Unit VI
Identifying Hazardous Materials

At the end of this unit, the student will be able to:

- Explain the process of identifying hazardous materials.
- Identify five specific sources of information to help identify hazardous materials.
- Prepare a "Hazardous Material Data Sheet."

UNIT VI—IDENTIFYING HAZARDOUS MATERIALS

TOTAL TIME REQUIRED FOR THIS UNIT: *90 minutes*

METHODOLOGY OUTLINE:

Step 1.	Lecture Introduce "Identifying Hazardous Materials." Present topics and objectives.	5 minutes
Step 2.	Lecture with slides Discuss identification of specific name of material.	15 minutes
Step 3.	Lecture with slides Discuss sources for identifying the characteristics and behavior of the hazardous material involved.	25 minutes
Step 4.	Group Project Have students work "Identification Project" using Hazardous Material Data Sheet.	45 minutes

INSTRUCTIONAL MATERIALS

1. Slides 313–315 (Step 1 lecture)
2. Slides 316–318 (Step 2 lecture)
3. Slides 319–335 (Step 3 lecture)
4. Copies of printed guides for identifying hazardous materials.

TIME	CONTENT/METHODOLOGY	MATERIALS
5 min.	**STEP 1**—Interactive Lecture—Introduce "Identifying Hazardous Materials"	SM VI-3

The emphasis now is on the characteristics of the material.

- *Discuss the purpose of identification.*

Purpose of identification is to: Slide 313

- **Identify the specific name of the material.**
- **Identify the known characteristics and behavior of the material to help estimate the likely harm without intervention resulting in estimating the likely outcome.**

- *Discuss some important points about the identification process.*

Remember three important points: Slide 314

- **You must ask for the information you need.**
- **You have to get some information yourself before other sources can give you more.**
- **When you get more information, you have to know how to use it.**

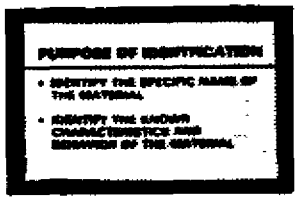
Ask for the information you need.

- **Do not wait for outsiders to contact you.**
- **You realize the need for information long before anyone else does.**
- **You need to know where to go to get the needed information.**

You need to get some information before other sources can give you more.

- **Identification.**
- **Something that unlocks information from the available sources.**

Slide 313



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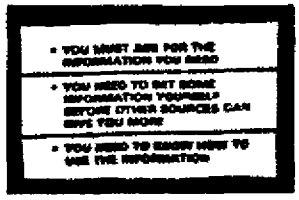


TIME	CONTENT/METHODOLOGY	MATERIALS

You need to know how to use the information.

- **Information may confuse you if you do not know how to use it.**
- **Events analysis helps you figure out how to put new information to work as fast as you get it.**
- **Look for information that helps you estimate likely harm without intervention.**
- *Identify the topics for this unit.*

  The unit will:

  - Present a description of the widely used hazardous material information sources available to emergency response personnel.
  - Demonstrate how these sources can help you estimate the likely harm without intervention.
  - Present a format for gathering necessary data from these sources.
  - Practice gathering information from these sources.
- *Identify the objectives for this unit.*

  By the end of the unit, you will be able to: Slide 315

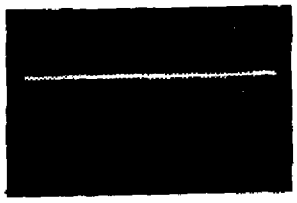
  - **Explain the process of identifying hazardous materials.**
  - **Identify five specific sources of information to help identify hazardous materials.**
  - **Prepare a hazardous material data sheet.**

  Any questions?

15 min. **STEP 2**—Lecture with slides—Identify how to determine the specific name of the materials involved

- *Sources for identifying the specific name of the hazardous material.*

Slide 315



TIME	CONTENT/METHODOLOGY	MATERIALS

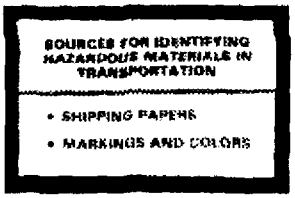
- **Sources for identifying hazardous materials in transportation.** Slide 316
  - **Shipping papers.**
    - Proper shipping name of material; identification number.
    - Caution students about Not Otherwise Specified (NOS) shipments; Standard Transportation Commodity Code number by rail can identify specific material in N.O.S. category.
  - **Markings and colors.**
    - Identification numbers.
      - Distance proximity to read numerals (less than 300 feet without binoculars).
      - Only for tank car, tank truck, and portable tank shipments.
- **Sources for identifying hazardous materials in fixed facilities.** Slide 317
  - **Markings and Colors** (names stenciled on containers).
  - **Pre-Emergency Planning** (Identify the materials handled).

In any case, write down the information. Do not rely on your memory.

Spell the name of the material correctly. Note the difference between ethanol and ethanal. Slide 318

- **Ethanol**—Clear, colorless liquid. Aromatic odor. Flash point of 59°F.

Slide 316



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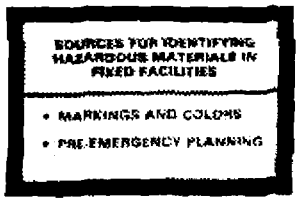
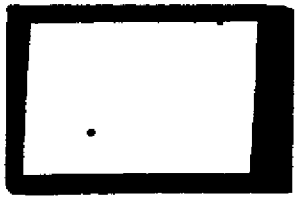


Slide 318

TIME	CONTENT/METHODOLOGY	MATERIALS
	• **Ethanal**—Clear, colorless liquid. Pungent, choking odor. Highly flammable; flash point of 36°F. Vapors are irritating to eyes and mucous membranes. May spontaneously polymerize. Forms unstable oxides in air.	
25 min.	STEP 3—Lecture with slides—Sources for identifying the characteristics and behaviors of hazardous materials	Slide 319
	• *Introduce sources of information.*	
	Sources of information fall into one of two categories:	
	• **Printed materials, like emergency action guides.**	
	• **Verbal advice, like CHEMTREC.**	
	• PRINTED MATERIAL SOURCES:	
	• **Emergency Handling of Hazardous Material in Surface Transportation**	
	• By the Bureau of Explosives.	Slide 320
	• Mention data available from publication. (Review sample page in student manual.)	
	• **Fire Protection Guide on Hazardous Materials**	Slide 321
	• By the national fire protection association.	
	• Compilation of five publications:	
	• **Flash Point Index of Trade Name Liquids**	
	• 8,800 trade name products (dated information).	
	• Gives flash point and manufacturer (Review sample page in student manual.)	
	• **Fire Hazard Properties of Flammable Liquids, Gases, and Volatile Solids**	
	1,300 flammable substances (Review sample page in student manual.)	

Slide 319

Slide 320



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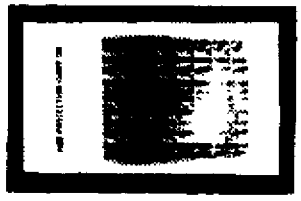

TIME	CONTENT/METHODOLOGY	MATERIALS

	• **Hazardous Chemicals Data**
	  • 416 chemicals
	  • Fire, explosion, and toxicity hazards (Review sample page in student manual.)
	• **Manual of Hazardous Chemical Reactions**
	  3,550 mixtures of two chemicals (Review sample page in student manual.)
	  • Recommended system for the identification of the fire hazards of materials.	

	• **Emergency Response Guidebook**	Slide 322
	• By the Department of Transportation. (Approximately 2,400 names). • Generic groupings of information—not by specific material. • Indexed by name and identification. (Review sample page in student manual.)	
	• **CHRIS Manual (Volume 2)**	
	• By the U.S. Coast Guard (Approximately 900 names).	Slide 323
	• Wealth of information (Review sample page in student manual.)	
	• **Dangerous Properties of Industrial Materials**	
	• By N. Irving Sax	Slide 324
	• Provides descriptive information about 16,000 common industrial and laboratory materials (Review sample page in student manual.)	

Slide 322

Slide 323

Slide 324

TIME	CONTENT/METHODOLOGY	MATERIALS
	• Manufacturers Chemical Data Safety Sheets	Slide 325
	• **Some others are:**	
	• **Fire Officer's Guide To Dangerous Chemicals** by Charles W. Bahme	Slide 326
	• **Condensed Chemical Dictionary** revised by Gessner G. Hawley	Slide 327
	• **Handbook of Reactive Chemical Hazards** by Bretherick	Slide 328
	• **Toxic and Hazardous Industrial Chemicals Safety Manual** from The International Technical Information Institute	Slide 329
	• **GATX Tank Car Manual**	Slide 330
	• **Farm Chemicals Handbook**	Slide 331
	• **Shell Safety Manual Agricultural Chemicals**	Slide 332

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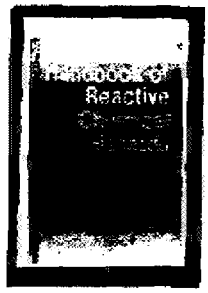
Slide 327

Slide 328



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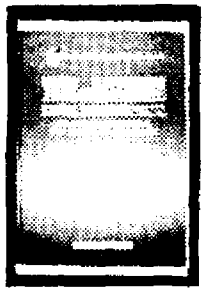

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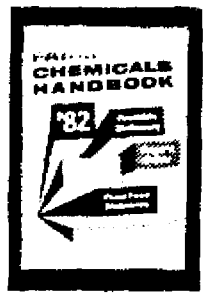

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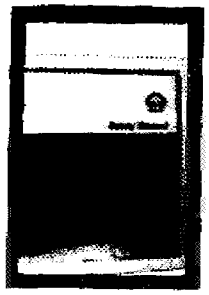


These and other references are listed in your Student Manual.

There is no one single resource that has all the information on all the hazardous materials. You have to use more than one.

Sometimes there are contradictions between resources. If you have a contradiction, play it safe—look at the worst case.

- VERBAL ADVICE SOURCES OF INFORMATION.
  - CHEMTREC — Slide 333
  - Located in Washington, D.C.
  - On-call chemical emergency assistance center established by the Chemical Manufacturers Association in 1971.
  - CHEMTREC communicator available 24 hours a day, 7 days a week, 365 days a year.
    - Provides information about chemicals
    - Links callers to experts who know the hazardous material
  - System contains the most up-to-date information available.
  - Telephone contact: 800-424-9300 only in emergencies
  - Provide communicator with: — Slide 334
    - Your name, location, and telephone number
    - Name of material
    - If name of the material is not known, provide any information you might have:
      - Shipper/Manufacturer

Slide 333

Slide 334

TIME	CONTENT/METHODOLOGY	MATERIALS
	• **Carrier** • **Consignee** • **Container Type** • **Identifying container numbers** • **Location of the emergency** • **Local conditions**	
	• **Chemical and transportation industries can indicate local contacts and activities.**	Slide 335 (Blank)
	• *Summarize Identification.* **The information you need is out there somewhere, whether you are calling** CHEMTREC for guidance, or referencing action **guides, or wherever your search leads you, the key to your success is your persistence. You must obtain correct and accurate information if you are going to accurately estimate likely harm without intervention.**	
	Any questions?	
45 min.	STEP 4—Group Project—Present Identification Project	
	• *Present hazardous materials data sheet.*	
	Ask students to turn to page VI-8 in their Student Manual. (There is also a blank Data Sheet in Appendix A, and an answered Data Sheet in your Answer Key following this Lesson Plan.)	SM VI-8 IG Answer Key
	Explanation sheets precede Hazardous Materials Data Sheet on pages VI-5 to VI-7 in Student Manual. You have a set of explanation sheets also.	SM VI-5 to VI-7 IG Answer Key
	Present and generally discuss the purpose of the Hazardous Materials Data Sheet:	

Slide 335

TIME	CONTENT/METHODOLOGY	MATERIALS
	The sheet presents the types of information needed to define the hazardous material problem. You will become more familiar with the terms as they are used in the rest of this course.	
	• *Present instructions for completing identification project.*	
	Have students form their workgroups.	
	Using the information from the various samples of pages of emergency action guides found in your student manual, **complete the hazardous material data sheets.**	SM VI-9 to VI-17
	You can work in groups to fill in the answers to the questions on the data sheet.	
	Complete as much as you can in the next **10 to 12 minutes.**	
	The material is ethylene oxide.	
	• Review student answers to ensure accuracy.	

Answer Key

$(CH_2)_2O$ - Chemical formula

Hazardous Material Data Sheet

Uses - reactant in production of polymeric and non-polymeric products // fumigant // industrial sterilant

Hazardous Material:

Shipping Name Ethylene Oxide
Chemical Name 1,2-Epoxyethane
DOT Hazard Class Flammable Liquid
ID Number 1040 STCC Number 4906610

Physical Description:

Normal Physical Form: Solid ___ Liquid < 51° Gas > 51°
Color Colorless, clear
Odor Ether like odor
Other Irritating at high concentrations /// Volatile

Chemical Properties:

Specific Gravity 0.9 Lighter than water - floats
Vapor Density 1.5 Heavier than air - settles to ground
Boiling Point 50.7 °F
Melting Point -171 °F
Vapor Pressure 1095 ~~per~~ mmHg at 20 °F
Expansion Ratio
Solubility: In water (Yes) No
Degree of solubility Miscible in water 24-1 ratio
Other

Health Hazards:

(X) Yes ( ) No
Inhalation Hazard: (Yes) No TLV/TWA 50 ppm(~~xxxxx~~) LC_{50} 1462 ppm/hr.
Ingestion Hazard: (Yes) No LD_{50} 330 mg/kg oral
Absorption Hazard (Yes) No Skin: Yes No Eyes: Yes No Absorption by contact only
IDLH Value 800 ppm/air(~~xxxxx~~) STEL Value ___ ppm/air(mg/m^3)
Chronic Hazard: Carcinogen: (Yes) No Mutagen: (Yes) No Teratogen: Yes No
Hazardous to Aquatic Life: Yes No
Other Water pollutant

Decontamination Procedures:

First Aid Procedures: Vapor - remove to fresh air, give O_2 // Liquid - remove contaminated clothing, flush skin, call for medical assistance (delayed effects)

Fire Hazards:

(X) Yes ( ) No
Flash Point 0 °F Ignition (Autoignition) Temperature 804 °F in air (1058°F in Ethylene Oxide)
Flammable (Explosive) Range: LFL (LEL) 3.6 % UFL (UEL) 100 %
Toxic Products of Combustion
Other Vapors may burn inside container.
Possible Extinguishing Agents: Solid streams for cooling containers exposed to fire CO_2, dry chemicals, alcohol foams, water spray

Reactivity Hazards:

(X) Yes ( ) No
Reactive with what Acids and bases, alcohols, aluminum chloride, aluminum oxide, ammonia, copper, iron oxides, magnesium perchorate, mercaptans, potassium, tin chlorides
Other Possible polymerization when contaminated with alkaline materials

Corrosivity Hazards:

(X) Yes ( ) No
pH ___ Corrosive to what: Skin (Yes) No Steel. Yes Nc Other
Other Delayed
Neutralizing Agents

Radioactivity Hazards:

( ) Yes (X) No
Type Radiation Emitted: Alpha Particles ___ Beta Particles ___ Gamma Radiation ___
Other

Recommended Protection:

For Public (Evacuation distance 5000, for tank car (quantity)) keep upwind
For Response Personnel (Level of protection required ___) Self contained breathing apparatus full protective clothing
For Environment

INSTRUCTOR'S KEY FOR ENTRIES ON HAZARDOUS MATERIAL DATA SHEET

	SOURCE(S) OF INFORMATION FROM STUDENT'S MANUAL UNIT VI
HAZARDOUS MATERIAL	
Shipping Name—The proper shipping name or other common name for the material; also any synonyms for the material.	
DOT Hazard Class—The hazard class designation for the material as found in the Department of Transportation regulations.	**CHRIS, DOT, AAR**
Chemical Name—The chemical name of the material and its chemical formula.	**CHRIS, NFPA, NIOSH, SAX**
ID Number—The four-digit identification number assigned to hazardous material by the Department of Transportation; also includes the prefix "UN" or "NA."	**AAR, DOT**
STCC Number—The Standard Transportation Commodity Code number used in the rail industry; a seven-digit number assigned to a specific material or group of materials and used in determination of rates; for a hazardous material, the STCC number will begin with the digits 49.	**AAR**
PHYSICAL DESCRIPTION	
Normal Physical State—Physical state or form of the material at normal ambient temperatures (68°F–77°F).	**CHRIS, NFPA, NIOSH**
Color—The color of the material under normal conditions.	**AAR, CHRIS, NFPA, SAX**
Odor—The odor of the material upon its release.	**CHRIS, NFPA, NIOSH**
CHEMICAL PROPERTIES	
Specific Gravity—The weight of a material as compared with the weight of an equal volume of water; if the specific gravity is less than 1, the material is lighter than water and will float; if the specific gravity is greater than 1, the material is heavier than water and will sink.	**CHRIS, NFPA, SAX**
Vapor Density—The weight of a pure vapor or gas compared with the weight of an equal volume of dry air at the same temperature and pressure; if the vapor density is less than 1, the material is lighter than air and may rise; if the vapor density is greater than 1, the material is heavier than air and will stay low to the ground.	**CHRIS, NFPA**
Boiling Point—The temperature at which a liquid changes to a vapor or gas; i.e., the temperature where the pressure of the liquid equals atmospheric pressure.	**CHRIS, NFPA, NIOSH**
Melting Point—The temperature at which a solid changes to a liquid; this temperature is also the freezing point depending on the direction of the change.	**CHRIS, NIOSH**

Vapor Pressure—The pressure exerted by the vapor within the container against the sides of a container This pressure exerted by the vapor within the container against the sides of a container. This pressure is temperature dependent; as the temperature increases, so does the vapor pressure, thus, more of the liquid evaporates or vaporizes. The lower the boiling point of a liquid, the greater the vapor pressure it will exert at a given temperature. — NIOSH, SAX

Solubility—The ability of a solid, liquid, gas, or vapor to dissolve in water; the ability of one material to blend uniformly with another, such as a solid in liquid, liquid in liquid, gas in liquid, or gas in gas. — AAR, DOT, NFPA

Degree of Solubility—Indication of the solubility of the material. — SAX, NFPA

Other—Any additional pertinent information or data found.

HEALTH HAZARDS

Are there any health hazards associated with the material? Mark yes or no, as appropriate If yes, then complete this section. — CHRIS, DOT, NIOSH, SAX

Inhalation Hazard—Is there any hazard from breathing this material? — CHRIS, DOT, NIOSH, SAX

TLV/TWA—(Threshold Limit Value/Time Weighted Average). The concentration of a material to which an average, healthy person may be repeatedly exposed for 8 hours a day, 40 hours per week, without suffering adverse health effects. — CHRIS, NIOSH

LC_{50}—The concentration in ppm that kills 50% of the laboratory animals in a given length of time. — CHRIS, NIOSH, SAX

Ingestion Hazard—Is there any hazard from ingesting (eating) this material? — SAX

LD_{50}—(Lethal Dose). The dose that kills 50% of the test animals. — NIOSH, SAX

Absorption Hazard—Is there any hazard from absorbing this material into the body? — NIOSH

Skin Absorption Hazard—Can material be absorbed through the skin? — NIOSH

Eye Absorption Hazard—Can material be absorbed through the eye? — NIOSH

IDLH Value—(Immediately Dangerous to Life and Health Value). An indication of atmospheres that are immediately dangerous to life and health. Within 30 minutes of exposure, death or irreversible health implications to the person exposed are expected. — NIOSH

STEL Value (Short-Term Exposure Limit Value)—Maximum allowable concentration, or ceiling, not to be exceeded during a 15-minute period. — NIOSH, CHRIS

Chronic Hazard—Are there any chronic hazards associated with this material?

Carcinogen—A material that can cause cancer in an organism — SAX

Mutagen—A material that creates a change in gene structure that is potentially capable of being transmitted to offspring. — SAX

Teratogen—A material that causes the production of a physical defect in a developing embryo.

Hazardous to Aquatic Life—Is the material harmful to aquatic life? — CHRIS

Other—Any additional pertinent information or data found.

Decontamination Procedures "Decontamination is the removal of hazardous materials from the skin, clothing, equipment, etc."; the purpose of decontamination is to prevent or reduce the physical transfer of any contaminants by people or equipment from onsite to offsite locations. List methods available for decontamination for this material. — CHRIS, DOT, NIOSH

First Aid Procedures—What procedures should be followed for someone contaminated with this material? — CHRIS, DOT, NFPA, SAX

FIRE HAZARD

Fire Hazard—Will the material burn or support the combustion process of other materials? Mark yes or no. If yes, complete this section. — CHRIS, DOT, SAX

Flash Point—The minimum temperature at which a liquid gives off enough vapors to ignite and flash over but will not continue to burn without the addition of more heat. — CHRIS, NFPA, SAX

Ignition (Autoignition) Temperature—The minimum temperature required to ignite gas or vapor without a spark or flame being present. — CHRIS, NFPA

Flammable (Explosive) Range—The range of a gas or vapor concentration (percentage by volume in air) that will burn or explode if an ignition source is present. Limiting concentrations are commonly called the *"LEL"—or "Lower Flammable (Explosive) Limit"* and the *"UEL"—or "Upper Flammable (Explosive) Limit."* Below the lower flammable limit, the mixture is too lean to burn; above the upper flammable limit, the mixture is too rich to burn. — CHRIS, NFPA

Toxic Products of Combustion—The toxic by-products of the combustion process. List them.

Other—Any additional pertinent information or data found.

Possible Extinguishing Agents—What extinguishing agents are suitable for control/extinguishment of a fire involving this material? — CHRIS, NFPA

REACTIVITY

Reactivity—Will the material react with any other materials? Mark yes or no. If yes, complete this section.

With what—What is this material reactive with and in what ways?

Other—Any additional pertinent information or data found.

CORROSIVITY HAZARDS

Corrosivity Hazards—Is the material corrosive to other materials? Mark yes or no. If yes, complete this section.

pH—Acidic or basic corrosives are measured to one another by their ability to dissociate in solution. Those that form the greatest number of hydrogen ions are the strongest acids, while those that form the hydroxide ion are the most potent bases. The measurement of the hydrogen ion concentration in solution is called the pH of the compound in solution. Strong acids have low pH values and strong bases have high pH values; the pH scale ranges from 0 to 14.

Corrosive to What—Materials with which the material is corrosive, particularly skin and steel.

Other—Any additional pertinent information or data found.

Neutralizing Agents—Those materials that can be used to neutralize the effects of the corrosive material.

RADIOACTIVITY HAZARDS

Radioactivity Hazards—Will the material emit radioactivity? Mark yes or no. If yes, complete this section.

Type of Radiation Emitted—Indicate the type of radiation emitted, either alpha particles, beta particles, or gamma radiation.

Other—Any additional pertinent information or data found.

RECOMMENDED PROTECTION

For Public—Recommended action to protect public health and safety; indicate evacuation distances for various amounts of the material. **AAR**

For Response Personnel—Level of protection required for emergency response personnel working in danger zone. **AAR, DOT, NFPA**

Level A—Requires the highest level of respiratory, skin, and eye protection, that is, a fully encapsulating, chemically appropriate, protective suit with its own self-contained breathing apparatus. **CHRIS**

Level B—Requires the highest level of respiratory protection, but a lower level of skin protection. It is the minimum level recommended on initial entries until the hazards have been further identified and defined by complete monitoring, sampling, and chemical analysis.

Level C—Requires air purifying respirators with adequate protection factors: coveralls and other protective equipment may be required. This level is selected when types and concentrations of respirable materials are known to have adequate warning properties.

Level D—Requires no respiratory protection; basic work clothing should be worn when sites are positively identified as having no toxic hazards.

For Environment—Potential mitigation schemes to protect the environment.

NOTE: The back of the Hazardous Material Data Sheet can be used to collect additional information of a more specific nature.

Unit VII
Visualizing
Hazardous Material Behavior

At the end of this unit, the student will be able to:

- Describe the Hazardous Materials Behavior Model.
- List and be able to recognize the types of stress, breach, releases, dispersion, and hazardous materials travel patterns.
- Differentiate between impingement and harm, and identify factors which influence the range of harm.
- Identify four factors which affect behavior of hazardous materials in emergencies.

UNIT VII—VISUALIZING HAZARDOUS MATERIALS BEHAVIOR

TOTAL TIME REQUIRED FOR THIS UNIT: *160 minutes*

METHODOLOGY OUTLINE:

Step 1.	Interactive Discussion Introduce concept of visualizing hazardous material behavior. Identify topics and objectives.	10 minutes
Step 2.	Lecture with slides Introduce hazardous material behavior model.	5 minutes
Step 3.	Lecture with slides Discuss stress and breach events.	10 minutes
Step 4.	Group Activity Stress/Breach skill building exercise.	25 minutes
Step 5.	Lecture with slides Discuss release and engulf events.	10 minutes
Step 6.	Group Activity Release/Engulf skill building exercise.	25 minutes
Step 7.	Lecture with slides Discuss impinge and harm events.	10 minutes
Step 8.	Group Activity Impinge/Harm skill building exercise	25 minutes
Step 9.	Group Activity Practice visualizing events using behavior model on LP gas truck incident.	40 minutes

INSTRUCTIONAL MATERIALS

1. Slides 336–338 (Step 1 interactive discussion
2. Slides 339–353 (Step 2 lecture)
3. Slides 354–366 (Step 3 lecture)
4. Slides 367–391 (Step 5 lecture)
5. Slides 392–400 (Step 7 lecture)
6. Slide 401 (Step 8 group activity)
7. Slides 402–417 (Step 9 group activity)

TIME	CONTENT/METHODOLOGY	MATERIALS
10 min.	**STEP 1**—Introduce visualizing hazardous material behavior	
	• ***Orient students to the difficulty of estimating likely harm without intervention in hazardous material emergencies.***	
	Look at this situation:	Slide 336
	Can you visualize what is likely to happen here if no effort is made to control the fire?	
	Let students discuss the answer to this question for a short time.	
	Answers:	
	Eventually the fire will go out and you will have a new parking lot.	
	Observation relatively easy for fire service personnel because:	
	—Principles of fire behavior are generally known and understood by the fire service.	
	—Knowledge and skills in applying principles of fire behavior are presented regularly in training programs.	
	—Knowledge and skills are reinforced regularly by response to structural fires.	
	But what about this situation:	Slide 337
	Can you visualize what is going to happen here?	
	Is there a hazardous material present?	
	Let students discuss briefly.	
	NOTE: Slide shows a tank car of phosphorus burning.	
	Answer here is more difficult! Why?	
	—Principles of hazardous material behavior are not well understood.	

Slide 336

Slide 337

TIME	CONTENT/METHODOLOGY	MATERIALS

—Training programs do not address the combination of hazardous material/container behavior, and if they do, it is done by covering only a limited number of materials.

—Personal experience with hazardous material emergencies is limited, limiting chance to develop necessary skills.

- *Identify the topics for this unit.*

  This unit will:

  - Present the hazardous material general behavior model.
  - Present a detailed look at each step in the hazardous material general behavior model.
  - Practice each step in the hazardous material general behavior model.
  - Practice visualizing events in a given LP gas truck exercise using the hazardous material general behavior model.

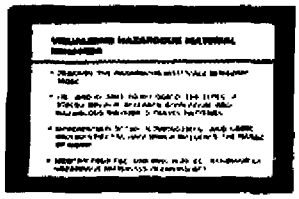
- *Identify the objectives for this unit.*

  By the end of this unit, you will be able to: Slide 338

  - **Describe the hazardous materials behavior model.**
  - **List and be able to recognize the types of stress, breach, releases, dispersion, and hazardous materials travel patterns.**
  - **Differentiate between impingement and harm, and identify factors which influence the range of harm.**
  - **Identify four factors which affect behavior of hazardous materials in emergencies.**

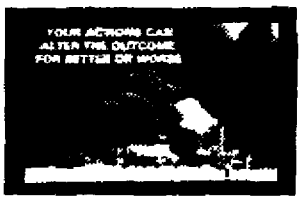
Any questions?

Slide 338



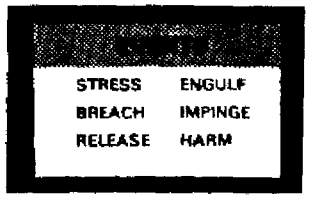
TIME	CONTENT/METHODOLOGY	MATERIALS
5 min.	**STEP 2**—Introduce Hazardous Material General Behavior Model	
	• *Present the four factors to be considered in visualizing hazardous material behavior.*	Slide 339
	• Four factors affect the behavior of hazardous materials in an emergency: —Inherent properties and quantity of the hazardous material —Built-in characteristics of the container —Natural laws of physics and chemistry —Environment, including the physical surroundings (terrain) and the conditions (weather)	
	• Determining the interrelationship among these factors can help considerably in visualizing what is likely to happen in the emergency.	
	• Additionally, your actions can alter the outcome, for better or worse. Remember, we want to become part of the solution, not part of the problem.	
	• *Present the general events sequence in hazardous material behavior in emergencies.*	
	• From experience, we know that hazardous material behavior in an emergency follows a basic sequence of events. • Remember the definition of a hazardous material—any substance that jumps out of its container at you when something goes wrong, and hurts or harms the things it touches or impinges upon.	Slide 340
	• Look at these events and consider how they interrelate in a hazardous materials emergency:	Slide 341

Slide 339



Slide 340

Slide 341



TIME	CONTENT/METHODOLOGY	MATERIALS
	• **Stress**	
	—Under normal conditions, hazardous materials are controlled by some kind of container (Tanks, pipes, cylinders, bottles, bags, etc.).	Slide 342
	—For an emergency to begin, the container must be disturbed or stressed in some way.	
	• **Breach**	Slide 343
	If the container is stressed beyond its recoverable limits (design strength or ability to hold the contents), the container opens up.	
	• **Release**	Slide 344
	When the container breaches, the contents can escape. Contents escape in the form of matter or energy or a combination of both.	
	• **Engulf**	Slide 345
	Escaping matter and/or energy travel away (disperse) from the point of release, forming predictable patterns governed by natural laws of physics and chemistry.	
	• **Impinge**	Slide 346
	As the hazardous material and or container travel away from the release point, it (they) may touch or impinge upon vulnerable exposures such as people, systems (including the environment), and property.	

Slide 342

Slide 344

Slide 346

Slide 343

Slide 345

TIME	CONTENT/METHODOLOGY	MATERIALS

- **Harm** — Slide 347

  The impinged exposures may be harmed depending on the dosage or concentration of the material impingement.

  Therefore, if this is what happens in an emergency, we can use this sequence of events to help us visualize specifically what is likely to happen in any emergency we face.

- *Introduce questions to be answered in visualizing what is likely to happen in a hazardous material emergency.*

  Certain questions should be answered in visualizing what is likely to happen in an emergency:

  - **Where** is the hazardous material or container likely to go when released in an emergency? — Slide 348
  - **Why** is the hazardous material/container likely to go there? — Slide 349
  - **How** will the hazardous material/container get there? — Slide 350
  - **When** will the hazardous material/container get there? — Slide 351
  - **What** harm will occur when the hazardous material gets there? — Slide 352

- *Introduce the hazardous material general behavior model.*

Slide 347

Slide 349

Slide 351

Slide 348

Slide 350

Slide 352

TIME	CONTENT/METHODOLOGY	MATERIALS
	Hazardous Material General Behavior Model and Basic Events Interruption Principles	
	• **For short—Behavior Model**	Slide 353
	• **Basic concepts in events format:**	SM VII-5
	—Stress **—Breach** **—Release** **—Engulf** **—Impinge** **—Harm**	
10 min.	**STEP 3**—Lecture with Slides—Discuss Stress/Breach Events.	
	• ***Discuss the stress event in detail.***	Slide 354
	Principle: First look for stressed containers in any emergency.	
	• **Stress:** Is applied force or system of forces that tend to:	
	—Strain or deform a container.	
	—Trigger a change in condition of the contents.	
	• **Stress can affect both/either the contents and/ or the container.**	
	• **Five basic forms of stress:**	
	• **Thermal**	Slide 355
	• Fire	
	• Sparks, friction, electricity	
	• Ambient temperature changes	
	• Extreme or intense cold	

Slide 353

Slide 354

Slide 355

TIME	CONTENT/METHODOLOGY	MATERIALS
	• **Mechanical**	Slide 356
	• Object physically contacting the container	
	• Effects: Punctures, gouges, bending, breaks, tears, etc.	
	• **Chemical**	Slide 357
	• Chemical action.	
	• Examples: Acids corroding container, pressure generated by decomposition or polymerization, corrosion	
	• **Irradiation**	Slide 358
	• Alpha, beta and gamma radiation	
	• Protection: shielding, distance and time	
	• **Etiologic**	Slide 359
	• **Two forms in combination mechanical/ thermal (Waverly, TN)**	Slide 360
	Summary Reminder: **Look for stressed containers.**	
	• *Discuss the breach event in detail.*	
	Principle: Make sure you know how your container will breach.	Slide 361
	Breach	
	• If the container is stressed beyond its recoverable limits, it will open up or breach.	
	• Different containers breach in different ways.	

Slide 356

Slide 357

Slide 358

Slide 359

Slide 360

Slide 361

TIME	CONTENT/METHODOLOGY	MATERIALS
	Five Basic Types of Breach:	
	• **Disintegration**	Slide 362
	• Total loss of integrity—Visualize a glass jar shattering	
	• Example: explosives	Slide 363
	• **Runaway cracking**	
	• Associated with closed containers or bleves	Slide 364
	• Rapidly growing crack/container breaks apart into 3–5 pieces	
	• Example: Bleve, Cresent City	
	• **Attachments open up**	
	Example: pressure relief device functioning	
	• **Puncture**	Slide 365
	Example: coupler puncture, drum puncture	
	• **Split or tear**	Slide 366
	Example: Torn bags or boxes, split plastic drums	
	Summary Reminder: Become familiar with how containers breach in emergencies. If you don't know, get help from someone who does!	
25 min.	**STEP 4**—Group Activity—Stress/Breach Skill Building Exercise	
	• **Stress/Breach Identification Exercise**	SM VII-6 to VII-7

Slide 362

Slide 364

Slide 366

Slide 363

Slide 365

TIME	CONTENT/METHODOLOGY	MATERIALS
	Before conducting this exercise, the instructor should determine which of the following cases should be used. Selection should be based upon relevancy to local problems and concerns. The number of cases used can be varied by the instructor in order to help maintain course timelines (three cases is the recommended number if you are on schedule). Repetition of cases from previous exercises is intentional. Identify these as newspaper accounts that will not be complete.	
	Case numbers for this exercise: 31, 33, 46. (Cases are located in Appendix B, pp. 1 to 9 in both the Instructor Guide and the Student Manual).	Appendix B (SM & IG) B-1 to B-9
	Have the students form into groups and turn to the Stress/Breach Identification skill-building sheet on pages 6 and 7 in the Student Manual. Call their attention to the behavior model information on page 5. This contains both the kind of information to put into the skill-building sheet, and other information to help the students visualize each incident.	
	Indicate which case incidents are to be used and start the exercise. Ask students to try to visualize each of the incidents as they read them. When the students are finished, ask them to share their answers and lead a discussion about the exercise.	
10 min.	**STEP 5**—Lecture with slides—Release and Engulf Events	
	• *Discuss release event in detail.*	Slide 367
	Principle: Look for energy or matter to escape.	
	Release	
	• Once the container is breached, the material can escape.	
	• Of importance is the release rate—the faster the release, the more harm likely.	
	• **Four Types of Release:**	Slide 368

Slide 367

Slide 368

TIME	CONTENT/METHODOLOGY	MATERIALS

	• **Detonation**
	  • Associated with explosive chemical reaction
	  • Time—less than 1/100th of a second
	  • Examples: Military munitions, dynamite, organic peroxides	

	• **Violent Rupture**
	  • Associated with runaway cracking/closed containers/Bleve
	  • Time—less than 1 second
		Slide 369

	• **Rapid Relief**
	  • Release through pressure relief devices, damaged valves, punctures, or broken piping
	  • Time—several seconds to several minutes
		Slide 370

	• **Spill or leak**
	  • Nonviolent flow through openings in fittings, splits or tears, and punctures
	  • Time—minutes to days
		Slide 371

	Remember, there are two forms that can jump out at you—matter and/or energy. *Summary Reminder:* **Learn how various materials escape from their containers under emergency conditions.** • *Discuss engulf event in detail.*	

Slide 369

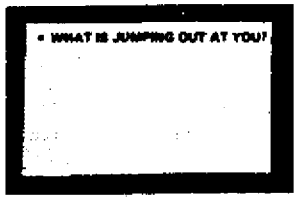
Slide 370

Slide 371

TIME	CONTENT/METHODOLOGY	MATERIALS
	Principle: Predict your dispersion patterns	Slide 372
	Engulf	
	• When the contents are released, they are free to travel and disperse. When the contents travel, the problem is more likely to escalate.	
	• Where the hazardous material goes at this time is dependent on the characteristics, various chemical laws, and the environment	
	• **Questions to be answered:**	
	• **What is jumping out at you?**	Slide 373
	◦ Matter	
	◦ Energy	
	• **What form is it in?**	Slide 374
	◦ Infra-red or gamma rays	
	◦ Pressure waves	
	◦ Dusts, powders, fragments, shrapnel, chunks	
	◦ Organisms	
	◦ Alpha or Beta rays	
	◦ Liquids	
	◦ Vapors	
	◦ Vaporizing liquids	
	• **What is making it move?**	Slide 375
	◦ Thermal differential	
	◦ Self-propelled	
	◦ Wind	

Slide 372

Slide 373



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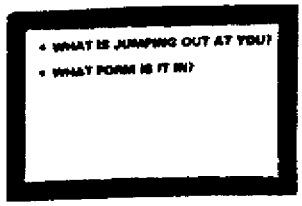
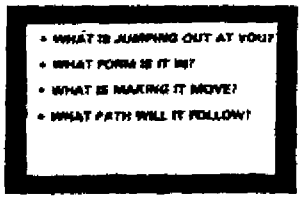


Slide 375

TIME	CONTENT/METHODOLOGY	MATERIALS
	• Personnel transport • Gravity • Diffusion	
	• **What path will it follow?** • Linear • Radial • Random • Follow contour • Upward or outward	Slide 376
	• **What dispersion pattern will it create?** • Cloud • Cone • Plume • Stream • Irregular deposits	Slide 377
	• **Gas dispersion patterns**	
	• Escape under pressure, such as leaks from a cylinder, forming a cloud or plume.	Slide 378
	• If enclosed, the cloud will expand and fill available spaces. For example, the slide shows a 270 × expansion ratio which is the expansion ratio for propane.	Slide 379
	• Carried by wind as a plume.	Slide 380
	• If the vapor density is greater than 1, the material is heavier than air: —Settles in low places —Travels along ground as a plume	Slide 381

Slide 376



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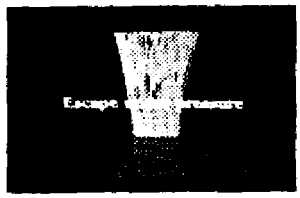

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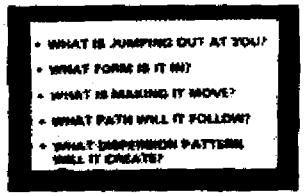
Slide 377



Slide 379

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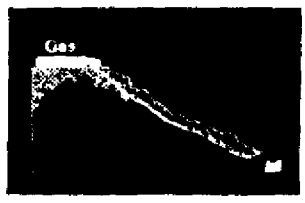


TIME	CONTENT/METHODOLOGY	MATERIALS
	Liquid Dispersion Patterns	
	• Flow along the ground as a stream	Slide 382
	• Vaporize and act as a gas (Stream with plume)	Slide 383
	• Seep into the ground or other absorbent surface (irregular deposits)	Slide 384
	• Carried in clothing worn at the scene irregular deposits)	Slide 385
	Solid Dispersion Patterns	
	• Scatter (irregular deposits)	Slide 386
	• Form dust clouds and are carried by the wind (plume)	Slide 387
	• Stick to surfaces, carried away from the scene (irregular deposits)	Slide 388
	• Rocket, like pieces of tank (irregular deposits)	Slide 389

Slide 382

Slide 385

Slide 388

Slide 383

Slide 386

Slide 389

Slide 384

Slide 387

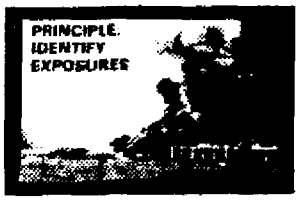
TIME	CONTENT/METHODOLOGY	MATERIALS
	Summary Reminder: **Visualize (predict or define) where the hazardous material and/or container will go when released.**	Slide 390
	Pay attention to how hazardous materials engulf to produce a danger zone in other emergencies.	Slide 391 (Blank)
25 min.	**STEP 6**—Group Activity—Release/engulf skill building exercise	
	• **Instructor conducts release/engulf exercise.**	SM VII-8 to VII-9
	Before conducting this exercise, the instructor should determine which of the following cases should be used. Selection should be based upon relevancy to local problems and concerns. The number of cases used can be varied by the instructor in order to help maintain course timelines (three cases is the recommended number if you are on schedule). Repetition of cases from previous exercises is intentional.	
	Case numbers for this exercise: 4, 15, 39. (Cases are located in Appendix B, pages 1 to 9 in both the Instructor Guide and the Student Manual.	Appendix B IG & SM
	Have the students form into groups, and turn to the Release/Engulf Skill-Building Sheet on page 9 of the Student Manual. Call their attention to the behavior model information on page 5 to put into the skill-building sheet, and other information to help them visualize each of the incidents as they read them.	
	When the students are finished, ask them to share their answers and lead a discussion about the exercise.	

Slide 390

Slide 391

TIME	CONTENT/METHODOLOGY	MATERIALS
10 min.	**STEP 7**—Lecture with slides—Impinge and harm events	
	• *Discuss impinge event in detail.*	SM VII-10 to VII-11 Slide 392
	Principle: Identify exposures.	
	Impinge	
	• **As the contents disperse (travel away from the point of release), they impinge on exposures.**	
	Exposures: People, Systems, Property.	Slide 393
	• **Impinged exposures may or may not suffer harm.**	
	• **Types of impingement:**	Slide 394
	—**Short Term**—Minutes/hours. For example, surrounded by a gas cloud, generally short-term exposure	
	—**Medium Term**—Days/weeks/months. For example lingering pesticide residue	
	—**Long Term**—Years/generations. For example, permanent radioactive source contact	
	NOTE: An incident can result in one or more types of impingement.	
	Guideline: Determine/visualize exposures likely to be impinged upon.	
	• *Discuss harm event in detail.*	
	Principle: Focus on emergency outcomes.	Slide 395

Slide 392



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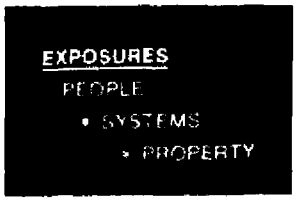

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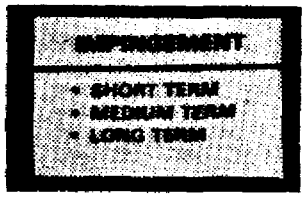


Slide 395

TIME	CONTENT/METHODOLOGY	MATERIALS
	Harm	
	• **Impinged exposures can be harmed** depending on the exposure they have to the effects of the hazardous material and/or container.	
	• **Three factors which affect or determine harm:**	
	—**Timing of release** (speed of escape and travel, length of exposure)	Slide 396
	—**Size** (size of area covered)	Slide 397
	—**Lethality** (Dosage or concentration received by the individual exposure)	Slide 398
	• **Types of harm:**	Slide 399
	—**Thermal** (consider both heat *and* cold)	
	—**Toxic** (poisonous)	
	—**Corrosive**	
	—**Mechanical** (direct contact from a piece of tank, etc.)	
	—**Asphyxiation** (lack of oxygen)	
	—**Radiation** (from radioactive material exposure)	
	—**Etiologic** (from etiologic agent exposure)	
	Summary Reminder: **Predict the type harm likely to exposures within dispersion area that are being impinged upon.**	Slide 400 (Blank)

Slide 396

Slide 398

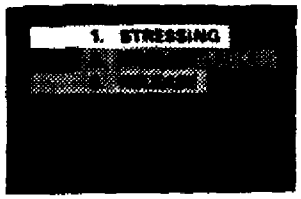
Slide 400

Slide 397

Slide 399

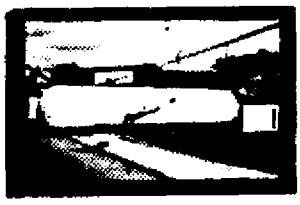
TIME	CONTENT/METHODOLOGY	MATERIALS
25 min.	**STEP 8**— Group Activity—Impinge/Harm Skill-Building Exercise	
	• **Instructor conducts impinge/harm event exercise.**	
	Before conducting this exercise, the instructor should determine which of the following cases should be used. Selection should be based upon relevancy to local problems and concerns. The number of cases used can be varied by the instructor in order to help maintain course timelines (three cases is the recommended number if you are on schedule.)	SM VII-10 to VII-11
	Case numbers for this exercise: 6, 32, 45. (Cases are located in Appendix B, pages 1 to 9 in both the Instructor Guide and the Student Manual).	Appendix B IG & SM
	Have the students form into groups and turn to the Impinge/Harm Event skill-building sheet on page 11 of the Student Manual.	
	Call students' attention to the behavior model information on page 5. This contains both the kind of information to put into the skill-building sheet, and other information to help the students visualize each incident.	
	Indicate which case incidents are to be used and start the exercise. Ask the students to try to visualize each of the incidents as they read them.	
	When the students are finished, ask them to share their answers and lead a discussion about the exercise.	
	Events in hazardous material general behavior model:	Slide 401
	1. Stress	
	2. Breach	
	3. Release	
	4. Engulf	

Slide 401



TIME	CONTENT/METHODOLOGY	MATERIALS
	5. **Impinge** 6. **Harm** *Summary Reminder:* **Use this format when you are confronted with an emergency involving hazardous materials to visualize behavior of the hazardous material and to identify behavior not understood (so you know you need help).** **Any questions?**	
40 min.	**STEP 9**—Group Activity—Practice visualizing events using general behavior model on an LP gas truck exercise NOTE: Instructor may use the slide set as indicated, or use only slide 402 and an OHT of the Behavior Model to record student answers. In either mode, two screens may be needed for this exercise. • *Introduce exercise.* • **Let's practice the skills of visualizing the behavior of hazardous materials in an emergency using the behavior model.** • Introduce the General Behavior Model Worksheet to students on page VII-12 of the Student Manual. • Describe and give instructions for use of worksheet. —**Identify event occurring at time of arrival.** —**Visualize future events.** —**Place a rectangle (or circle) around the expected event category.** —**Use arrows to provide sequence.** • Background information for exercise. —Tank truck traveling 35 mph when it swerves to miss car with mother and three children.	SM VII-5 Slide 402

Slide 402



—Truck flipped on its side and slid into the savings and loan building.

—Front end of trailer hit savings and loan hard enough to move the building two inches off the foundation.

—Driver was uninjured.

—Tank was shell full of LP gas (outage requirement not complied with).

—Temperature at time of accident—50°F.

—Time of accident 9 AM Sunday.

—Wind—10 mph.

- Select and identify local setting for accident so students can follow through with a description of the outcome (use map, drawing, slides, etc.).

- *Walk students through the use of the behavior model in this exercise.*

  - *Discussion outline for practice in estimating likely harm without intervention.*

Have students complete their general behavior model worksheet as you go through the exercise. Instruct them to practice their skills for defining the hazardous material problem in conjunction with the instructor. In this exercise, class members should complete both the behavior model and the outcome estimate worksheets.

SM VII-12, VII-13, VII-14

- *Instructor will guide this discussion.*

- **What type of stress do you see in this situation?**

  —Mechanical

  —Possible thermal

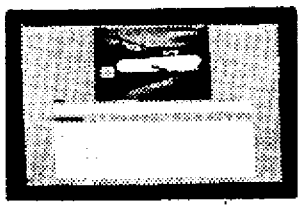
Slide 403

Let's track through the mechanical stress first.

Slide 403

TIME	CONTENT/METHODOLOGY	MATERIALS
	• **With this mechanical stress, what type of breach would you expect?**	
	—Split or tear	Slide 404
	—Puncture	
	—Attachments open up	
	• **With these types of breaches, what type release would you expect?**	
	—Rapid Relief	Slide 405
	• **With this type of release, what type of dispersion would you expect?**	
	—Stream (contour) for liquid LPG released	Slide 406
	—Plume (for vaporizing gases coming off released liquid)	
	• **What area would you expect to be engulfed by each of these dispersion patterns?**	
	—Stream (contour)	
	• What is the direction of travel?	
	• What are the dimensions of area affected?	
	• Will there be a sewer problem?	
	—Plume	
	• What is the direction of travel?	
	• What are the dimensions of area affected?	
	• Will there be a sewer problem?	

Slide 404



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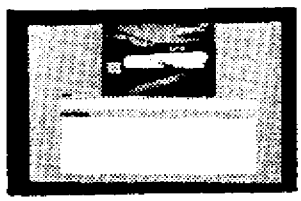

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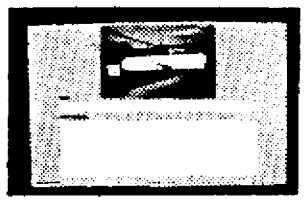
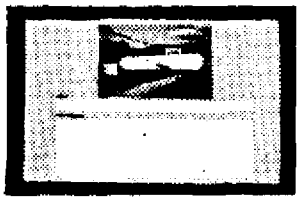
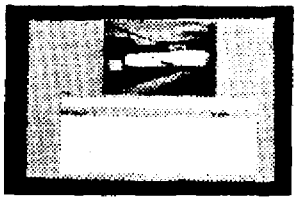


TIME	CONTENT/METHODOLOGY	MATERIALS
	• **What type impingement would you expect from these dispersions?**	
	—Short term (transient)	Slide 407
	• **What type harm would you expect within this danger zone?**	
	—Without ignition of contents	
	• Thermal from frostbite.	Slide 408
	• Asphyxiation.	
	—With ignition of contents	Slide 409
	• Thermal from direct contact or radiant heat.	
	• Sources readily available, unless you can control ignition sources.	
	• **Which one of these sets of harm would you expect in this situation?**	
	—Ignition	
	• Complete outcome estimate worksheet. (Ask for class consensus on each yes or no answer)	
	• Next, repeat the exercise with an initial thermal stress.	
	• **Now what other stresses are present?**	
	—Thermal—From what?	Slide 410
	• Ambient temperature increase	

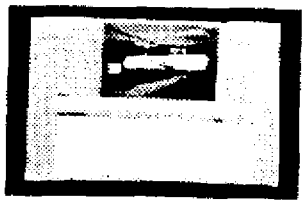
Slide 407



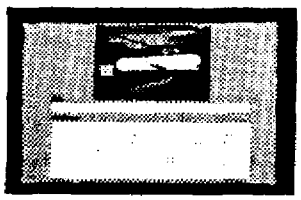
Slide 408



Slide 409



Slide 410



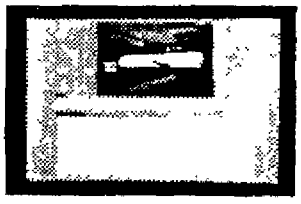
TIME	CONTENT/METHODOLOGY	MATERIALS
	• Fire involving leaking fuel	
	• Arcing from overhead wires	
	• **With this type of stress, what type of breach would you expect?**	
	—Attachments open up first, then,	Slide 411
	—Runaway cracking.	
	• **With these breaches, what type of release would you expect?**	
	—Rapid relief for attachments opening up (already tracked)	Slide 412
	—Violent rupture	
	• **With this type of release, what type dispersion would you expect?**	
	—Cloud	Slide 413
	• **What kind of impingement would you expect?**	Slide 414
	—Short term (initial blast)	
	• **What kind of harm would you expect?**	Slide 415
	—Thermal	
	—Mechanical	
	• **Now that we have tracked the possibilities, which of the two options do you think is most likely to happen?**	
	—Mechanical sequence.	

Slide 411

Slide 412

Slide 413

Slide 414



Slide 415

TIME	CONTENT/METHODOLOGY	MATERIALS
	At the incident, response personnel:	Slide 416
	• evacuated the area;	
	• eliminated ignition sources;	Slide 417 (Blank)
	• blocked the sewer;	
	• called for a contractor to right the truck, but did *not* offload the product;	
	• used airbags to right the truck;	
	• took 12 hours to terminate the incident.	

Slide 416

Slide 417

Answer Key

STRESS/BREACH SKILL-BUILDING EXERCISE

Directions: Your instructor will indicate the cases for you to read for this exercise. The cases are found in Appendix B at the back of your Student manual.

Read each case, then determine the stressor(s) and stressee(s) involved, indicate the type of stress applied, identify the container, the contents, and then indicate the breach type.

Cases: 31, 33 46

	Case 31	Case 33	Case 46
*Stressor(s)	Rail or coupling	Forklift	Steam under pressure
*Stressee(s)	Tank cars	Propane tank	Tank
Type Stress Applied	Mechanical, possibly thermal/chemical	Mechanical/thermal	Thermal and/or mechanical
Container Type	Tank cars	Tank	Enclosed tank
Contents	Vinyl chloride	Propane	Phenol formaldehyde and carbolic acid
Breach Type	Punctures, splits, tears	Puncture	Attachments opening up

*See definitions in Appendix C.

Notes:

RELEASE/ENGULF SKILL-BUILDING SHEET

Directions: Your instructor will indicate the cases for you to read for this exercise. The cases are found in Appendix B at the back of your Student Manual.

Read each case, determine the hazardous material involved, the form of the product released, the type of release, the dispersion pattern formed and the path it will follow.

Cases: 4, 15, 39

	Case 4	Case 15	Case 39
Hazardous Material(s)	Liquid Ammonia	PCB, Dioxin	Nitrogen Tetroxide
Form of Released Product*	Liquid and gas	Solid, liquid and gas	Vaporizing liquid
Type Release	Rapid release	Violent rupture	Spill or leak
Dispersion Pattern Formed	Stream and cloud	Stream, plume, irregular deposits	Irregular dispersion of vaporizing liquid
What path will it follow?	Contour; upward and outward	Random, depending on building structure	Random

*Solid, Liquid, or Gas

Notes:

IMPINGE/HARM SKILL-BUILDING SHEET

Directions: your instructor will indicate the cases for you to read for this exercise. The cases are found in Appendix B at the back of your Student Manual.

Read each case, determine the hazardous material, the type of impingement, and the type of harm created.

Cases: 6, 32, 45

	Case 6	Case 32	Case 45
Hazardous Material(s)	Organic phospate	Hydrobromic acid pentachlorophenol	Plutonium
Type of Stress	Mechanical	Mechanical	Thermal
Type Container	5-gallon container	Fiberboard drums	N/A
Type of Release	Spill	Spill or leak	Rapid release
Type of Impingement	Medium-term	Medium-term	Medium
Type of Harm	Toxic	Thermal, toxic, corrosive	Radiation

Notes: