Hazardous Materials: Managing the Incident

CHAPTER 7

Hazard Assessment and Risk Evaluation

Learning Objectives Overview

- Knowledge Objectives
- Skills Objectives

Introduction (1 of 2)

- The evaluation of hazard information and the assessment of risks is the most critical decision-making point in the successful management of a hazardous materials incident.
- You decide: To intervene or, more often, to not intervene.

Introduction (2 of 2)

- Most responders recognize the need for:
  - Isolating the area
  - Denying entry
  - Identifying the hazardous materials
- Responders need to develop effective analytical and problem-solving skills.

Basic Principles (1 of 2)

- Critical benchmarks
  - Hazard assessment
  - Risk evaluation
- The risk management and evaluation process influences all disciplines within the emergency response community.

Basic Principles (2 of 2)

- Review of incidents and case studies where emergency responders have been injured or killed shows that in most instances, it is not due to their failure to assess and understand the hazard but the failure to adequately evaluate and understand the level of risk involved.

What are Hazards and Risks? (1 of 4)

- Hazards refer to physical and chemical properties of a material.
  - Flash point
  - Toxicity levels
  - Exposure values

What are Hazards and Risks? (2 of 4)

- Risks are those intangibles that are different at every hazmat.
  - Can be successfully managed


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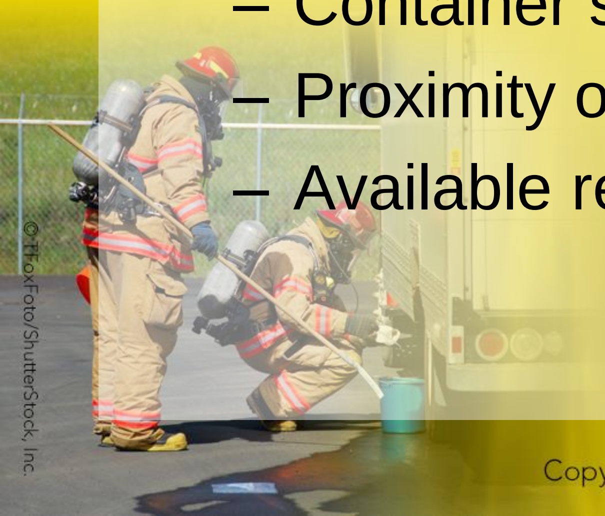
What are Hazards and Risks? (3 of 4)

- Level of risk factors include:
  - Nature of the material(s)
  - Quantity of the material
  - Exposure values
  - Containment system
  - Container stress
  - Proximity of exposures
  - Available resources



What are Hazards and Risks? (4 of 4)

- Hazard and risk evaluation process tasks:
  - Hazard assessment
  - Risk evaluation
  - Development of the IAP

Understanding the Enemy: Physical and Chemical Properties

- Responders must:
  - Identify and verify the materials involved
  - Determine hazards and behavior characteristics
- Safe and effective hazmat response requires responders to understand:
  - How the enemy will behave (Physical)
  - How it can harm (Chemical)
  - Environmental influences

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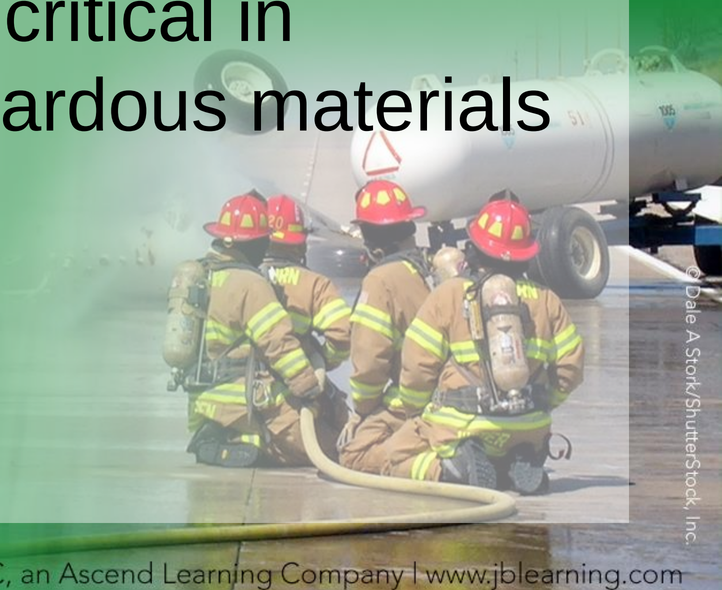
General Chemical Terms and Definitions (1 of 3)

- The following terms are commonly found on safety data sheets and in various emergency response references as part of a material's description or basic chemical make-up.
- Understanding these terms is critical in assessing the behavior of hazardous materials and their containers.



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General Chemical Terms and Definitions (2 of 3)

- Element
- Compound
- Mixture
- Solution
- Slurry
- Cryogenic liquid
- Chemical change
- Chemical interactions
- Ionic bonding

General Chemical Terms and Definitions (3 of 3)

- Covalent bonding
- Organic materials
- Inorganic materials
- Hydrocarbons
- Saturated hydrocarbons
- Unsaturated hydrocarbons
- Aromatic hydrocarbons
- Halogenated hydrocarbons

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Physical Properties (1 of 2)

- Physical properties provide information on the behavior of a material.
  - Normal physical state
    - Solids, liquids, gases
  - Temperature of product
  - Vapor pressure
  - Specific gravity
  - Vapor density
  - Boiling point
  - Melting point

Physical Properties (2 of 2)

- Sublimation
- Critical temperature and pressure
- Auto-refrigeration
- Volatility
- Evaporation rate
- Expansion ratio
- Solubility
- Miscibility
- Degree of solubility
- Viscosity

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Chemical Properties
(1 of 2)

- Chemical properties are the intrinsic characteristics or properties of a substance described by its tendency to undergo chemical change.
- Provide responders with an understanding of how a material may harm

Chemical Properties
(2 of 2)

- Chemical properties include:
  - Toxicity hazards
  - Flammability hazards
  - Reactivity hazards
  - Corrosivity hazards
  - Radioactive materials
  - Chemical and biological agents/weapons

Toxicity Hazards

- Dose
  - Dose = concentration × time
- Dose-Response
  - Biological reaction
  - Degree of harm
  - Can relate to chemical, biological, and radiological doses

Flammability Hazards

- Flammability hazards
  - Flash point
  - Fire point
  - Ignition (auto-ignition) temperature
  - Flammable (explosive) range
  - Toxic products of combustion

Reactivity Hazards
(1 of 2)

- Reactivity/instability
- Oxidation ability
- Water reactivity
- Air reactivity (pyrophoric materials)
- Chemical reactivity
- Polymerization

Reactivity Hazards

- Catalyst
- Inhibitor
- Maximum safe storage temperature (MSST)
- Self-accelerating decomposition temperature (SADT)

Corrosivity Hazards

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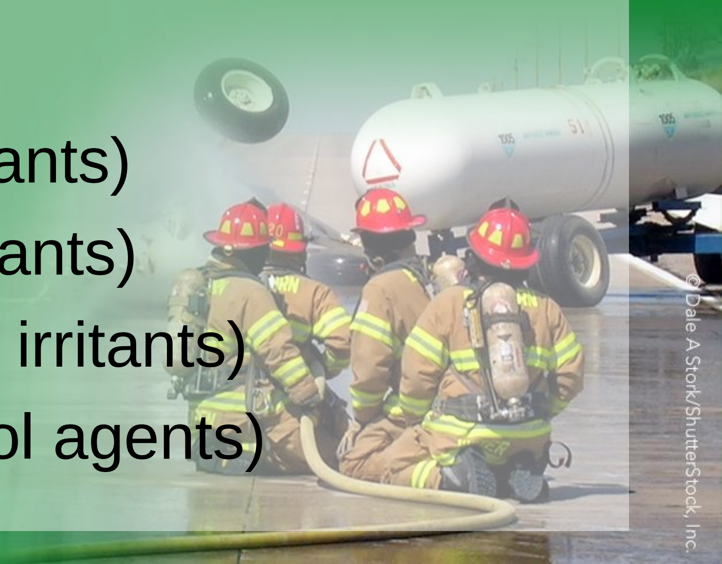
- Corrosivity
- Dissociation
- Acids
- Caustics (base, alkaline)
- pH
- Strength
- Concentration

Radioactive Materials

- Radioactivity
- Activity
- Counts per minute (CPM)
- Dose
- Dose rate
- Half-life

Chemical and Biological Agents/Weapons (1 of 3)

- Biological agents and toxins
- Incubation period
- Infectious dose
- Chemical agents
  - Nerve agents (neurotoxins)
  - Choking agents (respiratory irritants)
  - Blood agents (chemical asphyxiants)
  - Vesicants or blister agents (skin irritants)
  - Antipersonnel agents (riot control agents)



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Chemical and Biological Agents/Weapons (2 of 3)

- Nerve agents
  - Tabun (GA)
  - Sarin (GB)
  - Soman (GD)
  - VX
- Choking agents
  - Phosgene
  - Chlorine

Chemical and Biological Agents/Weapons (3 of 3)

- Blood agents
- Vesicants (blister agents)
  - Mustard (H)
  - Lewisite (L)
  - Phosgene oxime (CX)
- Riot control agents
  - Tear gas or mace (CN)
  - Pepper spray (i.e., capsaicin or OC)
- Persistence

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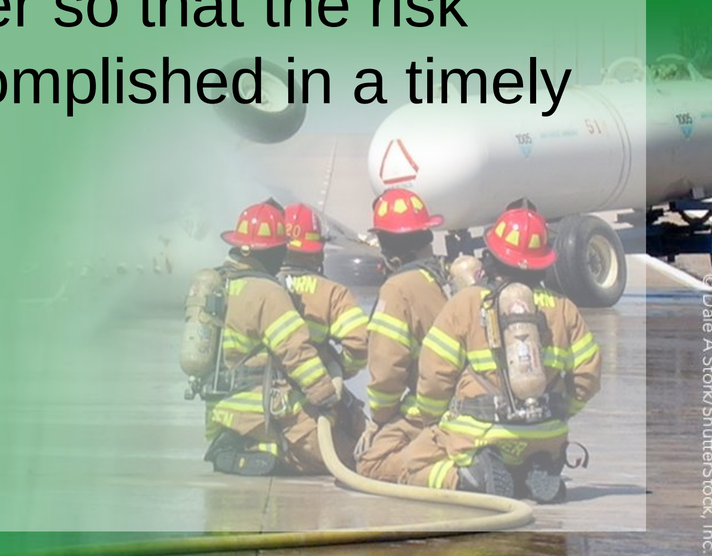
Sources of Hazard Data and Information (1 of 2)

- Two primary tasks within the hazard and risk evaluation process
  - Gather hazard data and information on the materials involved
  - Compile data in a useful manner so that the risk evaluation process can be accomplished in a timely and efficient manner



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Sources of Hazard Data and Information (2 of 2)

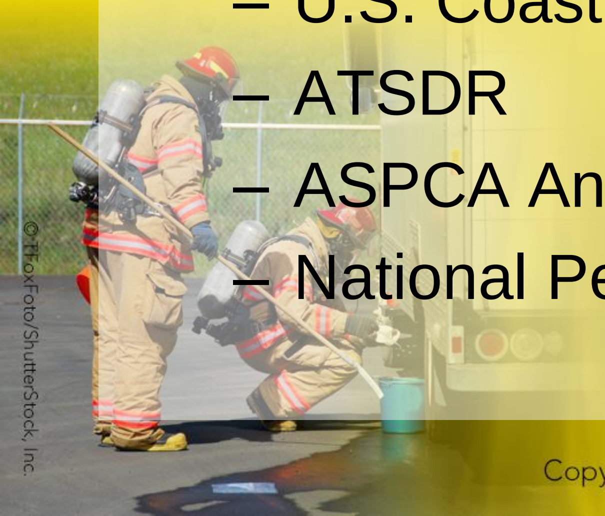
- Hazard data and information sources
  - Reference manuals and guidebooks
  - Technical information centers
  - Hazardous materials databases
  - Technical information specialists
  - Hazard communication and right-to-know regulations
  - Monitoring instruments

Reference Manuals and Guidebooks

- A wide variety of emergency response guidebooks and reference manuals exist.
- Operational considerations:
  - Know how to use the reference material.
  - There may be conflicting information.
  - Be realistic in your evaluation of the data.
  - Always rely on the protective clothing compatibility charts.
  - Electronic versions of response guidebooks are also available.

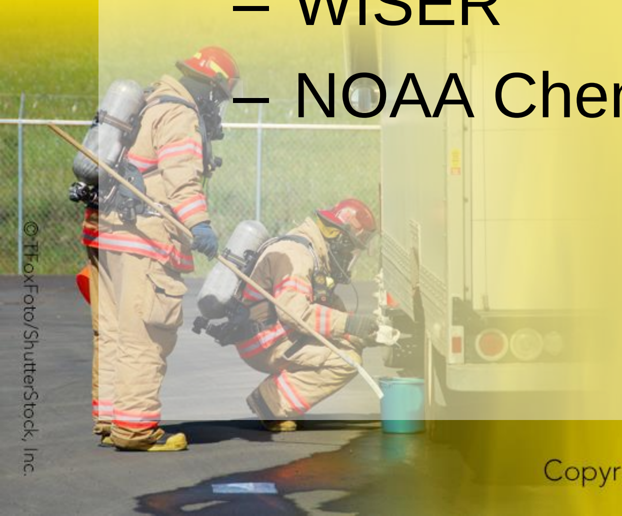
Technical Information Centers

- Private and public sector hazardous materials emergency telephone hotlines:
  - CHEMTREC®
  - CANUTEC
  - SETIQ
  - U.S. Coast Guard NRC
  - ATSDR
  - ASPCA Animal Poison Control Center
  - National Pesticide Information Center



Hazardous Materials Websites and Computer Databases

- Public-based electronic resources include:
  - CAMEO®
  - MARPLOT
  - ALOHA
  - CEPPO
  - WISER
  - NOAA Chemical Reactivity Worksheet



Technical Information Specialists (1 of 2)

- Technical specialists include:
  - Those who either work with the hazardous material(s) or their processing
  - Those who have some specialized knowledge, such as container design, toxicology, or chemistry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Technical Information Specialists (2 of 2)

- Technical specialists:
  - May be specialists in a narrow, specific technical area and lack understanding of the broad, multidisciplinary nature of hazmat
  - Have their own strengths and limitations
  - May have had no previous contact with you
  - Networking and relationships are everything.
  - Local and state “Good Samaritan” legislation may provide legal liability protection for outside representatives.

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Hazard Communication and Right-To-Know Regulations (1 of 4)

- OSHA Hazard Communication Standard (OSHA 29 CFR 1910.1200) has specific requirements pertaining to:
  - Hazard markings
  - Worker access to hazmat information
  - Worker exposures to chemicals in the workplace
- Most right-to-know laws provide emergency responders with access to SDSs.

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Hazard Communication and Right-To-Know Regulations (2 of 4)

- Under the revised GHS requirements, SDSs will be modified into 16 sections:
  - Section 1: Product and Company Identification
  - Section 2: Hazards Identification
  - Section 3: Composition/Information on Ingredients
  - Section 4: First-Aid Measures
  - Section 5: Firefighting Measures

Hazard Communication and Right-To-Know Regulations (3 of 4)

- Under the revised GHS requirements, SDSs will be modified into 16 sections (cont'd):
  - Section 6: Accidental Release Measures
  - Section 7: Handling and Storage
  - Section 8: Exposure Controls/Personal Protection
  - Section 9: Physical and Chemical Properties
  - Section 10: Stability and Reactivity
  - Section 11: Toxicological Information

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Hazard Communication and Right-To-Know Regulations (4 of 4)

- Under the revised GHS requirements, SDSs will be modified into 16 sections (cont'd):
  - Section 12: Ecological Information
  - Section 13: Disposal Considerations
  - Section 14: Transport Information
  - Section 15: Regulatory Information
  - Section 16: Other Information
- Remember current SDSs have no uniform or consistent format or layout.

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Monitoring Instruments

- Monitoring and detection equipment are critical evaluation tools to:
  - Determine hazmat presence
  - Classify or identify unknown hazards
  - Determine PPE
  - Determine hazard control zones
  - Develop protective action recommendations
  - Assess the potential health effects
  - Determine when the incident scene is safe

Selecting Direct-Reading Instruments (1 of 3)

- Real time sampling allows rapid on scene risk evaluation and decision-making.
- Used to detect and monitor:
  - Flammable or explosive atmospheres
  - Oxygen-enriched/-deficient conditions
  - Certain toxic and hazardous gases and vapors
  - Chemical agents
  - Certain biological agents
  - Ionizing radiation

Selecting Direct-Reading Instruments (2 of 3)

- Instrument selection criteria:
  - Portability and user friendliness
  - Instrument response time
  - Sensitivity and selectivity
  - Lower detection limit (LDL)
  - Calibration
  - Correction factors
  - Inherent safety

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Selecting Direct-Reading Instruments (3 of 3)

- Should also evaluate operational, storage and use considerations

Types of Direct-Reading Instruments (1 of 5)

- All direct-reading instruments have inherent limitations.
  - Only on class of chemicals
  - Generally will not detect levels <1 ppm
  - May give false readings
- A reading of zero should be reported as no instrument response rather than clean.

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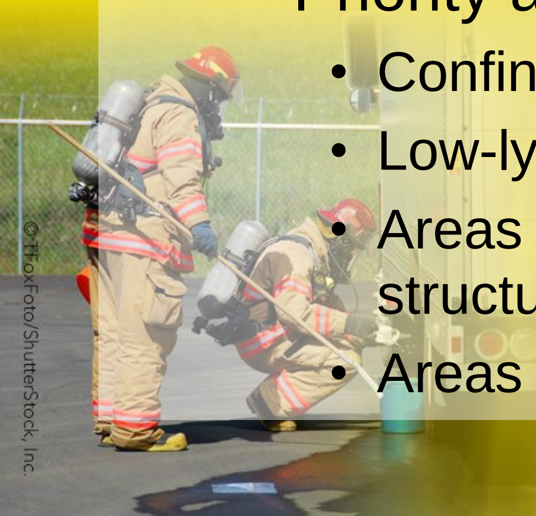
Types of Direct-Reading Instruments (2 of 5)

- Basic safety considerations
  - Monitoring personnel at greatest risk of exposure
  - Team should consist of at least two personnel
  - Protect the instruments
  - Approach the hazard area from upwind
  - Priority areas should include:
    - Confined spaces
    - Low-lying areas
    - Areas behind natural or artificial barriers (e.g., hills, structures, etc.)
    - Areas where heavier-than-air vapors can accumulate



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Types of Direct-Reading Instruments (3 of 5)






Direct-Reading Monitoring Instruments

Types of Direct-Reading Instruments (4 of 5)








Direct-Reading Monitoring Instruments, continued

Types of Direct-Reading Instruments (5 of 5)








Direct-Reading Monitoring Instruments, continued


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Monitoring Strategies
(1 of 4)

- Establish a monitoring strategy.
  - Establish monitoring priorities.
  - Use the appropriate monitoring instrument.
  - Have idea of what readings to expect.
  - No reading does not mean no contaminants.
  - Never assume that only one hazard is present.
  - Always play devil’s advocate.
  - Establish action levels based on readings.

Monitoring Strategies
(2 of 4)

- Document monitoring results:
  - Instrument: Type of monitoring instrument used
  - Location: Where monitoring is conducted
  - Time: Time at which the monitoring is conducted
  - Level: Level where the reading is taken (e.g., foot, waist, head)
  - Reading: Actual reading(s) of instrument

Monitoring Strategies
(3 of 4)

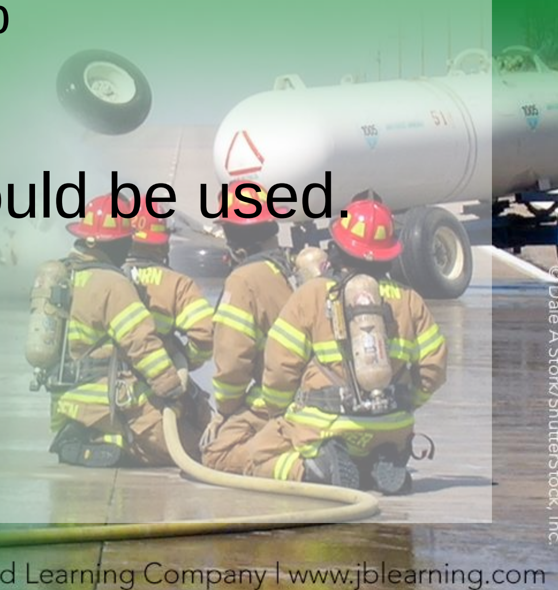
- Initial efforts should help determine if IDLH concentrations are present and provide a base to confirm/refute the existence of specific hazards.
  - Radiation
  - Flammability
  - Oxygen
  - Toxicity

Monitoring Strategies

- Confined space monitoring priorities:
  - Oxygen deficiency and enrichment
  - Flammability
  - Toxicity

Evaluating Monitoring Results: Actions Levels and Guidelines

- Parameters for PPE, hazard control zones, public protection actions
  - Radioactivity: Twice background levels
  - 10% of LEL
  - Oxygen: Less than or equal to 19.5%
    Greater than or equal to 23.5%
  - Without guideline, STEL or IDLH should be used.
- Remember—it's all about risk!



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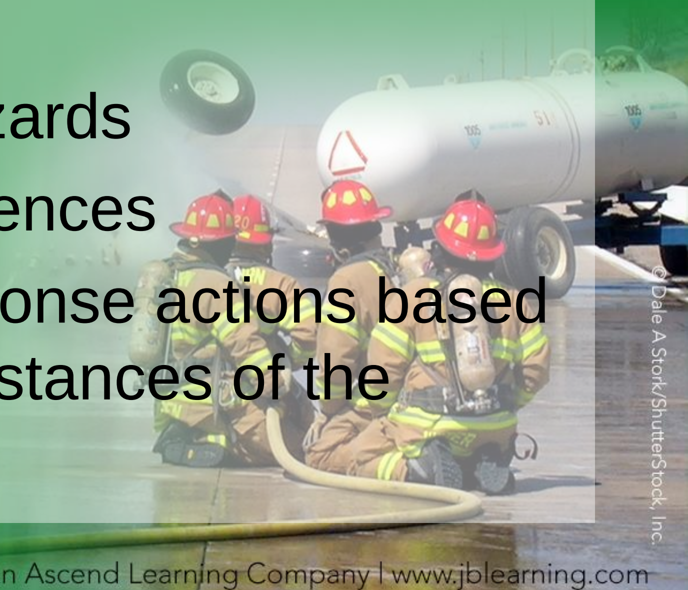
Identifying or Classifying Unknown Materials (1 of 2)

- Initial challenge is to identify and/or classify the material(s) involved and the type of hazards the material(s) may present
- Risk-based response process must include:
  - Analyzing the problem
  - Identifying and assessing the hazards
  - Evaluating the potential consequences
  - Determining the appropriate response actions based on the facts, science, and circumstances of the incident



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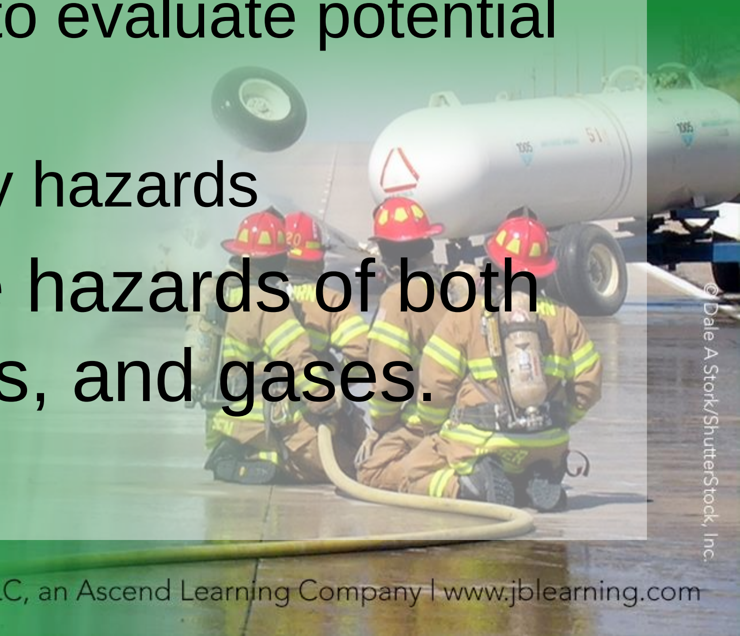
Identifying or Classifying Unknown Materials (2 of 2)

- Baseline HMRT capability:
  - A radiological detection device
  - Multi-gas detector to determine flammability and oxygen levels
  - Photoionization detector (PID) to evaluate potential toxicity
  - pH paper to evaluate corrosivity hazards
- These devices can determine hazards of both known/unknown liquids, solids, and gases.



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Using Equipment Provided By the AHJ

- The AHJ or testing authority determines available equipment.
- Operational procedures based on manufacturer operating instructions
- HMT must be competent in interpreting the results.
- Field screening is the doorway into the hazard classification process.

Demonstrating Field Maintenance and Testing Procedures

- The triangle of:
  - “Know the instrument
  - Know what it can do
  - Know what it’s telling you”
- Is crucial to the responder’s own health and safety.

Sampling

- May be needed to conduct field test or lab analysis
- Instruments and systems for analyzing samples include the following:
  - HazCat™ Chemical Identification System
  - Fourier-Transform Infrared Spectrometry
  - Biological detection systems

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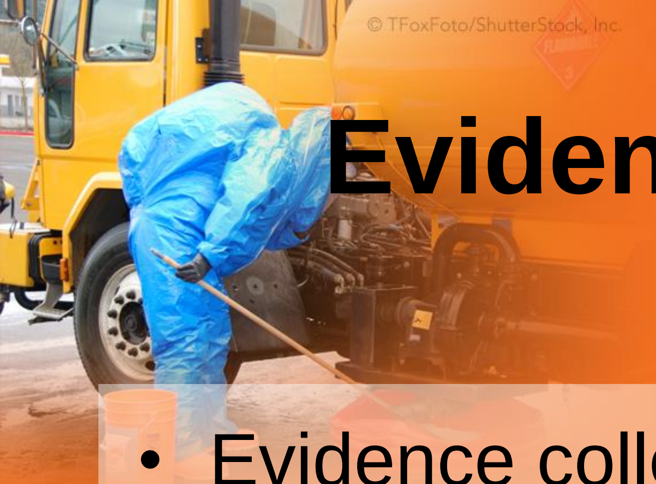
Sampling Considerations

- Basic sampling considerations
  - Personal safety and avoiding contamination of samples are key principles.
  - Collect the samples from an upwind position.
  - Wide mouth containers for liquid samples
  - Collect sample and move to a safe testing location in the warm zone.
  - Use only certified “clean” equipment for evidence collection (one-time use).
  - Follow chain of custody for criminal/regulatory investigations.



Evidence Considerations

- Evidence collection is a process that involves the collection of material that will be used in a legal proceeding.
- Scene management, chain of custody, and minimizing any contamination or cross-contamination of samples is critical.

Evidence Considerations

(2 of 2)

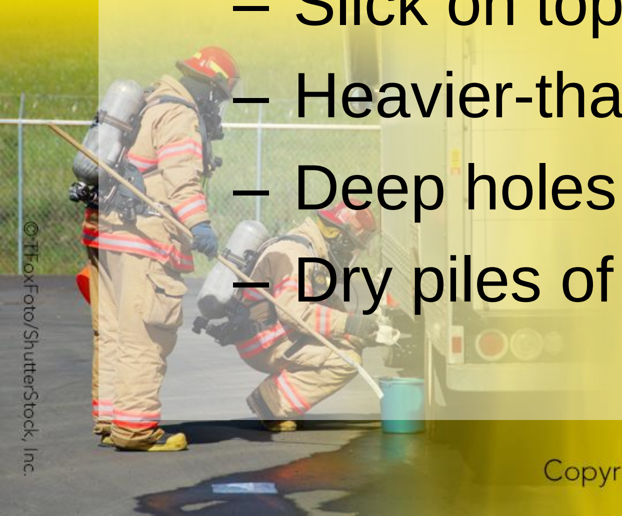
- Collecting evidence samples concerns:
  - Use a sampling plan.
  - Sampling tools should not be reused or recycled.
  - Avoid the potential of cross-contamination.
  - All sample containers should be clearly labeled.
  - Control blanks should be provided.
  - Sample containers certified as “clean”
  - Protect evidence samples from environmental concerns.
  - Screened for fire, corrosive, toxic, and radioactive hazards
  - Chain-of-custody must be maintained.

Sampling Equipment

- Commonly used sampling equipment:
  - Nonsparking bung wrench
  - Glass tube or disposable bailer
  - Coliwasa waste samplers
  - Nonsparking sample pole
  - Glass and plastic sample cups and bottles
  - Plastic bags: positive seal, tamper-proof
  - Bomb sampler or weighted bottle sampler
- *Additional equipment for liquid sampling, solid sampling, wipe sampling for residues*

Sampling Methods and Procedures

- Accepted methods for collecting samples:
  - Powders
  - Drums
  - Sumps and wells
  - Puddles
  - Slick on top of water
  - Heavier-than-water unknowns (from underwater)
  - Deep holes
  - Dry piles of solids



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Sample Collection

- Equipment composed of the same chemicals or material(s) as the samples being collected may influence and taint the sample.
  - Consider using glass, Teflon®, or stainless steel sampling equipment when looking for trace organic compounds
  - Consider using Teflon®, plastic, or glass equipment when sampling for trace metals.


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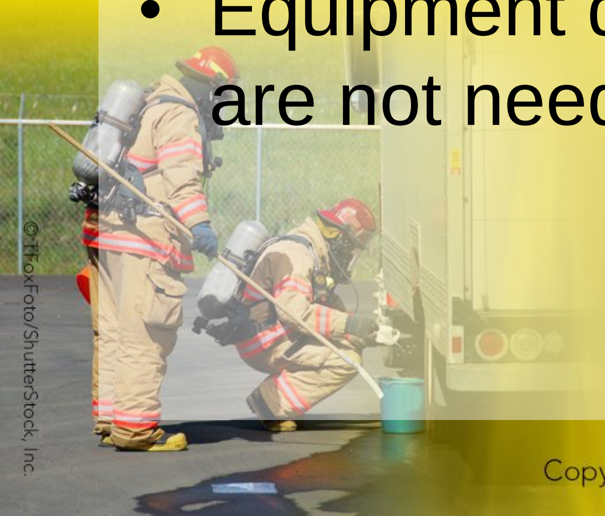
Managing Hazard Information (1 of 2)

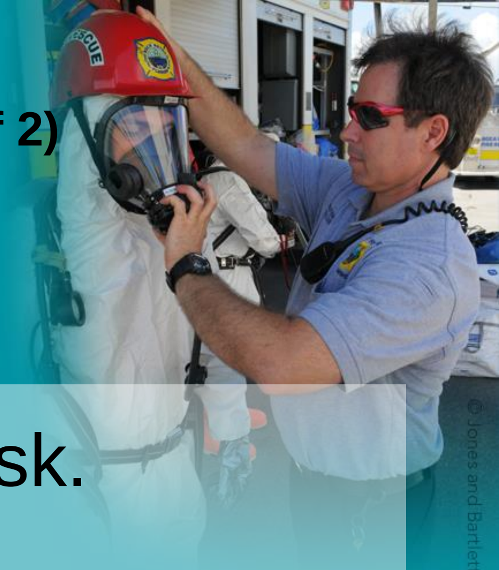
- Responders may become overwhelmed by volume of hazard information.

Managing Hazard Information (2 of 2)

- Responders should prioritize their information requirements.
  - What do I need to know right now?
  - In 1 hour?
  - In 8 hours?
- Equipment disposal and clean-up information are not needed in the initial stages.



Evaluating Risks (1 of 2)

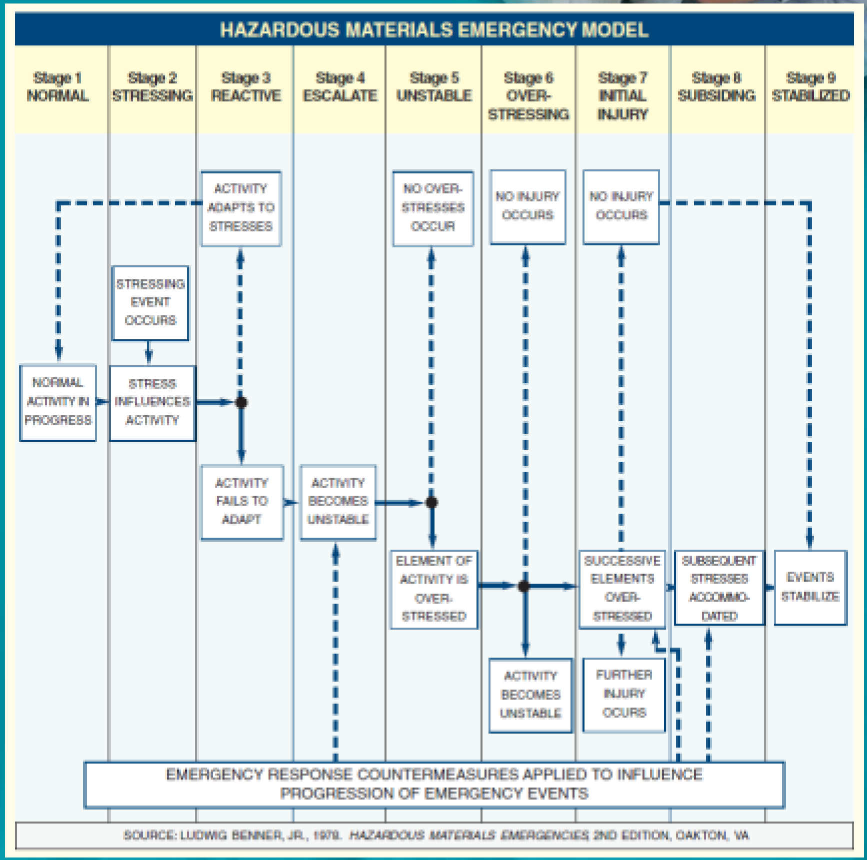


- Risk evaluation is the most critical task.
- Use a systems perspective.
- System input factors include:
  - Hazardous material(s) involved
  - Type of container and its integrity
  - Environment and location of the incident
  - Resources and capabilities of responders
- Develop an IAP to produce a favorable outcome.

Evaluating Risks (2 of 2)

The Hazardous Materials Emergency Model:

- All emergencies consist of a series of events that occur in a logical sequence.



Ludwig Benner, Jr., 1978. *Hazardous Materials Emergencies,* 2nd edition, Oakton, VA.

Basic Principles (1 of 2)

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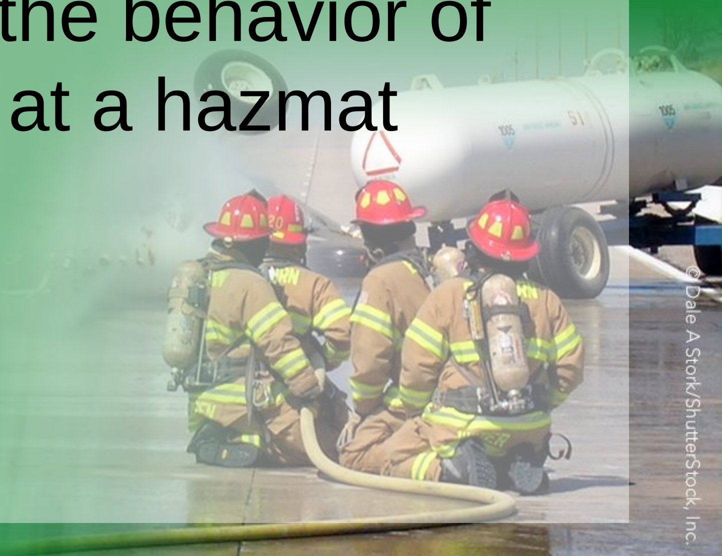
- Overall objective is to favorably change or influence the outcome.
- Direct outcomes are typically stated as:
  - Fatalities
  - Injuries
  - Property and environmental damage
- Indirect outcomes include:
  - Systems disruptions (water, trans., utility)
  - Damaged reputations
  - Residual fears

Basic Principles (2 of 2)

- To determine whether to intervene, responders must first estimate the likely harm that will occur without intervention or what will happen if nothing is done.
- The decision to intervene requires responders to:
  - Visualize the likely behavior of the hazardous material and/or its container
  - Visualize the likely harm associated with that behavior
  - Describe the outcome of that behavior

Behavior of Hazmats and Containers (1 of 3)

- Visualize hazmat behavior by using the General Hazardous Materials Behavior Model (GHBMO).
- The GHBMO is an excellent tool for understanding and predicting the behavior of the container and its contents at a hazmat incident.



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Behavior of Hazmats and Containers (2 of 3)
General Hazardous Materials Behavior Model (GHBMO)

- Six events are reviewed under GHBMO:
  - Stress event
  - Breach event
  - Release event
  - Engulfing event
  - Impingement (contact) event
  - Harm event

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Behavior of Hazmats and Containers (3 of 3)
General Hazardous Materials Behavior Model (GHBMO)

Table 7-3 General Hazardous Materials Behavior Model©

Event					
Stress	**Breach**	**Release**	**Engulf**	**Impinge**	**Harm**
Event Categories					
Thermal	Disintegration	Detonation	Cloud	Short term	Thermal
Radiation	Runaway cracking	Violent rupture	Plume	Medium term	Radiation reactive
-	Attachments opening	Rapid relief	Cone	Long term	Asphyxiation
Chemical	Punctures	Leak	Stream	-	Chemical
Mechanical	Splits or Tears	Spill	Irregular deposit	-	Etiologic Mechanical
Event Interruption Principles					
Influence Applied Stresses	**Influence Breach Size**	**Influence Quantity Released**	**Influence Size of Danger Zone**	**Influence Exposure Impinged**	**Influence Severity of Injury**
Redirect impingement	Chill contents	Change container position	Initiate controlled ignition	Provide shielding	Rinse off contamination
Shield stressed system	Limit stress level	Minimize pressure differential	Erect dikes or dams	Begin evacuation	Increase distance from source
Move stressed system	Activate venting devices	Cap off breach	Dilute	-	Provide shielding

Source: Ludwig Benner, Jr.

Ludwig Benner, Jr., 1978. *Hazardous Materials Emergencies,* 2nd edition, Oakton, VA.

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Stress Event (1 of 2)

- Three common types of stress include:
  - Thermal
  - Mechanical
  - Chemical
- Less likely, though still possible, stresses are:
  - Etiological
  - Radiation stresses


Richard Emery


Richard Emery

Stress Event (2 of 2)

- Determining amount of product
- Determining container pressure

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Breach Event

- Five basic types of breach behaviors:
  - Disintegration
  - Runaway cracking
  - Failure of container attachments
  - Container punctures
  - Container splits or tears

Release Event

- There are four types of release events:
  - Detonation
  - Violent rupture
  - Rapid relief
  - Spills or leaks

Engulfing Event

- To visualize the area the hazmat and/or energy is likely to engulf, consider the following questions:
  - What is jumping out at you?
  - What form is it in?
  - What is making it move?
  - What path will it follow?
  - What dispersion pattern will it create?

Hazardous Materials Behavior: Dispersion Considerations

Table 7-4 Hazardous Materials Behavior—Dispersion Considerations

All hazardous materials will behave in some predictable manner once released from their container. Know dispersion patterns and how they factor into the risk evaluation process.

What is Jumping Out at You?	What is its Form?	What is Making it Move?	What Path Will it Follow?	What Dispersion Pattern Could it Form?
Energy				
	Infra-Red Rays	Thermal Differential	Linear or Radial	Cloud
	Gamma Rays (Nuclear)	Self-Propelled	Linear or radial	Cone or Cloud
	Pressure Waves	Self-Propelled	Linear	Cloud
Matter				
Solids	Dust or Powders	Air Entrainment	With Wind (Linear)	Plume, if Unconfined
		Personal Transport	Random	Irregular Deposits
	Fragments, Shrapnel, or Chunks Organisms	Self-Propelled	Linear	Cloud
		Air Entrainment	With Wind (Linear)	Plume, if Unconfined
		Personal Transport	Random	Irregular Deposits
	Alpha and Beta	Self-Propelled	Linear	Cone or Cloud
Liquids	Pourable Liquids	Gravity	Follow Contour	Stream
Gases	Vapors	Gravity	Follow Contour	Stream
		Air Entrainment	With Wind (Linear)	Plume, if Unconfined
		Vapor Diffusion	Upward From Surface	Cloud Above Liquid
	Gaseous	Gaseous Diffusion	Outward From Surface	Plume, if Unconfined or Shape of Confined Area
Liquefied gases	Vaporizing	Self-Propelled and Boiling	Liquid Follows Contour, Gas Moves With Wind (Linear)	Liquid Forms Stream, Gas Forms Plume

Source: Ludwig Benner, Jr., 1978. Hazardous Materials Emergencies, 2nd Edition, Oakton, VA

Impingement (Contact) Event

- Impingements are categorized based on their duration.
  - Short-term impingements
  - Medium-term impingements
  - Long-term impingements

Harm Event

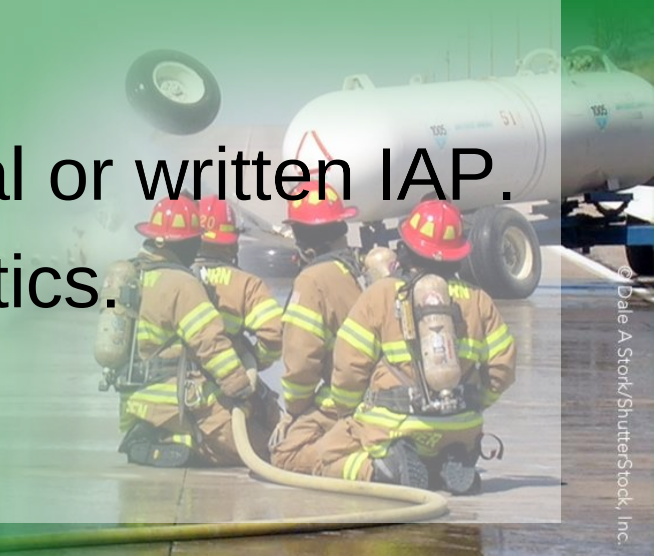
- Harm can be categorized in the following forms:
  - Thermal
  - Toxicity/poisons
  - Radiation
  - Asphyxiation
  - Corrosivity
  - Etiologic
  - Mechanical

Estimating Outcomes

- Key factors to estimate outcomes will include:
  - The size and dimension of the engulfed area
  - The number of exposures in the engulfed area
  - The concentration of “bad stuff” within the engulfed area
  - The extent of physical, health, and safety hazards within the engulfed area

Developing the Incident Action Plan (1 of 4)

- The IAP is developed based upon the IC’s assessment of the following:
  - Incident potential (i.e., visualizing hazardous materials behavior and estimating the outcome of that behavior)
  - The initial operational strategy
- Every incident must have an oral or written IAP.
- IAPs consist of strategy and tactics.



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Developing the Incident Action Plan (2 of 4)

- Examples of common strategic goals at hazmat incidents include the following:
  - Rescue
  - Public protective actions
  - Spill control (Confinement)
  - Leak control (Containment)
  - Fire control
  - Recovery

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Developing the Incident Action Plan (3 of 4)

- Tactical objectives are specific tasks assigned to particular response units.
  - Example: Tactical objectives for a spill control strategy would include diking, damming, and retention.

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Developing the Incident Action Plan (4 of 4)

- Tactical response objectives may be implemented in either an offensive, defensive, or nonintervention mode.

Evaluating Risks: Special Problems

- Three situations that responders commonly deal with are:
  - Damage assessment of pressurized bulk transport containers
  - The behavior of chemicals and petroleum products when released underground
  - The behavior of hazmats in sewer collection systems

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Damage Assessment of Pressurized Containers (1 of 5)

- The violent rupture of pressurized containers can be triggered by one of two related conditions:
  - The presence of a crack in the container shell associated with dents and rail burns
  - The thinning of the tank shell as a result of scores, gouges, and thermal stress

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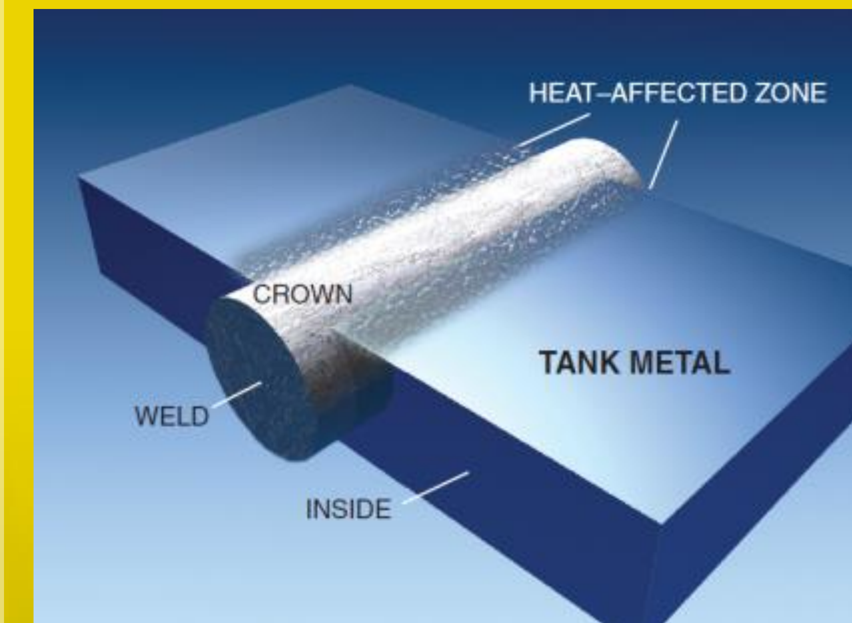
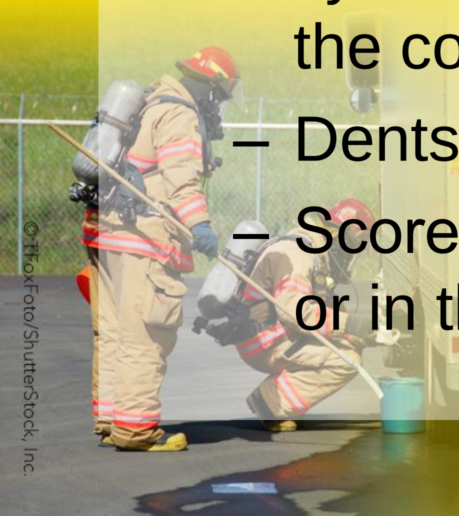
Damage Assessment of Pressurized Containers (2 of 5)

- Key factors that affect tank damage severity are as follows:
  - Specification of the steel
  - Internal pressure
  - Damage affecting the heat-affected zone of the weld
  - Cold work
  - Rate of application



Damage Assessment of Pressurized Containers (3 of 5)

- Most dangerous situations will include the following:
  - Cracks in the base metal of a tank or cracks in conjunction with a dent, score, or gouge
  - Sharply curved dents or abrupt dents in the cylindrical shell section parallel to the long axis of the container
  - Dents accompanied by scores and gouges
  - Scores and gouges across a container's seam weld or in the heat-affected zone of the weld



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Damage Assessment of Pressurized Containers (4 of 5)

Crack

Score

Wheel Burn

Gouge

Damage Assessment of Pressurized Containers (5 of 5)

Dent

Rail Burn

Street Burn

Examples of mechanical stress and damage to pressurized containers.

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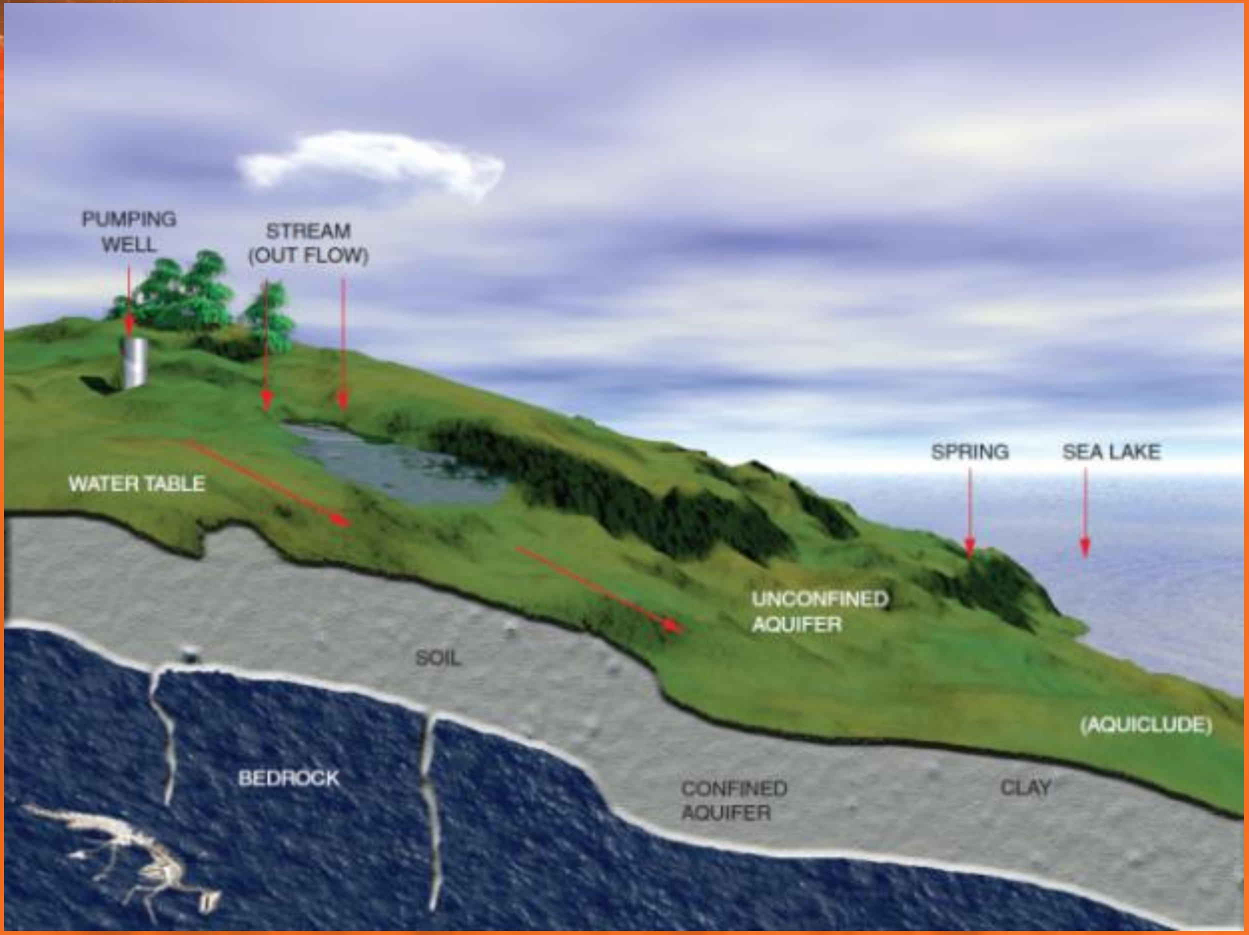
Movement and Behavior of Hazmats Underground

- The behavior of hazmats underground will depend on:
  - Their physical and chemical properties (e.g., liquid versus gas, hydrocarbon versus polar solvent)
  - The type of soil (e.g., clay versus gravel versus sand)
  - The underground water conditions (e.g., location and movement of the water table)

Geology and Groundwater (1 of 2)

- Aquifers are permeable sections of soil or rock capable of transmitting water.
- Groundwater accounts for the majority of the drinking water supply for the United States.
- The rate of flow depends on:
  - The permeability of the underground aquifer
  - The slope or “hydraulic gradient” of the water table

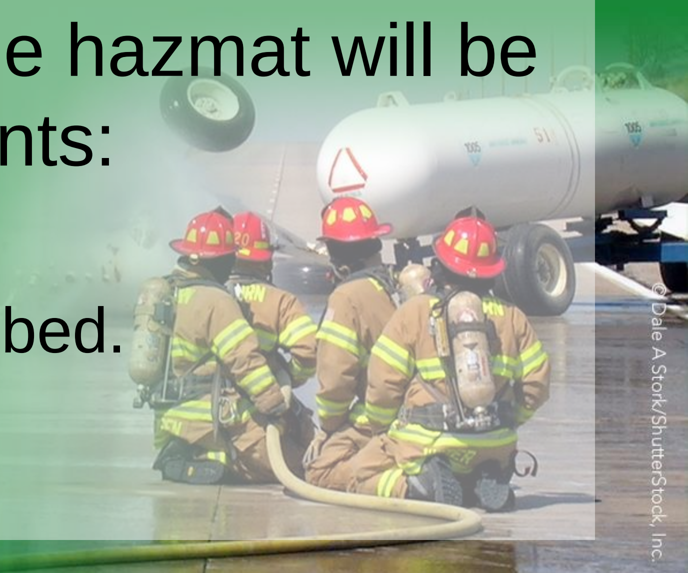
Geology and Groundwater (2 of 2)
Hypothetical Groundwater System



Hypothetical groundwater system.

Behavior of Hazmats in Soil and Groundwater (1 of 2)

- Flammable liquids and toxic solvents can create significant problems.
- The underground movement of hazmats follows the least resistant path.
- The downward movement of the hazmat will be interrupted by one of three events:
  - It will be absorbed by the soil.
  - It will encounter an impermeable bed.
  - It will reach the water table.



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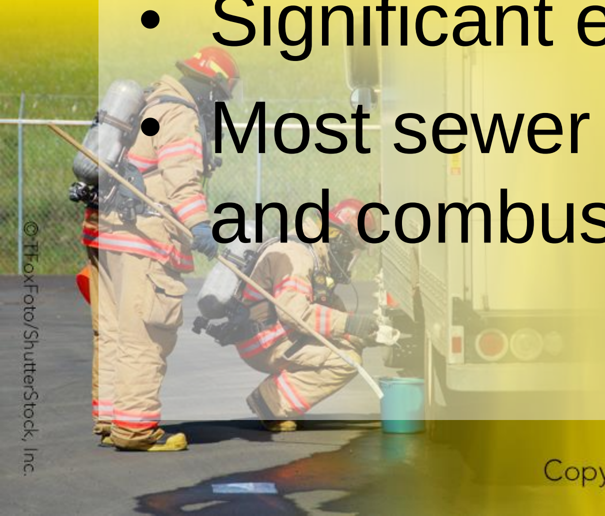
Behavior of Hazmats in Soil and Groundwater (2 of 2)

The movement of hazardous materials through soil will be dependent upon the viscosity of the liquid, properties of the soil, and the rate of the release.

Movement and Behavior of Spills Into Sewer Collection Systems (1 of 2)

- Sewers, manholes, electrical vaults, french drains, and other similar underground structures and conduits can be critical exposures in the event of a hazmat spill.
- Can pose an immediate fire problem
- Significant environmental concerns
- Most sewer emergencies involve flammable and combustible liquids.



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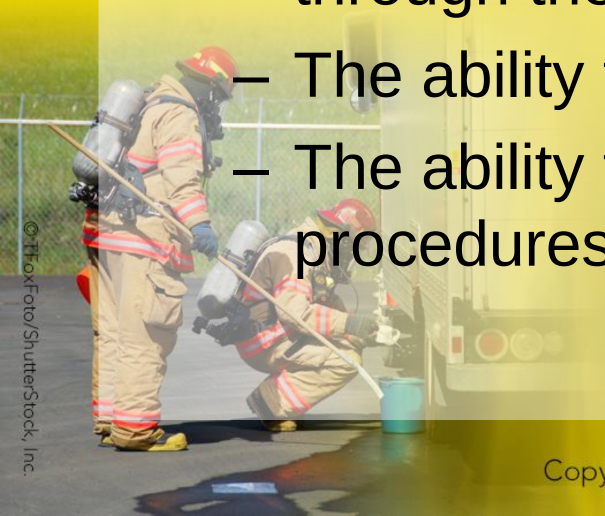
Movement and Behavior of Spills Into Sewer Collection Systems (2 of 2)

- The severity of an explosion and its consequences will depend on the following factors:
  - The type of sewer collection system
  - The process and speed at which the hazmat moves through the system
  - The ability to confine the release
  - The ability to implement fire and spill control procedures



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Types of Sewer Systems

- Sewer systems categories:
  - Sanitary sewers
  - Storm sewers
  - Combined sewers


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Wastewater System Operations

- Four primary system elements:
  - Collection and pumping
  - Filtering systems
  - Liquid treatment systems
  - Solid treatment systems

Primary Hazards and Concerns

- Spills and releases into the sewer collection system will create two primary concerns:
  - Fire concerns
    - Flammable liquids, such as gasoline and other low flash-point, high vapor-pressure liquids, will create the greatest risk of a fire or explosion.
  - Environmental concerns
    - Environmental concerns will be greatest when dealing with poisons and environmentally sensitive materials or when there is no ignition of flammable liquids following their release into the sewer system.

Coordination with Public Works and the Sewer Department

- Preplanning with public works and the sewer department is critical.
- Responders should identify areas of entry probability.
- Tactical control options should be based upon input from the sewer department and environmental agency.

Summary (1 of 6)

- Hazards refer to a danger or peril.
- In hazardous materials response operations, hazards generally refer to the physical and chemical properties of a material.
- Hazard and risk assessment is the most critical function in the successful management of a hazardous materials incident.

Summary (2 of 6)

- There is no replacement for hazard analysis and contingency planning at both the plant and community levels.
- There is no single detection/monitoring device on the market that can do everything.
- The nature of the incident and the intent of the monitoring mission will drive the selection of monitoring technologies.

Summary (3 of 6)

- Unknowns will create the greatest challenge for responders.
- Initial air monitoring efforts should be directed toward determining if IDLH concentrations are present.
- An accurate evaluation of the real and potential problems will enable response personnel to develop informed and appropriate strategic response objectives and tactical decisions.

Summary (4 of 6)

- Strategic goals are the broad game plan developed to meet the incident priorities (life safety, incident stabilization, environmental and property conservation).
- Tactical objectives are specific and measurable processes implemented to achieve the strategic goals.

Summary (5 of 6)

- Responders should get assistance from product or container specialists.
- When petroleum products or chemicals are released into the ground, their behavior will depend on their physical and chemical properties (e.g., liquid versus gas, hydrocarbon versus polar solvent), the type of soil (e.g., clay versus gravel versus sand), and the underground water conditions.

Summary (6 of 6)

- The responder's job is to be a risk evaluator, not a risk taker. Bad risk takers get buried; effective risk evaluators go home.