

OBJECTIVES

★ Understand the following concepts
  ▪ Contamination
  ▪ Secondary contamination
  ▪ Exposure vs. hazard
  ▪ Exposure vs. contamination
Contamination

The transfer of a hazardous material outside of the hot zone in quantities that are greater than what is acceptable and poses a risk to those outside of the hot zone.

Contamination Occurs By...

- Direct contact with the hazardous materials present in the hot zone
- Tools used by hazmat technicians may become contaminated
- Driving vehicles through a contaminated area

Contamination Occurs By...

- Contamination can occur through the dusts, particles, gases, vapors, fumes, mists and runoff of hazardous materials
- Smoke and products of combustion can also be sources of contamination
**Contamination Occurs By...**

**Decontamination**

- Responders may become contaminated if:
  - They walk through a spill
  - Touch the material
  - Come in contact with a vapor cloud

*Always avoid becoming contaminated!*

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**Exposure**

**Decontamination**

The process that occurs when people, equipment or the environment come in contact with a hazardous material.

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**Exposure vs. Contamination**

**Decontamination**

- **Exposure**
  - A person has been subjected to a hazardous material via any of the routes of entry into the body

- **Contamination**
  - Any quantity of a hazardous material that physically remains on people or objects
### Exposures

**Decontamination**

- An exposure’s hazard level depends on the material’s concentration and length of exposure
  - Spills of a less hazardous substance require greater quantities to reach a harmful exposure level
  - Spills of an extremely hazardous substances may only need a small quantity to cause a harmful exposure level

### Secondary Contamination

**Decontamination**

The contamination of people, the environment and equipment outside of the hot zone

- Results from coming into contact with contaminated personnel, equipment or property
- Causes contamination outside the hot zone
- Emergency and standard decon operations prevent this type of contamination
Decontamination

The removal of hazardous contaminants from personnel, equipment, property and the environment

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Basic Decontamination Strategies

- Physical
  - Dilution
  - Absorption
  - Isolation and disposal

- Chemical
  - Chemical degradation

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Physical Decon Strategies - Dilution

- Use water to flush contaminants off people or objects
- The most common method of decon for personnel, equipment and victims
Physical Decon Strategies - Dilution

Decontamination

- Advantages
  - Water is generally cheap, plentiful and easy to apply
- Disadvantages
  - Runoff must be contained and disposed of properly
  - Applying water to water reactive materials can cause greater problems

Physical Decon Strategies - Absorption

Decontamination

- Use an absorbent to pick up a liquid contaminant
- Absorbents are inert materials that have no active properties

Physical Decon Strategies - Absorption

Decontamination

- Advantages
  - Many absorbents are readily available and inexpensive
  - Work well on flat surfaces
- Disadvantages
  - Does not alter the hazardous material
  - Disposal of contaminant is an issue
  - Does not work well on PPE or vertical surfaces
Physical Decon Strategies - Disposal

Decontamination

- Isolation and disposal
  - Items which cannot be decontaminated must be collected and disposed of properly

Advantages
- Disposing of equipment may be simpler than decontaminating it

Disadvantages
- Can become costly when disposing of expensive equipment

Decon Strategies - Chemical Degradation

Decontamination

- Chemical degradation
  - Substances that change the chemical structure of the material
**Decon Strategies - Chemical Degradation**

**Advantages**
- Can reduce cleanup costs
- May also reduce risks present to responders

**Disadvantages**
- Requires knowledge of the interaction between the hazardous material and the material applied to it
- Should never be applied directly to the skin

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**Selecting a Decontamination Site**

**Accessibility**
- Should be adjacent to the hot zone in order to limit the spread of contaminants
- Place decontamination site as close to the incident as possible
- Consider the travel time to the decon area
- Ideally the ground should slope towards the hot zone

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**Lighting**
- Adequate lighting must be provided to prevent injury in the decontamination area

**Surface composition**
- Hard, non-porous surfaces provide the best setup area
Selecting a Decontamination Site

Decontamination

- Salvage tarps or plastic should be used to cover the ground

Selecting a Decontamination Site

Decontamination

- Adequate amounts of water must be available for decon operations

Selecting a Decontamination Site

Decontamination

- Drains and waterways
  - Avoid placing the decon area near storm/sewer drains, streams, ponds, ditches and other waterways
  - If this is not possible, use dikes to provide protection for these areas
Selecting a Decontamination Site

Decontamination

- **Weather**
  - Decon area should be established upwind of the hot zone to prevent airborne contaminants from spreading into “clean” areas.
  - Responders should be protected from inclement weather, such as cold, when donning and doffing protective clothing.

Setting up a Decontamination Site

- **Establish a decon corridor**
  - Located in the warm zone

- **Establish a decon corridor**
  - Should be set up with visible barriers
  - Plastic covering or salvage covers should be used to form the decon area
  - Use basins or pools to collect contaminated water
Setting up a Decontamination Site

Decontamination

- Establish a decon corridor
  - Utilize salvage drums/containers to collect contaminated equipment and protective clothing
  - Low volume, low pressure hoselines should be used for decontamination

- Protective clothing
  - Responders working in the decon area need to be dressed accordingly

- Minimum protection includes firefighting PPE, SCBA and chemical protective gloves

- Chemical protective clothing may be warranted, depending on the substance
Setting up a Decontamination Site - Layout

Decontamination Procedures

Ø Step One
  - Responders discard tools and equipment in a salvage drum or other container

Decontamination Procedures

Ø Step Two (Gross Decon)
  - Use a portable shower or a decon worker to hose down personnel or equipment
Decontamination Procedures

Step Three
- Decon personnel scrub the responder with detergent and water
- Give special attention to easily missed areas

Decontamination Procedures

Step 4
- Protective clothing and SCBA are removed
- Contaminated clothing is packaged

Emergency Decontamination

Immediate removal of dangerous contaminants from:
- Victims who need immediate medical attention
- Responders who have been accidentally exposed to the product as a result of a chemical protective equipment failure
Hazardous Materials Operational

Emergency Decontamination

Decontamination

- Essentially a “gross decon”
- Typically occurs before formal decon can be established

Victims needing immediate medical treatment may not be able to wait for a formal decon setup to be in place
- The individual is quickly washed down
- Emergency decon may be necessary even after formal decon is established

Emergency Decontamination

Decontamination

- Procedures
  1. Remove victim from contaminated area
  2. Wash with flooding quantities of water
  3. Remove all contaminated clothing
  4. Continue to wash the victim
  5. Move victim to an uncontaminated area
  6. Begin first aid procedures
Emergency Decontamination

Decontamination

- Transport to the hospital as soon as the victim is decontaminated
- Advise ambulance and hospital personnel of the contaminant involved

Limitations

- Considered a “quick fix”
- Some of the contaminants may not be removed completely
- Environmental damage may occur from the runoff

Advantages

- The need for immediate treatment of life threatening injuries outweighs the potential disadvantages
Hazmat Operational Review

**OBJECTIVES**

- Describe the role of the Operational level first responder at a hazmat incident
- Identify the steps to be taken by the Operational level first responder at a hazmat incident

Operational Level Responsibilities

Operational level first responders are expected to respond to an incident for the purpose of protecting people, the environment and property from the effects of a hazmat release. This is conducted in a defensive fashion to control the release from a safe distance and prevent it from spreading.
Operational Level Responsibilities

Hazmat Operational Review

Determine the Problem

- Secure the area and deny entry
- Observe conditions
- Survey containers
- Estimate extent of release
- Gather pertinent information
- Attempt to predict course of the material
- Estimate potential harm

Develop a Defense

- Initiate and maintain scene control
- Utilize the Incident Management System
- Determine response objectives and defensive goals
- Choose personal protective equipment
**Implement the Response**

- Perform defensive operations
- Evaluate the effectiveness of the response
- Decontaminate responders
- Terminate the response

**Putting the Pieces Together**

- Control the Scene
- Defensive Operations
- Decontamination
- Incident Management System
- Response Objectives
- Analyze the Scene
- Personal Protective Equipment

**Initiate Scene Control & Safety**

- Immediately isolate the area and deny entry to unauthorized personnel
- Isolation zones and protective action distances should be implemented as soon as that information can be determined
- Utilize the Incident Management System to coordinate operations
Survey the Scene

- Scene conditions
- Identify the type of container involved
- Determine potential exposures
- Look for identifying markings or placards
- Attempt to determine the identity of the material
- Request additional resources as the situation dictates

Determine the Problem

- Collect hazard and response information
  - DOT hazard classes and divisions
  - Chemical and physical properties
  - Use available information resources

Collect Hazard and Response Information

- DOT hazard class properties
- Chemical and physical properties
- Information resources
  - Material Safety Data Sheets
  - Shipping papers
  - Manufacturer or shipper
  - CHEMTREC/CANUTEC
  - DOT guidebook or other reference sources
**Determine the Likely Behavior of the Material**

- Is the material a solid, liquid or a gas?
- How large is the spill/leak?
- What are the weather conditions?
- Is there any danger that the situation will become more unstable?

**Estimate Potential Harm**

- Recognize types of container breaches
- Determine possible health hazards
- Estimate potential harm & implement protective actions
  - Evacuate or protect-in-place effected people

**Plan the Appropriate Response**

- Decide on the type of response action
  - Non-intervention
  - Defensive
- Determine the objectives of the response
  - Rescue
  - Exposure protection
  - Fire extinguishment
  - Confinement of the product
Plan the Appropriate Response

Hazmat Operational Review

- Choose the appropriate defensive actions
  - Diking, damming or diverting
  - Retention
  - Absorption
  - Dilution
  - Vapor dispersion
  - Vapor suppression
  - Remote valve shutoffs

Plan the Appropriate Response

Hazmat Operational Review

- Address safety issues or concerns for responders involved in defensive actions

- Determine the appropriate level of PPE for the material and defensive action
  - Bunker gear
  - Level “B”

Plan the Appropriate Response

Hazmat Operational Review

- Determine decontamination needs
  - Emergency decon
  - Formal decon operations
Implement the Response
Hazmat Operational Review

- Rescue victims if possible
- Take appropriate defensive actions
- Decontaminate response personnel

Terminate the Response
Hazmat Operational Review

- Debrief responding personnel
  - Notify all personnel of the material’s name that they may have been exposed to
  - Provide signs and symptoms of exposure
  - Review any applicable SOPs regarding procedures for handling exposures

- Ensure all contaminated equipment is clearly marked and prepared for cleaning or disposal
Hazmat Operational

REFERENCES


Occupational Safety and Health Administration.  “Hazardous Waste Operations and Emergency Response - 1910.120”.

Prepared By:

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