TRAINING FOR RADIATION EMERGENCIES: FIRST RESPONDER OPERATIONS

INSTRUCTOR GUIDE

Developed by

THE INTERNATIONAL ASSOCIATION OF FIRE FIGHTERS ®

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Agenda

Day 1

Welcome and Pre-Test	8:30 a.m. to 9:00 a.m.
Hazardous Materials Review	
Types of Alarms	9:00 a.m. to 9:45 a.m.
Break	9:45 a.m. to 10:00 a.m.
Health and Safety	10:00 a.m. to 10:30 a.m.
General Precautions	10:30 a.m. to 11:00 a.m.
Break	11:00 a.m. to 11:15 a.m.
Medical Surveillance	11:15 a.m. to 11:45 p.m.
Break	11:45 a.m. to 1:00 p.m.
Recognition and Identification	
Recognition and Identification	1:00 p.m. to 1:10 p.m.
Occupancy and Location	1:10 p.m. to 1:45 p.m.
Break	1:45 p.m. to 2:00 p.m.
Placards, Labels and Markings	2:00 p.m. to 2:30 p.m.
Containers, Shapes and Designs	2:30 p.m. to 3:00 p.m.
Break	3:00 p.m. to 3:15 p.m.
Shipping Papers and Facility Documents	3:15 p.m. to 3:45 p.m.
Chemical Properties	
States of Matter	3:45 p.m. to 4:00 p.m.
Break	4:00 p.m. to 4:15 p.m.
Chemical Properties	4:15 p.m. to 5:15 p.m.

Day 2

Introduction to Radioactive Materials	
Introduction and Radiological Terms	8:30 a.m. to 9:15 a.m.
Exposures	9:15 a.m. to 9:45 a.m.
Break	9:45 a.m. 10:00 a.m.
Protecting Your Health and Safety	10:00 a.m. to 10:45 a.m.
Packaging, Transportation and Storage	
Packaging	10:45 a.m. to 12:15 p.m.
Break	12:15 p.m. to 1:30 p.m.
Transportation	1:30 p.m. to 2:00 p.m.
Break	2:00 p.m. to 2:15 p.m.
Storage	2:15 p.m. to 2:45 p.m.

Radiation Emergencies	
Initial Response	2:45 p.m. to 3:00 p.m.
Detecting Radiation Hazards	3:00 p.m. to 3:45 p.m.
Break	3:45 p.m. to 4:00 p.m.
Treating Patients	4:00 p.m. to 4:30 p.m.
Controlling and Reporting Hazards	4:30 p.m. to 5:00 p.m.

Day 3

Personal Protective Equipment	
Types of Protective Equipment	8:30 a.m. to 9:00 a.m.
Respiratory Equipment	9:00 a.m. to 9:30 a.m.
Break	9:30 a.m. to 9:45 a.m.
Decontamination	9:45 a.m. to 10:15 a.m.
Scene Management	
Incident Management Systems	10:15 a.m. to 11:00 a.m.
Break	11:00 a.m. to 11:15 a.m.
Establishing a Hazard Area	11:15 a.m. to 12:00 p.m.
Break	12:00 p.m. to 1:15 p.m.
The Media	1:15 p.m. to 2:00 p.m.
Termination	2:00 p.m. to 2:15 p.m.
Break	2:15 p.m. to 2:30 p.m.
Pre-Incident Planning	
Introduction	2:30 p.m. to 2:40 p.m.
Hazard Identification	2:40 p.m. to 3:00 p.m.
Hazard Analysis and Risk Assessment	3:00 p.m. to 3:30 p.m.
Break	3:30 p.m. to 3:45 p.m.
Analysis of Resources	3:45 p.m. to 4:30 p.m.
Post-Test	4:30 p.m. to 5:00 p.m.

PREFACE

Mission Statement

The Hazardous Materials Department of the International Association of Fire Fighters, (IAFF) in cooperation with the U.S. Department of Energy and Fluor Daniel Fernald, has produced this training program for fire fighters working in communities along DOE transportation routes. Our intent is to teach fire fighters the skills they need to protect their health and safety when responding to hazardous materials emergencies and specifically, to incidents involving radioactive materials.

Course Objective

The purpose of this program is to provide refresher operations training, as well as in-depth training in radiation, to fire fighters who are currently trained to the National Fire Protection Association (NFPA) *Standard for Professional Competence of Responders to Hazardous Materials (NFPA 472)*.

While we believe all of the information contained herein to be accurate and timely, we are in no way prescribing this information as the final authority. Where there are discrepancies between the material presented in this program and local policies and proce-dures, those of your own jurisdiction will take precedence. The U.S. Department of Energy, Fluor Daniel Fernald and the IAFF assume no responsibility based on any representations made in these materials.

Individual copies of the Student Text cannot be supplied by the IAFF. However, the IAFF authorizes qualified fire instructors to duplicate the Student Text exactly and completely so that each student will have a copy. In addition, exact and complete copies of this training package can be made for the purpose of increasing distribution of the materials. Copies of the Student Text or the training package cannot be sold. These materials have been copyrighted under the copyright laws of the United States. Permission to duplicate these materials is conditional upon meeting the criteria listed above and may be rescinded by the IAFF for failure to comply.

As with any skill or knowledge area, refresher training and regular practice are necessary in order to maintain your level of proficiency. Refresher training on an annual basis, at a minimum, should be conducted and drills are needed more frequently. Keep in mind that requirements from federal and state occupational safety and health agencies, as well as industry standards, should always be incorporated into departmental training.

UNIT 1:
HAZARDOUS MATERIALS REVIEW

LEARNING OBJECTIVES

By the end of this unit, participants will be able to:

- Explain why the ability to recognize and identify hazards is important to First Responders
- Explain how the location of an incident may indicate the type and quantity of hazards present
- Distinguish between **contamination** and **exposure**
- Describe the difference between **acute** exposure and **chronic** exposure
- Describe the four major routes of entry
- Describe the toxic effects that may result from chemical exposure
- Define **medical surveillance**
- Identify the elements of medical surveillance

INSTRUCTOR NOTES

Purpose of Unit:

This unit provides background information on hazardous materials, including a summary of the effects of exposure.

Materials and Supplies:

Chalkboard or flip chart
Overhead transparency projector and transparencies 1-1 through 1-4
Slide projector and slides 1 through 11

Instructor Preparation:

Make sure you have enough copies of the following items for each student:

- Notepad
- Student Text
- *North American Emergency Response Guidebook*
- *NIOSH Pocket Guide to Chemical Hazards*

Introduction

Welcome the students. Tell them who you are and a little about your background. Have the students do the same.

INTRODUCTION

This course is designed as a refresher program to reinforce previous training in hazardous materials response. “Hazardous materials” are defined as substances that have the potential to cause harm. They include the Department of Transportation (DOT) hazardous materials (sometimes referred to as “dangerous goods”), and Environmental Protection Agency (EPA) hazardous substances and wastes.

Your rights and responsibilities as a First Responder to hazardous materials incidents are identified by the Occupational Safety and Health Administration (OSHA) in Regulation 29 CFR 1910.120 or EPA 40 CFR 311.

Activity

Conduct the Pre-Test to the course. Allow about 20 minutes, then collect the students’ answers.

Course Reference Materials

Throughout this course you will be asked to look up various chemicals in two reference books, the *North American Emergency Response Guidebook* and the *NIOSH Pocket Guide to Chemical Hazards*. Your instructor will distribute copies of these resources for your use during class and show you how to use them. As a First Responder, you should obtain your own copies of these books as a permanent reference.

Activity

Distribute a *North American Emergency Response Guidebook* and a *NIOSH Pocket Guide to Chemical Hazards* to each student. Instructions for using the Emergency Response Guidebook are on page one of the guidebook. Review the common codes and symbols for the NIOSH book. Select one chemical to demonstrate how to use the book.

Introduction

Tell the students:

- **What they will learn in**
- **this section**
- **Approximately how long it will take**

TYPES OF ALARMS

Hazardous materials can be found in virtually any type of setting. You may find them at non-structural emergencies, such as gas leaks, fires at open waste disposal sites, brush fires, and other "suspicious odor" calls that occur outside.

Structural Fires

Structural fires often involve hazardous materials.
For example, medical facilities contain dangerous substances such as liquid oxygen, formaldehyde, mercury and ether. Other industries use and process millions of tons of hazardous materials every year and the amount is growing five to ten percent annually. Even residences are not exempt from hazardous materials. Pool chemicals, compressed propane for a gas barbecue grill, pesticides, paints and solvents all can be extremely dangerous if they are present in sufficient quantities.

Questions

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Although the Howell case study is unusual, it clearly demonstrates that you can never know what hazards an "ordinary" home contains. Ask the students about past experiences on residential calls and some of the unusual hazards they have found.

Howell, New York, August, 1994

After reports of unusual activity, police discovered a bomb factory in this residential subdivision. The bomb maker was a 15-year old high school freshman. For over a year he had been making C4 explosives – the type used by terrorists. Hazardous materials specialists were able to remove all the chemicals without evacuating the neighborhood, but about 20 specially-equipped vehicles were needed to haul them away. Authorities speculated that had the house exploded, it would have taken part of the subdivision with it. — "Hazardous Materials Emergencies," John R. Cashman, 1995

TABLE 1.1 HAZARDS CHECKLIST STRUCTURAL ALARMS	
IF THESE SITES ARE INVOLVED…	**LOOK FOR THESE HAZARDS:**
Hospitals, medical labs or clinics	Biological waste Infectious patients or lab animals Radioactive materials Compressed and anesthetic gases Cryogenic liquid oxygen Syringes, sharp instruments Ethylene oxide Nitrous oxides Radioisotopes
Manufacturing and processing	Resins (alkyds, vinyls) Pigments (dry metallic powders) Compressed gases Ammonia refrigerant Lubricating and cooking oils Dusts and nitrocellulose (cotton fibers) Aerosols Radioisotopes and radioactive materials
Retail and commercial	Flammable gases and liquids Corrosives
Business offices	Cleaning products Copy chemicals (anhydrous ammonia)
Residences and hotels	Gasoline and solvents Pesticides and fertilizers Pool products Paint Cleaning supplies Illegal drug labs
Schools	Pool products Cleaning products Lab chemicals such as: Acids and bases Peroxides and ethers Alcohols and solvents
Farms	Pesticides Oxidizers Anhydrous ammonia
Construction	Ammonium nitrate fuel oil mixture (ANFO) Compressed gases Solvents Radioisotopes
Mining	Methane Coal dust and metal sulfide ores Radioactive materials (uranium)
Semiconductor manufacturing	Organic liquids (butyl acetone, toluene) Cyanide, carbon monoxide Arsine gas Phosphine

Slides

Show slides 1 through 11 as you discuss transportation alarms involving hazardous materials.

Transportation Alarms

Identifying hazardous materials is more difficult at transportation incidents than at fixed sites, simply because there is less control over the situation. You may have little information about the amount and type of cargo, particularly with highway shipments. Because of this, the Department of Transportation (DOT) regulates the shipment of dangerous substances by public highway, rail, aircraft, and waterway. All DOT regulations are detailed in the Code of Federal Regulations (CFR) Title 49. The table below shows a breakdown of hazardous materials involved in accidents during the 1980s.

Incident Reports Involving Hazardous Materials	
Flammable Liquids	39.9%
Corrosive Materials	37.9%
Combustible Liquids	6.4%
Poisons (B)	4.3%
Compressed Gas (flammable)	1.9%
Oxidizing Materials	2.7%
Compressed Gas (non-flammable)	2.1%
Radioactive Materials	0.3%
Other	4.5%

TABLE 1.2 HAZARDS CHECKLIST NON-STRUCTURAL AND TRANSPORTATION ALARMS	
IF THESE SITES ARE INVOLVED…	**LOOK FOR THESE HAZARDS:**
Construction materials	Explosion hazards Gas leaks Pressurized containers Temporary electrical equipment
Trenches, tanks, or other confined spaces	Asphyxiants Oxygen-deficient atmospheres Other toxic gases
LP tanks	Containers under pressure Butane, propane Other flammable gases
Unidentified odors	Gas leaks Toxic chemicals
Victims down; no apparent reasons	Asphyxiants Toxic gases Biological hazards
Trash, garbage, or other wastes, as well as unknown materials	Solvents Aerosols Flammable liquids Medical waste Poisons Radioactive materials Biological hazards All other dangerous materials
Electrical transformers	Mineral oil Polychlorinated biphenyls (PCBs)
Cargo Tanks	Corrosives Gasoline and fuels Methanol Ethyl alcohol Crude oil Asphalts Propane, butane, and LP gases Anhydrous ammonia Liquid oxygen Bulk flowable commodities Containers under pressure Multiple products Radioactive materials
Rail cars	Chlorine Propane, butane Anhydrous ammonia Poisons Corrosives Flammable liquids Containers under pressure Multiple products Radioactive materials
Adjacent chemical, manufacturing, or utilities	All types of hazardous materials

Key Points

- **Hazardous materials include a wide range of substances**
- **Effects of exposure can be immediate, delayed, or undetectable**
- **Your department should have procedures that protect you from exposure**
- **But you must also be able to protect yourself**

HEALTH AND SAFETY

The term “hazardous materials” covers a broad range of substances with a wide variety of effects. Some materials are highly toxic to humans. Others are dangerous primarily because they are flammable, though many can cause health effects as well. Exposure to various hazardous materials may have immediate effects, delayed effects, or no detectable effects at all. Although no standard operating procedures can protect you against all hazards, your department should establish and follow operating procedures that minimize your exposure to hazardous materials. To help protect yourself, you must become familiar with the health effects of various chemicals so that you can recognize early signs and symptoms of exposure, provide effective first aid to victims, and give complete information to your health care provider about exposures.

This section discusses how hazardous materials exposures can occur, the different ways that toxic substances can affect the body, and where you can turn for additional information.

Exposures and Effects

Questions

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Ask the students the following questions:

- **Has your PPE ever failed to protect you from a hazard?**
- **How do you think it would hold up against highly corrosive chemicals? Hazardous chemical vapors? Radiation?**

You can often prevent exposure to hazardous materials even if you must work in close proximity to a hazardous substance. For example, your positive-pressure self-contained breathing apparatus prevents your exposure to carbon monoxide during fire fighting. In some cases, however, your equipment cannot adequately protect you from the hazards at the scene; many gases and vapors can easily penetrate turnout clothing. To prevent exposure, you need to become familiar with the limitations of your turnout clothing.

Contamination vs. Exposure

It is sometimes difficult to distinguish between exposure and contamination. You might think of yourself as “exposed” whenever you are in the vicinity of a hazard. However, for the purposes of this program, we will assume that you are **exposed** when you contact a harmful substance and your body reacts in some way. The material may or may not remain on or in your body. We will assume that you are **contaminated** when you contact a harmful substance and the material remains on or in your body. Your body may or may not react to the substance.

Transparency

Show Transparency 1-1 and discuss the differences between acute and chronic effects.

Acute vs. Chronic Effects

Acute and chronic "effects" are often confused with acute and chronic "exposures." These are best defined in 29 CFR 1910.1200, Appendix A. This regulation states that:

Generally, the terms "acute" and "chronic" are used to delineate between effects on the basis of severity or duration. Acute effects usually occur rapidly as a result of short-term exposures, and are of short duration. Chronic effects generally occur as a result of long-term exposure, and are of long duration.

For many agents, the effects following different types of exposures are very different.

For example, the primary toxic acute effect of a short-term exposure to benzene is central nervous system depression causing confusion, a "high" feeling, and possibly some difficulty breathing. On the other hand, a chronic effect of long-term exposure to benzene is cancer.

Activity

Draw two columns on the chalkboard. Write Acute at the top of one column and Chronic at the top of the other. Have the students list examples of both types of effects, based on familiar chemicals.

Routes of Entry

There are four routes through which hazardous materials can enter your body:

- Direct contact via skin and mucous membranes
- Inhalation
- Ingestion
- Penetration

Direct contact and inhalation, which are discussed below, are the two most common routes of exposure for fire fighters.

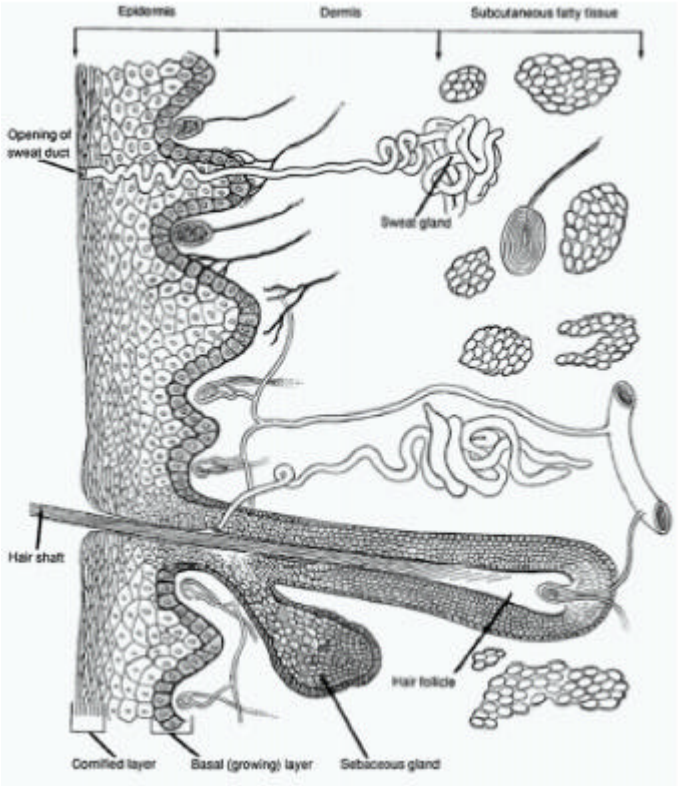
Direct Contact

Transparency

Show Transparency 1-2 and discuss absorption through the skin and mucous membranes as a route of exposure.

Intact skin provides a barrier that varies in its protective effectiveness depending on its condition, the site of contact, and the properties of the hazardous material. Your body will absorb more if:

- The entry site has an abundance of hair follicles, such as the scalp, forehead, jaw area, and underarm (for example, the potential for exposure is twelve times greater in the groin area than the forearm)
- You are in contact with the substance over a longer period of time
- The chemical is concentrated
- Skin temperature is relatively high and blood supply heavy at the entry site. Usually, the more chemical absorbed, the more severe the health effects.



Certain categories of substances, such as fat-soluble chemicals, are more easily absorbed by the skin. For example, paint thinner and other solvents can be absorbed through the skin during direct contact.

Hair follicles and pores are the entry points for chemicals. These openings on the epidermis allow chemicals to penetrate deep into the dermis and subcutaneous tissue.

Intact skin is normally a good barrier to foreign substances. However, skin can be damaged by mechanical injury (trauma), thermal injury (heat or cold), or chemical exposure. Damaged skin is more susceptible to further damage from hazardous materials and may allow more chemicals to be absorbed. Absorption may also be enhanced if the substance and skin are covered, for example, by a bandage or clothing that traps a chemical. Moisture on the skin, especially sweat, also increases absorption.

Skin may be directly affected by exposure, as in the case of corrosives. Or, it may provide a route of entry for hazardous materials, and not be affected by the absorbed material.

Key Points

Skin will absorb more if it is:

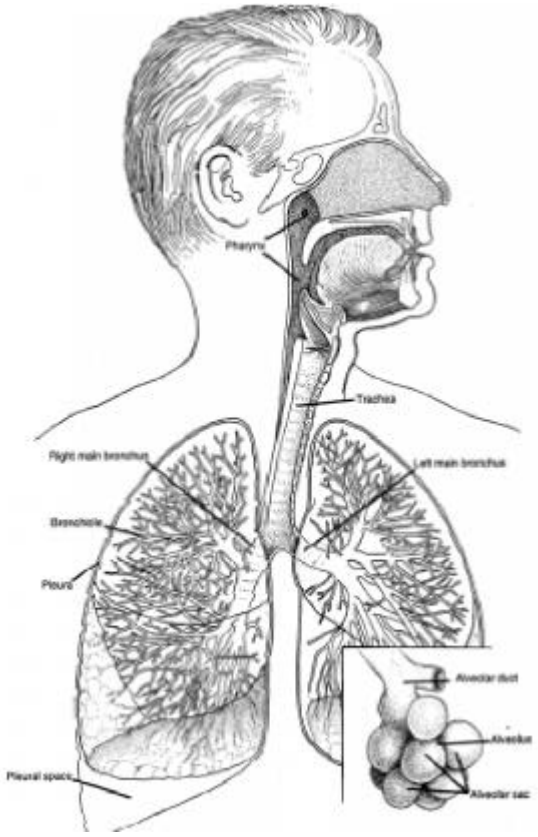
- **Damaged by trauma or chemicals**
- **Covered by bandages or clothing**
- **Moist**

Inhalation

Transparency

Show Transparency 1-3 and discuss inhalation through the respiratory system as a route of exposure.

The lungs act as a **transfer point** in the human body. Oxygen and other substances pass from the atmosphere to the bloodstream, and carbon dioxide passes from the bloodstream to the atmosphere. Many chemicals are absorbed through the respiratory system after they have been inhaled. The respiratory system does have some protective features. Cilia (hair-like projections) line the main airway and trap foreign particles, pushing them toward the throat where they can be swallowed. However, most small particles and gases can penetrate deep into the lungs and bronchial tree. Bronchioles at the end of the bronchial tree can pass chemicals into the bloodstream.



Like the skin, the lungs may serve as a route of entry and may not be affected by the inhaled hazardous material. For example, carbon monoxide easily enters the bloodstream when inhaled. There it binds with red blood cells and prevents oxygen from entering the body's tissues. Solvent vapors are also absorbed after inhalation, and may affect only the nervous system. With any inhalation exposure, absorption is increased when the rate and depth of respiration is increased.

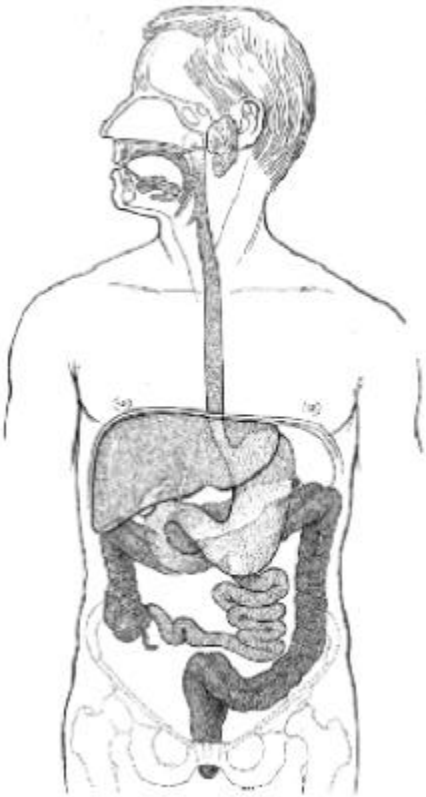
Transparency

Show Transparency 1-4 and discuss ingestion through the gastrointestinal system as a route of exposure.

Ingestion

The gastrointestinal system includes the mouth, pharynx, esophagus, stomach, small intestine, and large intestine. Collectively, these organs are responsible for the absorption, digestion, and storage of nutrients.

Like all routes of exposure, the gastrointestinal system can be directly affected by hazardous materials, or may serve as the point of entry for a chemical that affects other organs in the body.



Although hazardous materials exposure through ingestion is common in cases of suicide and childhood poisoning, it is less common in work and environmental exposures.

However, ingestion can occur when hazardous substances come in direct contact with the mouth or when contaminated hands or clothing come into contact with the mouth. It is also possible to consume toxic materials by eating or smoking in an environment where food and cigarettes are contaminated.

Key Points

Penetration can be:
- **Intradermal**
- **Subcutaneous**
- **Intravenous**
- **Intramuscular**

Penetration

Penetration can also be considered a route of entry for toxic chemicals. Penetration can be **intradermal** (into the skin), **subcutaneous** (under the skin), **intravenous** (into a vein), or **intramuscular** (into a muscle). First Responders are not as commonly exposed via penetration as by the other three routes.

Generally, penetrations are the result of contact with a physical agent, such as:

- Syringes
- High pressure devices (e.g., pressurized steam lines or
- pneumatic lines)
- Sharp objects such as jagged pieces of glass or metal

Key Points

Penetration usually involves:
- **Syringes**
- **High pressure devices**

Questions

???

Ask the students the following question:

- **If you have ever been exposed to hazardous materials on the job, what effects did you have?**

Types of Toxic Effects

Different chemicals have different effects on the body. Some effects are acute; others are chronic depending on the length of exposure. A single chemical may produce a range of effects. The effects of chemicals are not always well-researched, so you should document all significant exposures and be alert for any changes in normal body functions.

References often provide information about toxic substances based on their toxic effects. There are several categories of toxic chemicals.

Asphyxiants

Activity

Have the students suggest a simple asphyxiant, or have them look up carbon dioxide in the NIOSH Pocket Guide. Ask the following questions:

- **Why might this chemical be hard to detect?**
- **In what other ways is this chemical hazardous?**

Asphyxiants are gases that deprive the body tissue of oxygen. There are two types of asphyxiants: **simple asphyxiants** and **chemical asphyxiants.**

Simple asphyxiants displace oxygen. Examples include methane and nitrogen. If the oxygen concentration in the atmosphere drops too low, it cannot support life.

The normal concentration of oxygen in air is 20.9 percent. Atmospheres with lower concentrations are considered oxygen-deficient, especially if the concentration of oxygen is less than 19.5 percent. Oxygen deficiencies typically occur in confined spaces such as tanks, underground spaces, or enclosed rooms. Even if oxygen levels are between the acceptable range of 19.5 to 23.5 percent there can still be a toxic atmosphere.

Chemical asphyxiants are gases that prevent oxygen use by the body's tissues, even though enough oxygen is inhaled. Carbon monoxide is probably the chemical asphyxiant with which most fire fighters are familiar.

Corrosives

Questions

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Ask the students for other examples of corrosives.

Corrosives can cause irreversible tissue damage. Caustic soda and sulfuric acid are common examples. Mild tissue damage from a corrosive may resemble a burn from heat. Acids and alkalis (bases) are corrosives. Their effects depend on the concentration of the chemical and the strength of the acid or base. Hydrochloric acid, for instance, is a stronger acid than acetic acid, which is found in vinegar. Many radioactive materials are also corrosive. For example, the corrosive properties of uranium hexafluoride are much more dangerous than the radioactive properties.

Questions

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Ask the students for other examples of irritants.

Irritants

Irritants can cause effects ranging from uncomfortable to fatal. Some irritants can cause chronic damage to other organs and systems. For example, sulfur dioxide (SO_2) is a colorless gas with a sharp irritating odor commonly used for disinfecting, bleaching, and preservation. The primary organs affected by exposure to sulfur dioxide are the skin, eyes and respiratory system. Continued or very heavy exposures can affect the central nervous system, the cardiovascular, gastrointestinal, and renal systems, and metabolism. Extremely high or long-term doses can lead to pulmonary edema and anaphylaxis.

Questions

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Ask the students for other examples of sensitizers.

Sensitizers

Sensitizers can cause allergic reactions after repeated exposures. Gasoline and many pesticides are examples. A reaction may appear several hours after exposure to the sensitizing chemical. Reactions vary, depending on the route of exposure. Also, reactions may be different because some people are more susceptible to the effects of sensitizers. Repeated exposure may cause a rash on skin, or an asthma-like reaction if the sensitizer is inhaled.

Questions

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Ask the students for other examples of carcinogens.

Carcinogens

Substances that cause cancer are called carcinogens. Benzene and some polyaromatic hydrocarbons are suspected carcinogens. Some carcinogens are known to cause cancer in humans; others are known to cause cancer in laboratory animals and are suspected of causing cancer in humans. It is difficult to study the cancer-causing potential of chemicals among humans for several reasons. Cancers may take up to 20 years to develop following exposure. Asbestos is one example. Levels of exposure to a particular chemical may be difficult to document. Also, very little is known about the effects of exposure to multiple carcinogens.

Questions

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Ask the students for other examples of neurotoxins.

Neurotoxins

Neurotoxic chemicals cause damage—either permanent or reversible—to the central nervous system (the brain and the spinal cord) or the peripheral nervous system (the nerves responsible for movement and sensation in the arms, hands, legs, and feet). Neurotoxins can affect the central or peripheral nervous systems by blocking the electrical signals that the brain sends and receives, or by exciting the systems to send false signals. Symptoms range from uncomfortable to life-threatening, depending on the chemical and the dose. Solvents such as gasoline and benzene are examples of neurotoxins.

Biological Hazards

Like chemicals, biological agents can enter your body through inhalation, ingestion, skin contact, or injection. Biological agents can also enter the bloodstream directly through breaks in the skin.

Infectious agents include **viruses**, such as hepatitis A, hepatitis B, hepatitis C, human immunodeficiency virus (HIV), and the herpes virus.

Bacteria are also infectious organisms that can cause disease in humans. In general, bacteria are better adapted than viruses to live outside of the body. Different types of bacteria cause tuberculosis, strep throat, and most wound infections. Tuberculosis infections are currently increasing and are of concern to responders who have direct patient contact.

Any container that carries a biohazard symbol (as shown below) carries an infectious material. Also, keep in mind that laboratory specimens, particularly “red bag” waste from hospitals or laboratories may be infectious. By pre-planning your area, especially laboratories and health care facilities, you can become familiar with the infectious agents you are likely to encounter in an emergency.

GENERAL PRECAUTIONS

The best way to protect yourself against health risks is, of course, to avoid exposure in the first place.

You can avoid exposure by:

- Being alert to the possible presence of hazardous materials and remaining at a safe distance
- Protecting the four routes of entry by wearing the proper protective equipment and positive-pressure self-contained breathing apparatus
- Avoiding secondary contamination by making sure that contaminated patients and equipment are decontaminated before you have contact with them
- Avoiding ongoing exposure by making sure that you and your clothing are fully decontaminated as soon as possible

In addition, you can prevent health effects from infectious organisms by obtaining all vaccinations that are necessary for your area and your likely exposures. And, finally, you can also increase your resistance to disease and infections by maintaining good health habits.

Key Points

Avoid exposure by:

- **Being alert to the presence of hazardous materials**
- **Protecting routes of entry**
- **Avoiding secondary contamination**
- **Avoiding ongoing exposure**
- **Obtaining vaccinations**
- **Maintaining good health habits**

MEDICAL SURVEILLANCE

Activity

If you have obtained copies of a medical surveillance plan, distribute these to the students as you discuss this topic.

Medical surveillance is the collection and interpretation of data from monitoring programs and other available sources for the purpose of detecting changes in health status. The focus of medical surveillance is on identifying changes that have already taken place and providing a means of addressing potential medical problems. Ideally, surveillance should be performed on First Responders throughout their working lifetimes.

A medical surveillance program must be reviewed periodically. Information on specific exposures, working conditions, and use of protective equipment must be incorporated into the review.

Elements of Medical Surveillance

The health status information required for a medical surveillance program is gathered from several different sources:

- Baseline physical examinations
- Annual/biannual examinations
- Exposure-specific or injury examinations
- Exit examinations
- Personal exposure records

Key Points

Baseline physical examinations should include:

- **Baseline studies of all body systems**
- **Diagnostic medical testing**
- **Questionnaire data**

Baseline Physical Examinations

Your baseline, or entry examination should be a comprehensive study of all body systems, especially vision, hearing, cardiovascular, pulmonary, liver function, blood testing, and musculoskeletal systems. The purpose of this exam is to establish a baseline against which later tests can be measured. Differences between baseline results and subsequent testing may indicate a change in your health status. Baseline exams should also include questionnaire data about your medical history, occupation, family, and background. Be sure to discuss with your doctor any current symptoms that might be related to exposure to hazardous substances.

Key Points

Annual/biannual examinations should include:

- **Studies of all body systems**
- **Comparisons to baseline exam**
- **Health assessments**

Annual Examinations

Like your baseline exam, an annual or biannual exam should include a comprehensive study of all body systems. The results of these studies should be compared to your baseline exam. Your doctor should then assess your health status, note any changes, and discuss them with you. During these exams be sure to tell your doctor of any possible exposures, changes in your medical history or background, symptoms of illness, or other conditions that might affect your overall health picture.

Exposure-Specific Examinations

Key Points

Exposure-specific examinations should include:

- **Biological monitoring for specific agents**
- **Diagnostic medical testing for specific agents**

You should have an exposure-specific examination whenever you think you may have been exposed to a hazardous substance. These exams usually include biological monitoring to measure the amount of a substance in your body fluid, or its effects.

Ordinarily, biological monitoring is not included in a general medical surveillance program because of the lack of knowledge about the chemicals involved and the lack of specific tests to evaluate exposure. However, if you are exposed to an agent for which specific tests are available, you should have those tests conducted.

Exit Examinations

When you leave your job or are transferred to another type of work, you should have an exit exam. This physical exam should include the same tests that your physician conducted during your baseline exam. Any changes from your baseline should be discussed with you.

You should also let your physician know of any changes in your health status that have occurred since your last annual exam.

Personal Exposure Records

Key Points

Personal exposure records should include:

- **Results of tests from all baseline, exposure-specific, and exit exams**
- **Dates and conditions of potential exposures**
- **Treatments received**

Although your work record will contain most of your medical history, you should keep your own records as well. Note the results of tests, dates and conditions of possible or known exposures, and any treatments you received. These records are important because you may not always realize you were exposed, particularly if you have no symptoms. In addition, some symptoms may appear long after exposure. Having these records on hand will help refresh your memory about an incident if you need later treatment for an exposure.

Medical Surveillance for First Responders

Key Points

You are entitled to medical surveillance under:

- **29 CFR 1910.120, or**
- **40 CFR 311, and**
- **NFPA 1500**

The federal regulations pertaining to hazardous materials emergency response operations are found in Title 29 of the Code of Federal Regulations, Part 1910.120 (29 CFR 1910.120). This law is duplicated by the EPA in 40 CFR 311 for First Responders not covered by OSHA in their state.

In addition, the National Fire Protection Association developed a standard for fire department occupational safety and health programs (NFPA 1500). This standard addresses the need for a comprehensive approach to the health and safety of fire fighters and emergency medical care providers. For your own protection, you should be familiar with these laws and guidelines.

The OSHA regulation has specific requirements regarding medical surveillance. These are minimum requirements; state and local laws may exceed these requirements. Under 29 CFR 1910.120, fire fighters who operate as members of hazardous materials teams must be provided with a medical surveillance program. Information from questionnaires, medical exams, and diagnostic medical testing must be collected every one to two years for hazardous materials team members.

Key Points

- **Haz Mat team members must have a medical surveillance program**
- **First responders need medical surveillance only if they are exposed to hazardous substances 30+ days/year or if they are injured**

First Responders who are not members of hazardous materials teams are required to participate in medical surveillance programs if they are exposed to hazardous substances for thirty or more days per year at or above exposure limits set by OSHA. Medical surveillance is also required if you are injured at an emergency incident involving hazardous substances.

Records from medical surveillance must be kept confidential for 30 years. Records on radiological exposures must be kept for 50 years. You must be informed of the results of any examinations and tests. Your physician will provide a written report. However, your employer should be informed only of any work restrictions, not of the specific condition that results in the restriction.

If you are exposed to a hazardous material, a health professional trained in toxicology or occupational medicine can help you determine possible effects and any appropriate treatment if you know:

- The identity of the material involved
- The concentration of the material when the exposure occurred
- The duration of exposure

Conclusion

Briefly review the key points covered in this section.

UNIT 1
APPENDIX

29 CFR 1910.120
Hazardous Waste Operations
and Emergency Response

(a) Scope, application, and definitions.

(1) Scope. This section covers the following operations, unless the employer can demonstrate that the operation does not involve employee exposure or the reasonable possibility for employee exposure to safety or health hazards: (I) Clean-up operations required by a governmental body, whether Federal, state local or other involving hazardous substances that are conducted at uncontrolled hazardous waste sites (including, but not limited to, the EPA's National Priority Site List (NPL), state priority site lists, sites recommended for the EPA NPL, and initial investigations of government identified sites which are conducted before the presence or absence of hazardous substances has been ascertained; (ii) Corrective actions involving clean-up operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA) as amended (42 U.S.C. 6901 et seq); (iii) Voluntary clean-up operations at sites recognized by Federal, state, local or other governmental bodies as uncontrolled hazardous waste sites; (iv) Operations involving hazardous waste that are conducted at treatment, storage, disposal (TSD) facilities regulated by 40 CFR Parts 264 and 265 pursuant to RCRA; or by agencies under agreement with U.S.E.P.A. to implement RCRA regulations; and (v) Emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard.

(2) Application. (I) All requirements of Part 1910 and Part 1926 of Title 29 of the Code of Federal Regulations apply pursuant to their terms to hazardous waste and emergency response operations whether covered by this section or not. If there is a conflict or overlap, the provision more protective of employee safety and health shall apply without regard to 29 CFR 1910.5(c)(1). (ii) Hazardous substance clean-up operations within the scope of paragraphs (a)(1)(I) through (a)(1)(iii) of this section must comply with all paragraphs of this section except paragraphs (p) and (q). (iii) Operations within the scope of paragraph (a)(1)(I) of this section must comply only with the requirements of paragraph (p) of this section.

Notes and Exceptions:(A) All provisions of paragraph (p) of this section cover any treatment, storage or disposal (TSD) operation regulated by 40 CFR parts 264 and 265 or by state law authorized under RCRA, and required to have a permit or interim status from EPA pursuant to 40 CFR 270.1 or from a state agency pursuant to RCRA. (B) Employers who are not required to have a permit or interim status because they are conditionally exempt small quantity generators under 40 CFR 261.5 or are generators who qualify under 40 CFR 262.34 for exemptions from regulation under 40 CFR 262.34 for exemptions from regulation under 40 CFR parts 264, 265, and 270 ("excepted employers") are not covered by paragraphs (p)(1) through (p)(7) of this section. Excepted employers who are required by the EPA or state agency to have their employees engage in emergency response or who direct their employees to engage in emergency response are covered by paragraph (p)(8) of this section, and cannot be exempted by (p)(8)(I) of this section. (C) If an area is used primarily for treatment, storage or disposal, any emergency response operations in that area shall comply with paragraph (p) (8) of this section. In other areas not used primarily for treatment, storage, or disposal, any emergency response operations shall comply with paragraph (q) of this section. Compliance with the requirements of paragraph (q) of this section shall be deemed to be in compliance with the requirements of paragraph (p)(8) of this section.

(iv) Emergency response operations for releases of, or substantial threats of releases of, hazardous substances which are not covered by paragraphs (a)(1)(I) through (a)(1)(iv) of this section must only comply with the requirements of paragraph (q) of this section.

(3) Definitions - "Buddy system" means a system of organizing employees into work groups in such a manner that each employee of the work group is designated to be observed by at least one other employee in the work group. The purpose of the buddy system is to provide rapid assistance to employees in the event of an emergency. "Clean-up operation" means an operation where hazardous substances are removed, contained, incinerated, neutralized, destabilized, cleared-up, or in any other

manner processed or handled with the ultimate goal of making the site safer for people or the environment. “Decontamination” means the removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of foreseeable adverse health effects. “Emergency response” or “responding to emergencies” means a response effort by employees from outside the immediate release area or by other designated responders (i.e., mutual aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to incidental releases of hazardous substances where the substance can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel are not considered to be emergency responses within the scope of this standard. Responses to releases of hazardous substances where there is no potential safety or health hazard (i.e., fire, explosion, or chemical exposure) are not considered to be emergency responses. “Facility” means (A) any building, structure, installation, equipment, pipe or pipeline (including any pipe into a sewer or publicly owned treatment works), well, pit, pond, lagoon, impoundment, ditch, storage container, motor vehicle, rolling stock, or aircraft, or (B) any site or area where a hazardous substance has been deposited, stored, disposed of, or placed, or otherwise come to be located; but does not include any consumer product in consumer use or any water-borne vessel. “Hazardous materials response (HAZMAT) team” means an organized group of employees, designated by the employer, who are expected to perform work to handle and control actual or potential leaks or spills of hazardous substances requiring possible close approach to the substance. The team members perform responses to releases or potential releases of hazardous substances for the purpose of control or stabilization of the incident. A HAZMAT team is not a fire brigade nor is a typical fire brigade a HAZMAT team. A HAZMAT team, however, may be a separate component of a fire brigade or fire department. “Hazardous substance” means any substance designated or listed under (A) through (D) of this definition, exposure to which results or may result in adverse effects on the health or safety of employees: [A] Any substance defined under section 101(14) of CERCLA; [B] Any biologic agent and other disease causing agent which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations in such persons or their offspring. [C] Any substance listed by the U.S. Department of Transportation as hazardous materials under 49 CFR 172.101 ; and [D] Hazardous waste as herein defined. “Hazardous waste” means - A] A waste or combination of wastes as defined in 40 CFR 261.3, or [B] Those substances defined as hazardous wastes in 49 CFR 171.8. “Hazardous waste operation” means any operation conducted within the scope of this standard. “Hazardous waste site” or “Site” means any facility or location within the scope of this standard at which hazardous waste operations take place. “Health hazard” means a chemical, mixture of chemicals or a pathogen for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. The term “health hazard” includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, nephrotoxins, neurotoxins, agents which act on the hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes. It also includes stress due to temperature extremes. Further definition of the terms used above can be found in Appendix A to 29 CFR 1910.1200. “IDLH” or “Immediately dangerous to life or health” means an atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would interfere with an individual’s ability to escape from a dangerous atmosphere. “Oxygen deficiency” means that concentration of oxygen by volume below which atmosphere supplying respiratory protection must be provided. It exists in atmospheres where the percentage of oxygen by volume is less than 19.5 percent oxygen. “Permissible exposure limit” means the exposure, inhalation or dermal permissible exposure limit specifiedin 29 CFR Part 1910, Subparts G and Z. “Published exposure level” means the exposure limits published in “NIOSH Recommendations for Occupational Health Standards” dated 1986, which is incorporated by reference as specified in Sec. 1910.6, or if none is specified, the exposure limits published in the standards specified by the American Conference of Governmental Industrial Hygienists in their publication “Threshold Limit Values and Biological Exposure Indices for 1987 - 88” dated 1987, which is incorporated by reference as specified in Sec. 1910.6. “Post emergency response” means that portion of an emergency response performed after the immediate threat of a release has been stabilized or eliminated and clean-up of the site has begun. If post emergency response is performed by an employer’s own employees who

were part of the initial emergency response, it is considered to be part of the initial response and not post emergency response. However, if a group of an employer's own employees, separate from the group providing initial response, performs the clean-up operation, then the separate group of employees would be considered to be performing post-emergency response and subject to paragraph (q)(11) of this section. "Qualified person" means a person with specific training, knowledge and experience in the area for which the person has the responsibility and the authority to control. "Site safety and health supervisor (or official" means the individual located on a hazardous waste site who is responsible to the employer and has the authority and knowledge necessary to implement the site safety and health plan and verify compliance with applicable safety and health requirements. "Small quantity generator" means a generator of hazardous wastes who in any calendar month generates no more than 1,000 kilograms (2,205) pounds of hazardous waste in that month. "Uncontrolled hazardous waste site" means an area identified as an uncontrolled hazardous waste site by a governmental body, whether Federal, state, local or other where an accumulation of hazardous substances creates a threat to the health and safety of individuals or the environment or both. Some sites are found on public lands such as those created by former municipal, county or state landfills where illegal or poorly managed waste disposal has taken place. Other sites are found on private property, often belonging to generators or former generators of hazardous substance wastes. Examples of such sites include, but are not limited to, surface impoundments, landfills, dumps, and tank or drum farms. Normal operations at TSD sites are not covered by this definition.

(b) Safety and health program.

NOTE TO (b): Safety and health programs developed and implemented to meet other federal, state, or local regulations are considered acceptable in meeting this requirement if they cover or are modified to cover the topics required in this paragraph. An additional or separate safety and health program is not required by this paragraph.

(1) General. (I) Employers shall develop and implement a written safety and health program for their employees involved in hazardous waste operations. The program shall be designed to identify, evaluate, and control safety and health hazards, and provide for emergency response for hazardous waste operations. (ii) The written safety and health program shall incorporate the following: (A) An organizational structure; (B) A comprehensive workplan; (C) A site-specific safety and health plan which need not repeat the employer's standard operating procedures required in paragraph (b)(1)(ii)(F) of this section; (D) The safety and health training program; (E) The medical surveillance program; (F) The employer's standard operating procedures for safety and health; and (G) Any necessary interface between general program and site specific activities. (iii) Site excavation. Site excavations created during initial site preparation or during hazardous waste operations shall be shored or sloped as appropriate to prevent accidental collapse in accordance with Subpart P of 29 CFR Part 1926. (iv) Contractors and sub-contractors. An employer who retains contractor or sub-contractor services for work in hazardous waste operations shall inform those contractors, sub-contractors, or their representatives of the site emergency response procedures and any potential fire, explosion, health, safety or other hazards of the hazardous waste operation that have been identified by the employer's information program. (v) Program availability. The written safety and health program shall be made available to any contractor or subcontractor or their representative who will be involved with the hazardous waste operation; to employees; to employee designated representatives; to OSHA personnel, and to personnel of other Federal, state, or local agencies with regulatory authority over the site.

(2) Organizational structure part of the site program. (I) The organizational structure part of the program shall establish the specific chain of command and specify the overall responsibilities of supervisors and employees. It shall include, at a minimum, the following elements: (A) A general supervisor who has the responsibility and authority to direct all hazardous waste operations. (B) A site safety and health supervisor who has the responsibility and authority to develop and implement the site safety and health plan and verify compliance. (C) All other personnel needed for hazardous waste site operations and emergency response and their general functions and responsibilities. (D) The lines of authority, responsibility, and communication. (ii) The organizational structure shall be reviewed and updated as necessary to reflect the current status of waste site operations.

(3) Comprehensive workplan part of the site program. The comprehensive workplan part of the program shall address the tasks and objectives of the site operations and the logistics and resources required to reach those tasks and objectives. (I) The comprehensive workplan shall define anticipated clean-up activities as well as normal operating procedures which need not repeat the employer's procedures available elsewhere. (ii) The comprehensive workplan shall define work tasks and objectives and identify the methods for accomplishing those tasks and objectives. (iii) The comprehensive workplan shall establish personnel requirements for implementing the plan. (iv) The comprehensive workplan shall provide for the implementation of the training required in paragraph (e) of this section. (v) The comprehensive workplan shall provide for the implementation of the required informational programs required in paragraph (I) of this section. (vi) The comprehensive workplan shall provide for the implementation of the medical surveillance program described in paragraph (f) if this section.

(4) Site-specific safety and health plan part of the program. (I) General. The site safety and health plan, which must be kept on site, shall address the safety and health hazards of each phase of site operation and include the requirements and procedures for employee protection. (ii) Elements. The site safety and health plan, as a minimum, shall address the following: (A) A safety and health risk or hazard analysis for each site task and operation found in the workplan. (B) Employee training assignments to assure compliance with paragraph (e) of this section. (C) Personal protective equipment to be used by employees for each of the site tasks and operations being conducted as required by the personal protective equipment program in paragraph (g)(5) of this section. (D) Medical surveillance requirements in accordance with the program in paragraph (f) of this section. (E) Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used. (F) Site control measures in accordance with the site control program required in paragraph (d) of this section. (G) Decontamination procedures in accordance with paragraph (k) of this section. (H) An emergency response plan meeting the requirements of paragraph (l) of this section for safe and effective responses to emergencies, including the necessary PPE and other equipment. (I) Confined space entry procedures. (J) A spill containment program meeting the requirements of paragraph (j) of this section. (iii) Pre-entry briefing. The site specific safety and health plan shall provide for pre-entry briefings to be held prior to initiating any site activity, and at such other times as necessary to ensure that employees are apprised of the site safety and health plan and that this plan is being followed. The information and data obtained from site characterization and analysis work required in paragraph (C) of this section shall be used to prepare and update the site safety and health plan. (iv) Effectiveness of site safety an health plan. Inspections shall be conducted by the site safety and health supervisor or, in the absence of that individual, another individual who is knowledgeable in occupational safety and health, acting on behalf of the employer as necessary to determine the effectiveness of the site safety and health plan. Any deficiencies in the effectiveness of the site safety and health plan shall be corrected by the employer.

(c) Site characterization and analysis.

(1) General. Hazardous waste sites shall be evaluated in accordance with this paragraph to identify specific site hazards and to determine the appropriate safety and health control procedures needed to protect employees from the identified hazards.

(2) Preliminary evaluation. A preliminary evaluation of a site's characteristics shall be performed prior to site entry by a qualified person in order to aid in the selection of appropriate employee protection methods prior to site entry. Immediately after initial site entry, a more detailed evaluation of the site's specific characteristics shall be performed by a qualified person in order to further identify existing site hazards and to further aid in the selection of the appropriate engineering controls and personal protective equipment for the tasks to be performed.

(3) Hazard identification. All suspected conditions that may pose inhalation or skin absorption hazards that are immediately dangerous to life or health (IDLH) or other conditions that may cause death or serious harm shall be identified during the preliminary survey and evaluated during the detailed survey. Examples of such hazards include, but are not limited to, confined space entry, potentially explosive or flammable situations, visible vapor clouds, or areas where biological indicators such as dead animals or vegetation are located.

(4) Required information. The following information to the extent available shall be obtained by the employer prior to allowing employees to enter a site: (I) Location and approximate size of the site. ii) Description of the response activity and/or the job task to be performed. (iii) Duration of the planned employee activity. (iv) Site topography and accessibility by air and roads. (v) Safety and health hazards expected at the site. (vi) Pathways for hazardous substance dispersion. (vii) Present status and capabilities of emergency response teams that would provide assistance to on-site employees at the time of an emergency. (viii) Hazardous substances and health hazards involved or expected at the site and their chemical and physical properties.

(5) Personal protective equipment (PPE) shall be provided and used during initial site entry in accordance with the following requirements: (I) Based upon the results of the preliminary site evaluation, an ensemble of PPE shall be selected and used during initial site entry which will provide protection to a level of exposure below permissible exposure limits and published exposure levels for known or suspected hazardous substances and health hazards and which will provide protection against other known and suspected hazards identified during the preliminary site evaluation. If there is no permissible exposure limit or published exposure level, the employer may use other published studies and information as a guide to appropriate personal protective equipment. (ii) If positive-pressure self-contained breathing apparatus is not used as part of the entry ensemble, and if respiratory protection is warranted by the potential hazards identified during the preliminary site evaluation, an escape self-contained breathing apparatus of at least five minute's duration shall be carried by employees during initial site entry. (iii) If the preliminary site evaluation does not produce sufficient information to identify the hazards or suspected hazards of the site an ensemble providing equivalent to Level B PPE shall be provided as minimum protection, and direct reading instruments shall be used as appropriate for identifying IDLH conditions. (See Appendix B for guidelines on Level B protective equipment.) (iv) Once the hazards of the site have been identified, the appropriate PPE shall be selected and used in accordance with paragraph (g) of this section.

(6) Monitoring. The following monitoring shall be conducted during initial site entry when the site evaluation produces information which shows the potential for ionizing radiation or IDLH conditions, or when the site information is not sufficient reasonably to eliminate these possible conditions: (I) Monitoring with direct reading instruments for hazardous levels of ionizing radiation. (ii) Monitoring the air with appropriate direct reading test equipment for (i.e., combustible gas meters, detector tubes) for IDLH and other conditions that may cause death or serious harm (combustible or explosive atmospheres, oxygen deficiency, toxic substances.) (iii) Visually observing for signs of actual or potential IDLH or other dangerous conditions. (iv) An ongoing air monitoring program in accordance with paragraph (h) of this section shall be implemented after site characterization has determined the site is safe for the start-up of operations.

(7) Risk identification. Once the presence and concentrations of specific hazardous substances and health hazards have been established, the risks associated with these substances shall be identified. Employees who will be working on the site shall be informed of any risks that have been identified. In situations covered by the Hazard Communication Standard, 29 CFR 1910.1200, training required by that standard need not be duplicated. NOTE TO (c)(7). - Risks to consider include, but are not limited to: [a] Exposures exceeding the permissible exposure limits and published exposure levels. [b] IDLH Concentrations. [c] Potential Skin Absorption and Irritation Sources. [d] Potential Eye Irritation Sources. [e] Explosion Sensitivity and Flammability Ranges. [f] Oxygen deficiency.

(8) Employee notification. Any information concerning the chemical, physical, and toxicologic properties of each substance known or expected to be present on site that is available to the employer and relevant to the duties an employee is expected to perform shall be made available to the affected employees prior to the commencement of their work activities. The employer may utilize information developed for the hazard communication standard for this purpose.

(d) Site control.

(1) General. Appropriate site control procedures shall be implemented to control employee exposure to hazardous substances before clean-up work begins.

(2) Site control program. A site control program for protecting employees which is part of the employer's site safety and health program required in paragraph (b) of this section shall be developed during the planning stages of a hazardous waste clean-up operation and modified as necessary as new information becomes available.

(3) Elements of the site control program. The site control program shall, as a minimum, include: A site map; site work zones; the use of a "buddy system"; site communications including alerting means for emergencies; the standard operating procedures or safe work practices; and, identification of the nearest medical assistance. Where these requirements are covered elsewhere they need not be repeated.

(e) Training.

(1) General. (I) All employees working on site (such as but not limited to equipment operators, general laborers and others) exposed to hazardous substances, health hazards, or safety hazards and their supervisors and management responsible for the site shall receive training meeting the requirements of this paragraph before they are permitted to engage in hazardous waste operations that could expose them to hazardous substances, safety, or health hazards, and they shall receive review training as specified in this paragraph. (ii) Employees shall not be permitted to participate in or supervise field activities until they have been trained to a level required by their job function and responsibility.

(2) Elements to be covered. The training shall thoroughly cover the following: (I) Names of personnel and alternates responsible for site safety and health; (ii) Safety, health and other hazards present on the site; (iii) Use of PPE; (iv) Work practices by which the employee can minimize risks from hazards; (v) Safe use of engineering controls and equipment on the site; (vi) Medical surveillance requirements including recognition of symptoms and signs which might indicate over exposure to hazards; and (vii) The contents of paragraphs (G) through (J) of the site safety and health plan set forth in paragraph (b)(4)(ii) of this section.

(3) Initial training. (I) General site workers (such as equipment operators, general laborers and supervisory personnel) engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances and health hazards shall receive a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained experienced supervisor. (ii) Workers on site only occasionally for a specific limited task (such as, but not limited to, ground water monitoring, land surveying, or geophysical surveying) and who are unlikely to be exposed over permissible exposure limits and published exposure limits shall receive a minimum of 24 hours of instruction off the site, and the minimum of one day actual field experience under the direct supervision of a trained, experienced supervisor. (iii) Workers regularly on site who work in areas which have been monitored and fully characterized indicating that exposures are under permissible exposure limits and published exposure limits where respirators are not necessary, and the characterization indicates that there are no health hazards or the possibility of an emergency developing, shall receive a minimum of 24 hours of instruction off the site, and the minimum of one day actual field experience under the direct supervision of a trained, experienced supervisor. (iv) Workers with 24 hours of training who are covered by para-graphs (e)(3)(ii) and (e)(3)(iii) of this section, and who become general site workers or who are required to wear respirators, shall have the additional 16 hours and two days of training necessary to total the training specified in paragraph (e)(3)(I).

(4) Management and supervisor training. On-site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations shall receive 40 hours initial and three days of supervised field experience (the training may be reduced to 24 hours and one day if the only area of their responsibility is employees covered by paragraphs (e)(3)(ii) and (e)(3)(iii) and at least eight additional hours of specialized training at the time of job assignment on such topics as, but no limited to, the employer's safety and health program, personal protective equipment program, spill containment program, and health hazard monitoring procedure and techniques.

(5) Qualifications for trainers. Trainers shall be qualified to instruct employees about the subject matter that is being presented in training. Such trainers shall have satisfactorily completed a training program for teaching the subjects they are expected to teach, or they shall have the academic credentials and instructional experience necessary for teaching the subjects. Instructors shall demonstrate competent instructional skills and knowledge of the applicable subject matter.

(6) Training certification. Employees and supervisors that have received and successfully completed the training and field experience specified in paragraphs (e)(1) through (e)(4) of this section shall be certified by their instructor or the head instructor and trained supervisor as having completed the necessary training. A written certificate shall be given to each person so certified. Any person who has not been so certified or who does not meet the requirements of paragraph (e)(9) of this section shall be prohibited from engaging in hazardous waste operations.

(7) Emergency response. Employees who are engaged in responding to hazardous emergency situations at hazardous waste clean-up sites that may expose them to hazardous substances shall be trained in how to respond to such expected emergencies.

(8) Refresher training. Employees specified in paragraph (e)(1) of this section, and managers and supervisors specified in paragraph (e)(4) of this section, shall receive eight hours of refresher training annually on the items specified in paragraph (e)(2) and/or (e)(4) of this section, any critique of incidents that have occurred in the past year that can serve as training examples of related work, and other relevant topics.

(9) Equivalent training. Employers who can show by documentation or certification that an employee's work experience and/or training has resulted in training equivalent to that training required in paragraphs (e)(1) through (e)(4) of this section shall not be required to provide the initial training requirements of those paragraphs to such employees and shall provide a copy of the certification or documentation to the employee upon request. However, certified employees or employees with equivalent training new to a site shall receive appropriate, site specific training before site entry and have appropriate supervised field experience at the new site. Equivalent training includes any academic training or the training that existing employees might have already received from actual hazardous waste site experience.

(f) Medical surveillance.

(1) General. Employees engaged in operations specified in paragraphs (a)(1)(I) through (a)(1)(iv) of this section and not covered by (a)(2)(iii) exceptions and employers of employees specified in paragraph (q)(9) shall institute a medical surveillance program in accordance with this paragraph.

(2) Employees covered. The medical surveillance program shall be instituted by the employer for the following employees: (I) All employees who are or may be exposed to hazardous substances or health hazards at or above the established permissible exposure limit, above the published exposure levels for these substances, without regard to the use of respirators, for 30 days or more a year; (ii) All employees who wear a respirator for 30 days or more a year or as required by 1910.134; (iii) All employees who are injured, become ill or develop signs or symptoms due to possible overexposure involving hazardous substances or health hazards from an emergency response or hazardous waste operation; and (iv) Members of HAZMAT teams.

(3) Frequency of medical examinations and consultations. Medical examinations and consultations shall be made available by the employer to each employee covered under paragraph (f)(2) of this section on the following schedules: (I) For employees covered under paragraphs (f)(2)(I), (f)(2)(ii), and (f)(2)(iv); (A) Prior to assignment; (B) At least once every twelve months for each employee covered unless the attending physician believes a longer interval (not greater than biennially) is appropriate; (C) At termination of employment or reassignment to an area where the employee would not be covered if the employee has not had an examination within the last six months. (D) As soon as possible upon notification by an employee that the employee has developed signs or symptoms indicating possible overexposure to hazardous substances or health hazards, or that the employee has been injured or exposed above the permissible exposure limits or published exposure levels in an emergency situation; (E) At more frequent times, if the examining physician determines that an increased frequency of examination is medically necessary. (ii) For employees covered under paragraph (f)(2)(iii) and for all employees including of employers covered by paragraph (a)(1)(iv) who may have been injured, received a health impairment, developed signs or symptoms which may have resulted from exposure to hazardous substances resulting from an emergency incident, or exposed during an emergency incident to hazardous substances at concentrations above the permissible exposure limits or the published exposure levels without the necessary personal protective equipment being used: (A) As soon as possible following the emergency incident or development of signs or symptoms; (B) At additional times, if the examining physician determines that follow-up examinations or consultations are medically necessary.

(4) Content of medical examinations and consultations. (I) Medical examinations required by paragraph (f)(3) of this section shall include a medical and work history (or updated history if one is in the employee's file) with special emphasis on symptoms related to the handling of hazardous substances and health hazards, and to fitness for duty including the ability to wear any required PPE under conditions (i.e., temperature extremes) that may be expected at the work site. (ii) The content of medical examinations or consultations made available to employees pursuant to paragraph (f) shall be determined by the attending physician. The guidelines in the Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities (See Appendix D, reference # 10) should be consulted.

(5) Examination by a physician and costs. All medical examinations and procedures shall be performed by or under the supervision of a licensed physician, preferably one knowledgeable in occupational medicine, and shall be provided without cost to the employee, without loss of pay, and at a reasonable time and place.

(6) Information provided to the physician. The employer shall provide one copy of this standard and its appendices to the attending physician and in addition the following for each employee: (I) A description of the employee's duties as they relate to the employee's exposures, (ii) The employee's exposure levels or anticipated exposure levels. (iii) A description of any personal protective equipment used or to be used. (iv) Information from previous medical examinations of the employee which is not readily available to the examining physician. (v) Information required by 1910.134.

(7) Physician's written opinion. (I) The employer shall obtain and furnish the employee with a copy of a written opinion from the examining physician containing the following: (A) The physician's opinion as to whether the employee has any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health from work in hazardous waste operations or emergency response, or from respirator use. (B) The physician's recommended limitations upon the employees assigned work. (C) The results of the medical examination and tests if requested by the employee. (D) A statement that the employee has been informed by the physician of the results of the medical examination and any medical conditions which require further examination or treatment. (ii) The written opinion obtained by the employer shall not reveal specific findings or diagnoses unrelated to occupational exposure.

(8) Recordkeeping. (I) An accurate record of the medical surveillance required by paragraph (f) of this section shall be retained. This record shall be retained for the period specified and meet the criteria of 29 CFR 1910.20. (ii) The record required in paragraph (f)(8)(I) of this section shall include at least the following information: (A) The name and social security number of the employee; (B) Physicians' written opinions, recommended limitations and results of examinations and tests; (C) Any employee medical complaints related to exposure to hazardous substances; (D) A copy of the information provided to the examining physician by the employer, with the exception of the standard and its appendices.

(g) Engineering controls, work practices, and personal protective equipment for employee protection.

Engineering controls, work practices and PPE for substances regulated in Subpart Z.

(I) Engineering controls, work practices, personal protective equipment, or a combination of these shall be implemented in accordance with this paragraph to protect employees from exposure to hazardous substances and safety and health hazards. (1) Engineering controls, work practices and PPE for substances regulated in Subparts G and Z. (I) Engineering controls and work practices shall be instituted to reduce and maintain employee exposure to or below the permissible exposure limits for substances regulated by 29 CFR Part 1910, to the extent required by Subpart Z, except to the extent that such controls and practices are not feasible. NOTE TO (g)(1)(I): Engineering controls which may be feasible include the use of pressurized cabs or control booths on equipment, and/or the use of remotely operated material handling equipment. Work practices which may be feasible are removing all non-essential employees from potential exposure during opening of drums, wetting down dusty operations and locating employees upwind of possible hazards. (ii) Whenever engineering controls and work practices are not feasible, or not required, any reasonable combination of engineering controls, work practices and PPE shall be used to reduce and maintain to or below the permissible exposure limits or dose limits for substances regulated by 29 CFR Part 1910, Subpart Z. (iii) The employer shall not implement a schedule of employee rotation as a means of compliance with permissible exposure limits or dose limits except when there is no other feasible way of complying with the airborne or dermal dose limits for ionizing radiation.

(2) Engineering controls, work practices, and PPE for substances not regulated in Subparts G and Z. An appropriate combination of engineering controls, work practices, and personal protective equipment shall be used to reduce and maintain employee exposure to or below published exposure levels for hazardous substances and health hazards not regulated by 29 CFR Part 1910, Subparts G and Z. The employer may use the published literature and MSDS as a guide in making the employer's determination as to what level of protection the employer believes is appropriate for hazardous substances and health hazards for which there is no permissible exposure limit or published exposure limit.

(3) Personal protective equipment selection. (I) Personal protective equipment (PPE) shall be selected and used which will protect employees from the hazards and potential hazards they are likely to encounter as identified during the site characterization and analysis. (ii) Personal protective equipment selection shall be based on an evaluation of the performance characteristics of the PPE relative to the requirements and limitations of the site, the task-specific conditions and duration, and the hazards and potential hazards identified at the site. (iii) Positive pressure self-contained breathing apparatus, or positive pressure air-line respirators equipped with an escape air supply shall be used when chemical exposure levels present will create a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape. (iv) Totally-encapsulating chemical protective suits (protection equivalent to Level A protection as recommended in Appendix B) shall be used in conditions where skin absorption of a hazardous substance may result in a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape. (v) The level of protection provided by PPE selection shall be increased when additional information or site conditions show that increased protection is necessary to reduce employee exposures below permissible exposure limits and published exposure levels for hazardous substances and health hazards. (See Appendix B for guidance on selecting PPE ensembles.)

NOTE TO (g)(3): The level of employee protection provided may be decreased when additional information or site conditions show that decreased protection will not result in hazardous exposures to employees.

(vi) Personal protective equipment shall be selected and used to meet the requirements of 29 CFR Part 1910, Subpart I, and additional requirements specified in this section.

(4) Totally-encapsulating chemical protective suits. (I) Totally-encapsulating suits shall protect employees from the particular hazards which are identified during site characterization and analysis. (ii) Totally-encapsulating suits shall be capable of maintaining positive air pressure. (See Appendix A for a test method which may be used to evaluate this requirement.) (iii) Totally-encapsulating suits shall be capable of preventing inward test gas leakage of more than 0.5 percent. (See Appendix A for a test method which may be used to evaluate this requirement.)

(5) Personal protective equipment (PPE) program. A personal protective equipment program, which is part of the employer's safety and health program required in paragraph (b) of this section or required in paragraph (p)(1) of this section and which is also a part of the site-specific safety and health plan shall be established. The PPE program shall address the elements listed below. When elements, such as donning and doffing procedures, are provided by the manufacturer of a piece of equipment and are attached to the plan, they need not be rewritten into the plan as long as they adequately address the procedure or element. (I) PPE selection based upon site hazards, (ii) PPE use and limitations of the equipment, (iii) Work mission duration, (iv) PPE maintenance and storage, (v) PPE decontamination and disposal, (vi) PPE training and proper fitting, (vii) PPE donning and doffing procedures, (viii) PPE inspection procedures prior to, during, and after use, (ix) Evaluation of the effectiveness of the PPE program, and (x) Limitations during temperature extremes, heat stress, and other appropriate medical considerations.

(h) Monitoring.

(1) General. (I) Monitoring shall be performed in accordance with this paragraph where there may be a question of employee exposure to hazardous concentrations of hazardous substances in order to assure proper selection of engineering controls, work practices and personal protective equipment so that employees are not exposed to levels which exceed permissible exposure limits, or published exposure levels if there are no permissible exposure limits, for hazardous substances. (ii) Air monitoring shall be used to identify and quantify airborne levels of hazardous substances and safety and health hazards in order to determine the appropriate level of employee protection needed on site.

(2) Initial entry. Upon initial entry, representative air monitoring shall be conducted to identify any IDLH condition, exposure over permissible exposure limits or published exposure levels, exposure over a radioactive material's dose limits or other dangerous condition such as the presence of flammable atmospheres, oxygen-deficient environments.

(3) Periodic monitoring. Periodic monitoring shall be conducted when the possibility of an IDLH condition or flammable atmosphere has developed or when there is indication that exposures may have risen over permissible exposure limits or published exposure levels since prior monitoring. Situations where it shall be considered whether the possibility that exposures have risen are as follows: {i}When work begins on a different portion of the site. {ii} When contaminants other than those previously identified are being handled. {iii}When a different type of operation is initiated (e.g., drum opening as opposed to exploratory well drilling.) {iv}When employees are handling leaking drums or containers or working in areas with obvious liquid contamination (e.g., a spill or lagoon.)

(4) Monitoring of high-risk employees. After the actual clean-up phase of any hazardous waste operation commences; for example, when soil, surface water or containers are moved or disturbed; the employer shall monitor those employees likely to have the highest exposures to those hazardous substances and health hazards likely to be present above permissible exposure limits or published exposure levels by using personal sampling frequently enough to characterize employee exposures. The employer may utilize a representative sampling approach by documenting that the employees and chemicals chosen for

monitoring are based on the criteria stated in the first sentence of this paragraph. If the employees likely to have the highest exposure are over permissible exposure limits or published exposure limits, then monitoring shall continue to determine all employees likely to be above those limits. The employer may utilize a representative sampling approach by documenting that the employees and chemicals chosen for monitoring are based on the criteria stated above.

NOTE TO (h): It is not required to monitor employees engaged in site characterization operations covered by paragraph (C) of this section.

(i) Informational programs.

Employers shall develop and implement a program which is part of the employer's safety and health program required in paragraph (b) of this section to inform employees, contractors, and subcontractors (or their representative) actually engaged in hazardous waste operations of the nature, level and degree of exposure likely as a result of participation in such hazardous waste operations. Employees, contractors and subcontractors working outside of the operations part of a site are not covered by this standard.

(j) Handling drums and containers

(1) General. (I) Hazardous substances and contaminated, liquids and other residues shall be handled, transported, labeled, and disposed of in accordance with this paragraph. (ii) Drums and containers used during the clean-up shall meet the appropriate DOT, OSHA, and EPA regulations for the wastes that they contain. (iii) When practical, drums and containers shall be inspected and their integrity shall be assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions (i.e., buried beneath the earth, stacked behind other drums, stacked several tiers high in a pile, etc.) shall be moved to an accessible location and inspected prior to further handling. (iv) Unlabeled drums and containers shall be considered to contain hazardous substances and handled accordingly until the contents are positively identified and labeled. (v) Site operations shall be organized to minimize the amount of drum or container movement. (vi) Prior to movement of drums or containers, all employees exposed to the transfer operation shall be warned of the potential hazards associated with the contents of the drums or containers. (vii) U.S. Department of Transportation specified salvage drums or containers and suitable quantities of proper absorbent shall be kept available and used in areas where spills, leaks, or ruptures may occur. (viii) Where major spills may occur, a spill containment program, which is part of the employer's safety and health program required in paragraph (b) of this section, shall be implemented to contain and isolate the entire volume of the hazardous substance being transferred. (ix) Drums and containers that cannot be moved without rupture, leakage, or spillage shall be emptied into a sound container using a device classified for the material being transferred. (x) A ground-penetrating system or other type of detection system or device shall be used to estimate the location and depth of buried drums or containers. (xi) Soil or covering material shall be removed with caution to prevent drum or container rupture. (xii) Fire extinguishing equipment meeting the requirements of 29 CFR Part 1910, Subpart L, shall be on hand and ready for use to control incipient fires.

(2) Opening drums and containers. The following procedures shall be followed in areas where drums or containers are being opened: (I) Where an airline respirator system is used, connections to the source of air supply shall be protected from contamination and the entire system shall be protected from physical damage. (ii) Employees not actually involved in opening drums or containers shall be kept a safe distance from the drums or containers being opened. (iii) If employees must work near or adjacent to drums or containers being opened, a suitable shield that does not interfere with the work operation shall be placed between the employee and the drums or containers being opened to protect the employee in case of accidental explosion. (iv) Controls for drum or container opening equipment, monitoring equipment, and fire suppression equipment shall be located behind the explosion-resistant barrier. (v) When there is a reasonable possibility of flammable atmospheres being present, material handling equipment and hand

tools shall be of the type to prevent sources of ignition. (vi) Drums and containers shall be opened in such a manner that excess interior pressure will be safely relieved. If pressure cannot be relieved from a remote location, appropriate shielding shall be placed between the employee and the drums or containers to reduce the risk of employee injury. (vii) Employees shall not stand upon or work from drums or containers.

(3) Material handling equipment. Material handling equipment used to transfer drums and containers shall be selected, positioned and operated to minimize sources of ignition related to the equipment from igniting vapors released from ruptured drums or containers.

(4) Radioactive wastes. Drums and containers containing radioactive wastes shall not be handled until such time as their hazard to employees is properly assessed.

(5) Shock sensitive wastes. As a minimum, the following special precautions shall be taken when drums and containers containing or suspected of containing shock-sensitive wastes are handled: (I) All non-essential employees shall be evacuated from the area of transfer. (ii) Material handling equipment shall be provided with explosive containment devices or protective shields to protect equipment operators from exploding containers. (iii) An employee alarm system capable of being perceived above surrounding light and noise conditions shall be used to signal the commencement and completion of explosive waste handling activities. (iv) Continuous communications (i.e., portable radios, hand signals, telephones, as appropriate) shall be maintained between the employee-in-charge of the immediate handling area and both the site safety and health supervisor and the command post until such time as the handling operation is completed. Communication equipment or methods that could cause shock sensitive materials to explode shall not be used. (v) Drums and containers under pressure, as evidenced by bulging or swelling, shall not be moved until such time as the cause for excess pressure is determined and appropriate containment procedures have been implemented to protect employees from explosive relief of the drum. (vi) Drums and containers containing packaged laboratory wastes shall be considered to contain shock-sensitive or explosive materials until they have been characterized.

Caution: Shipping of shock sensitive wastes may be prohibited under U.S. Department of Transportation regulations. Employers and their shippers should refer to 49 CFR 173.21 and 173.50.

(6) Laboratory waste packs. In addition to the requirements of paragraph (j)(5) of this section, the following precautions shall be taken, as a minimum, in handling laboratory waste packs (lab packs): (I) Lab packs shall be opened only when necessary and then only by an individual knowledgeable in the inspection, classification, and segregation of the containers within the pack according to the hazards of the wastes. (ii) If crystalline material is noted on any container, the contents shall be handled as a shock-sensitive waste until the contents are identified.

(7) Sampling of drum and container contents. Sampling of containers and drums shall be done in accordance with a sampling procedure which is part of the site safety and health plan developed for and available to employees and others at the specific worksite.

(8) Shipping and transport. (I) Drums and containers shall be identified and classified prior to packaging for shipment. (ii) Drum or container staging areas shall be kept to the minimum number necessary to safely identify and classify materials and prepare them for transport. (iii) Staging areas shall be provided with adequate access and egress routes. (iv) Bulking of hazardous wastes shall be permitted only after a thorough characterization of the materials has been completed.

(9) Tank and vault procedures. (I) Tanks and vaults containing hazardous substances shall be handled in a manner similar to that for drums and containers, taking into consideration the size of the tank or vault. (ii) Appropriate tank or vault entry procedures as described in the employer's safety and health plan shall be followed whenever employees must enter a tank or vault.

(k) Decontamination

(1) General. Procedures for all phases of decontamination shall be developed and implemented in accordance with this paragraph.

(2) Decontamination procedures. (I) A decontamination procedure shall be developed, communicated to employees and implemented before any employees or equipment may enter areas on site where potential for exposure to hazardous substances exists. (ii) Standard operating procedures shall be developed to minimize employee contact with hazardous substances or with equipment that has contacted hazardous substances. (iii) All employees leaving a contaminated area shall be appropriately decontaminated; all contaminated clothing and equipment leaving a contaminated area shall be appropriately disposed of or decontaminated. (iv) Decontamination procedures shall be monitored by the site safety and health supervisor to determine their effectiveness. When such procedures are found to be ineffective, appropriate steps shall be taken to correct any deficiencies.

(3) Location. Decontamination shall be performed in geographical areas that will minimize the exposure of uncontaminated employees or equipment to contaminated employees or equipment.

(4) Equipment and solvents. All equipment and solvents used for decontamination shall be decontaminated or disposed of properly.

(5) Personal protective clothing and equipment. (I) Protective clothing and equipment shall be decontaminated, cleaned, laundered, maintained or replaced as needed to maintain their effectiveness. (ii) Employees whose non-impermeable clothing becomes wetted with hazardous substances shall immediately remove that clothing and proceed to shower. The clothing shall be disposed of or decontaminated before it is removed from the work zone.

(6) Unauthorized employees shall not remove protective clothing or equipment from change rooms.

(7) Commercial laundries or cleaning establishments. Commercial laundries or cleaning establishments that decontaminate protective clothing or equipment shall be informed of the potentially harmful effects of exposures to hazardous substances.

(8) Showers and change rooms. Where the decontamination procedure indicates a need for regular showers and change rooms outside of a contaminated area, they shall be provided and meet the requirements of 29 CFR 1910.141. If temperature conditions prevent the effective use of water, then other effective means for cleansing shall be provided and used.

(l) Emergency response by employees at uncontrolled hazardous waste sites

(1) Emergency response plan. (I) An emergency response plan shall be developed and implemented by all employers within the scope of paragraphs (a)(1)(I) through (ii) of this section. section to handle anticipated emergencies prior to the commencement of hazardous waste operations. The plan shall be in writing and available for inspection and copying by employees, their representatives, OSHA personnel and other governmental agencies with relevant responsibilities. (ii) Employers who will evacuate their employees from the danger area when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from the requirements of this paragraph if they provide an emergency action plan complying with section 1910.38(a) of this part.

(2) Elements of an emergency response plan. The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following: (I) Pre-emergency planning. (ii) Personnel roles, lines of authority, training, and communication. (iii) Emergency recognition and prevention. (iv) Safe distances and places of refuge. (v) Site security and control. (vi) Evacuation routes and procedures. (vii) Decontamination procedures which are not covered by the site safety and health plan. (viii) Emergency medical treatment and first aid. (ix) Emergency alerting and response procedures. (x) Critique of response and follow-up. (xi) PPE and emergency equipment.

(3) Procedures for handling emergency incidents. (I) In addition to the elements for the emergency response plan required in paragraph (l)(2) of this section, the following elements shall be included for emergency response plans: (A) Site topography, layout, and prevailing weather conditions. (B) Procedures for reporting incidents to local, state, and federal governmental agencies. (ii) The emergency response plan shall be a separate section of the Site Safety and Health Plan. (iii) The emergency response plan shall be compatible and integrated with the disaster, fire and/or emergency response plans of local, state, and federal agencies. (iv) The emergency response plan shall be rehearsed regularly as part of the overall training program for site operations. (v) The site emergency response plan shall be reviewed periodically and, as necessary, be amended to keep it current with new or changing site conditions or information. (vi) An employee alarm system shall be installed in accordance with 29 CFR 1910.165 to notify employees of an emergency situation, to stop work activities if necessary, to lower background noise in order to speed communication, and to begin emergency procedures. (vii) Based upon the information available at time of the emergency, the employer shall evaluate the incident and the site response capabilities and proceed with the appropriate steps to implement the site emergency response plan.

(m) Illumination.

Areas accessible to employees shall be lighted to not less than the minimum illumination intensities listed in the following Table H-120.1 while any work is in progress.

(n) Sanitation at temporary workplaces

(1) Potable water. (I) An adequate supply of potable water shall be provided on the site. (ii) Portable containers used to dispense drinking water shall be capable of being tightly closed, and equipped with a tap. Water shall not be dipped from containers. (iii) Any container used to distribute drinking water shall be clearly marked as to the nature of its contents and not used for any other purpose. (iv) Where single service cups (to be used but once) are supplied, both a sanitary container for the unused cups and a receptacle for disposing of the used cups shall be provided.

(2) Nonpotable water. (I) Outlets for nonpotable water, such as water for firefighting purposes shall be identified to indicate clearly that the water is unsafe and is not to be used for drinking, washing, or cooking purposes. (ii) There shall be no cross-connection, open or potential, between a system furnishing potable water and a system furnishing nonpotable water.

(3) Toilets facilities. (I) Toilets shall be provided for employees according to Table H-120.2. (ii) Under temporary field conditions, provisions shall be made to assure not less than one toilet facility is available. (iii) Hazardous waste sites, not provided with a sanitary sewer, shall be provided with the following toilet facilities unless prohibited by local codes: (A) Chemical toilets; (B) Recirculating toilets; (C) Combustion toilets; or (D) Flush toilets. (iv) The requirements of this paragraph for sanitation facilities shall not apply to mobile crews having transportation readily available to nearby toilet facilities. (v) Doors entering toilet facilities shall be provided with entrance locks controlled from inside the facility.

(4) Food handling. All food service facilities and operations for employees shall meet the applicable laws, ordinances, and regulations of the jurisdictions in which they are located.

(5) Temporary sleeping quarters. When temporary sleeping quarters are provided, they shall be heated, ventilated, and lighted.

(6) Washing facilities. The employer shall provide adequate washing facilities for employees engaged in operations where hazardous substances may be harmful to employees. Such facilities shall be in near proximity to the worksite; in areas where exposures are below permissible exposure limits and which are under the controls of the employer; and shall be so equipped as to enable employees to remove hazardous substances from themselves.

(7) Showers and change rooms. When hazardous waste clean-up or removal operations commence on a site and the duration of the work will require six months or greater time to complete, the employer shall provide showers and change rooms for all employees exposed to hazardous substances and health hazards involved in hazardous waste clean-up or removal operations. (I) Showers shall be provided and shall meet the requirements of 29 CFR 1910.141(d)(3). (ii) Change rooms shall be provided and shall meet the requirements of 29 CFR 1910.141(e). Change rooms shall consist of two separate change areas separated by the shower area required in paragraph (n)(7)(I) of this section. One change area, with an exit leading off the worksite, shall provide employees with an area where they can put on, remove and store work clothing and personal protective equipment. (iii) Showers and change rooms shall be located in areas where exposures are below the permissible exposure limits and published exposure levels. If this cannot be accomplished, then a ventilation system shall be provided that will supply air that is below the permissible exposure limits and published exposure levels. (iv) Employers shall assure that employees shower at the end of their work shift and when leaving the hazardous waste site.

(o) New technology programs.

(1) The employer shall develop and implement procedures for the introduction of effective new technologies and equipment developed for the improved protection of employees working with hazardous waste clean-up operations, and the same shall be implemented as part of the site safety and health program to assure that employee protection is being maintained.

(2) New technologies, equipment or control measures available to the industry, such as the use of foams, absorbents, absorbents, neutralizers, or other means to suppress the level of air contaminants while excavating the site or for spill control, shall be evaluated by employers or their representatives. Such an evaluation shall be done to determine the effectiveness of the new methods, materials, or equipment before implementing their use on a large scale for enhancing employee protection. Information and data from manufacturers or suppliers may be used as part of the employer's evaluation effort. Such evaluations shall be made available to OSHA upon request.

(p) Certain Operations Conducted Under the Resource Conservation and Recovery Act of 1976 (RCRA).

Employers conducting operations at treatment, storage and disposal (TSD) facilities specified in paragraph (a)(1)(iv) of this section shall provide and implement the programs specified in this paragraph. See the "Notes and Exceptions" to paragraph (a)(2)(iii) of this section for employers not covered.

(1) Safety and health program. The employer shall develop and implement a written safety and health program for employees involved in hazardous waste operations that shall be available for inspection by employees, their representatives and OSHA personnel. The program shall be designed to identify, evaluate and control safety and health hazards in their facilities for the purpose of employee protection, to provide for emergency response meeting the requirements of paragraph (p)(8) of this section and to address as appropriate site analysis, engineering controls, maximum exposure limits, hazardous waste handling procedures and uses of new technologies.

(2) Hazard communication program. The employer shall implement a hazard communication program meeting the requirements of 29 CFR 1910.1200 as part of the employer's safety and program.

NOTE TO 1910.120 - The exemption for hazardous waste provided in 1910.1200 is applicable to this section.

(3) Medical surveillance program. The employer shall develop and implement a medical surveillance program meeting the requirements of paragraph (f) of this section.

(4) Decontamination program. The employer shall develop and implement a decontamination procedure meeting the requirements of paragraph (k) of this section.

(5) New technology program. The employer shall develop and implement procedures meeting the requirements of paragraph (o) of this section for introducing new and innovative equipment into the workplace.

(6) Material handling program. Where employees will be handling drums or containers, the employer shall develop and implement procedures meeting the requirements of paragraphs (j)(1)(ii) through (viii) and (xi) of this section, as well as (j)(3) and (j)(8) of this section prior to starting such work.

(7) Training program - (I) New employees. The employer shall develop and implement a training program which is part of the employer's safety and health program, for employees exposed to health hazards or hazardous substances at TSD operations to enable the employees to perform their assigned duties and functions in a safe and healthful manner so as not to endanger themselves or other employees. The initial training shall be for 24 hours and refresher training shall be for eight hours annually. Employees who have received the initial training required by this paragraph shall be given a written certificate attesting that they have successfully completed the necessary training. (ii) Current employees. Employers who can show by an employee's previous work experience and/or training that the employee has had training equivalent to the initial training required by this paragraph, shall be considered as meeting the initial training requirements of this paragraph as to that employee. Equivalent training includes the training that existing employees might have already received from actual site work experience. Current employees shall receive eight hours of refresher training annually. (iii) Trainers. Trainers who teach initial training shall have satisfactorily completed a training course for teaching the subjects they are expected to teach or they shall have the academic credentials and instruction experience necessary to demonstrate a good command of three subject matter of the courses and competent instructional skills.

(8) Emergency response program - (I) Emergency response plan. An emergency response plan shall be developed and implemented by all employers. Such plans need not duplicate any of the subjects fully addressed in the employer's contingency planning required by permits, such as those issued by the U.S. Environmental Protection Agency, provided that the contingency plan is made part of the emergency response plan. The emergency response plan shall be a written portion of the employers safety and health program required in paragraph (p)(1) of this section. Employers who will evacuate their employees from the worksite location when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from the requirements of paragraph (p)(8) if they provide an emergency action plan complying with section 1910.38(a) of this part. (ii) Elements of an emergency response plan. The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following areas to the extent that they are not addressed in any specific program required in this paragraph: (A) Pre-emergency planning and coordination with outside parties. (B) Personnel roles, lines of authority, training, and communication. (C) Emergency recognition and prevention. (D) Safe distances and places of refuge. (E) Site security and control. (F) Evacuation routes and procedures. (G) Decontamination procedures. (H) Emergency medical treatment and first aid. (I) Emergency alerting and response procedures. (J) Critique of response and follow-up. (K) PPE and emergency equipment. (iii) Training. (A) Training for emergency response employees shall be completed before they are called upon to perform in real emergencies. Such training shall include the elements of the emergency response plan, standard operating procedures the employer has established for the job, the personal protective equipment to be worn and procedures for handling emergency incidents.

Exception #1: an employer need not train all employees to the degree specified if the employer divides the work force in a manner such that a sufficient number of employees who have responsibility to control emergencies have the training specified, and all other employees, who may first respond to an emergency incident, have sufficient awareness training to recognize that an emergency response situation exists and that they are instructed in that case to summon the fully trained employees and not attempt control activities for which they are not trained.

Exception #2: An employer need not train all employees to the degree specified if arrangements have been made in advance for an outside fully-trained emergency response team to respond in a reasonable period and all employees, who may come to the incident first, have sufficient awareness training to recognize that an emergency response situation exists and they have been instructed to call the designated outside fully-trained emergency response team for assistance.

(B) Employee members of TSD facility emergency response organizations shall be trained to a level of competence in the recognition of health and safety hazards to protect themselves and other employees. This would include training in the methods used to minimize the risk from safety and health hazards; in the safe use of control equipment; in the selection and use of appropriate personal protective equipment; in the safe operating procedures to be used at the incident scene; in the techniques of coordination with other employees to minimize risks; in the appropriate response to over exposure from health hazards or injury to themselves and other employees; and in the recognition of subsequent symptoms which may result from over exposures. (C) The employer shall certify that each covered employee has attended and successfully completed the training required in paragraph (p)(8)(iii) of this section, or shall certify the employee's competency for certification of training shall be recorded and maintained by the employer. (iv) Procedures for handling emergency incidents. (A) In addition to the elements for the emergency response plan required in paragraph (p)(8)(ii) of this section, the following elements shall be included for emergency response plans to the extent that they do not repeat any information already contained in the emergency response plan: {1}Site topography, layout, and prevailing weather conditions. {2}Procedures for reporting incidents to local, state, and federal governmental agencies. (B) The emergency response plan shall be compatible and integrated with the disaster, fire and/or emergency response plans of local, state, and federal agencies. (C) The emergency response plan shall be rehearsed regularly as part of the overall training program for site operations. (D) The site emergency response plan shall be reviewed periodically and, as necessary, be amended to keep it current with new or changing site conditions or information. (E) An employee alarm system shall be installed in accordance with 29 CFR 1910.165 to notify employees of an emergency situation, to stop work activities if necessary, to lower back-ground noise in order to speed communication; and to begin emergency procedures. (F) Based upon the information available at time of the emergency, the employer shall evaluate the incident and the site response capabilities and proceed with the appropriate steps to implement the site emergency response plan.

(q) Emergency response program to hazardous substance releases.

This paragraph covers employers whose employees are engaged in emergency response no matter where it occurs except that it does not cover employees engaged in operations specified in paragraphs (a)(1)(I) through (a)(1)(iv) of this section. Those emergency response organizations who have developed and implemented programs equivalent to this paragraph for handling releases of hazardous substances pursuant to section 303 of the Superfund Amendments and Reauthorization Act of 1986 (Emergency Planning and Community Right-to-Know Act of 1986, 42 U.S.C. 11003) shall be deemed to have met the requirements of this paragraph.

(1) Emergency response plan. An emergency response plan shall be developed and implemented to handle anticipated emergencies prior to the commencement of emergency response operations. The plan shall be in writing and available for inspection and copying by employees, their representatives, OSHA personnel. Employers who will evacuate their employees from the danger area when an emergency occurs, and who do not permit any of their employees to assist in handling the emergency, are exempt from the requirements of this paragraph if they provide an emergency action plan complying with section 1910.38(a) of this part.

(2) Elements of an emergency response plan. The employer shall develop an emergency response plan for emergencies which shall address, as a minimum, the following areas to the extent that they are not addressed in any specific program required in this paragraph: (I) Pre-emergency planning and coordination with outside parties. (ii) Personnel roles, lines of authority, training, and communication. (iii) Emergency recognition and prevention. (iv) Safe distances and places of refuge. (v) Site security and control. (vi) Evacuation routes and procedures. (vii) Decontamination. (viii) Emergency medical treatment and first aid. (ix) Emergency alerting and response procedures. (x) Critique of response and follow-up. (xi)

PPE and emergency equipment. (xii) Emergency response organizations may use the local emergency response plan or the state emergency response plan or both, as part of their emergency response plan to avoid duplication. Those items of the emergency response plan that are being properly addressed by the SARA Title III plans may be substituted into their emergency plan or otherwise kept together for the employer and employee's use.

(3) Procedures for handling emergency response. (I) The senior emergency response official responding to an emergency shall become the individual in charge of a site-specific Incident Command System (ICS). All emergency responders and their communications shall be coordinated and controlled through the individual in charge of the ICS assisted by the senior official present for each employer.

NOTE TO (q)(3)(I). - The "senior official" at an emergency response is the most senior official on the site who has the responsibility for controlling the operations at the site. Initially it is the senior officer on the first-due piece of responding emergency apparatus to arrive on the incident scene. As more senior officers arrive (i.e. , battalion chief, fire chief, state law enforcement official, site coordinator, etc.) the position is passed up the line of authority which has been previously established. (ii) The individual in charge of the ICS shall identify, to the extent possible, all hazardous substances or conditions present and shall address as appropriate site analysis, use of engineering controls, maximum exposure limits, hazardous substance handling procedures, and use of any new technologies. (iii) Based on the hazardous substances and/or conditions present, the individual in charge of the ICS shall implement appropriate emergency operations, and assure that the personal protective equipment worn is appropriate for the hazards to be encountered. However, personal protective equipment shall meet, at a minimum, the criteria contained in 29 CFR 1910.156(e) when worn while performing fire fighting operations beyond the incipient stage for any incidnt. (iv) Employees engaged in emergency response and exposed to hazardous substances presenting an inhalation hazard or potential inhalation hazard shall wear positive pressure self-contained breathing apparatus while engaged in emergency response, until such time that the individual in charge of the ICS determines through the use of air monitoring that a decreased level of respiratory protection will not result in hazardous exposures to employees. (v) The individual in charge of the ICS shall limit the number of emergency response personnel at the emergency site, in those areas of potential or actual exposure to incident or site hazards, to those who are actively performing emergency operations. However, operations in hazardous areas shall be performed using the buddy system in groups of two or more. (vi) Back-up personnel shall be standing by with equipment ready to provide assistance or rescue. Qualified basic life support personnel, as a minimum, shall also be standing by with medical equipment and transportation capability. (vii) The individual in charge of the ICS shall designate a safety officer, who is knowledgeable in the operations being implemented at the emergency response site, with specific responsibility to identify and evaluate hazards and to provide direction with respect to the safety of operations for the emergency at hand. (viii) When activities are judged by the safety officer to be an IDLH and/or to involve an imminent danger condition, the safety officer shall have the authority to alter, suspend, or terminate those activities. The safety official shall immediately inform the individual in charge of the ICS of any actions needed to be taken to correct these hazards at the emergency scene. (ix) After emergency operations have terminated, the individual in charge of the ICS shall implement appropriate decontamination procedures. (x) When deemed necessary for meeting the tasks at hand, approved self-contained compressed air breathing apparatus may be used with approved cylinders from other approved self-contained compressed air breathing apparatus provided that such cylinders are of the same capacity and pressure rating. All compressed air cylinders used with self-contained breathing apparatus shall meet U.S. Department of Transportation and National Institute for Occupational Safety and Health criteria.

(4) Skilled support personnel. Personnel, not necessarily an employer's own employees, who are skilled in the operation of certain equipment, such as mechanized earth moving or digging equipment or crane and hoisting equipment, and who are needed temporarily to perform immediate emergency support work that cannot reasonably be performed in a timely fashion by an employer's own employees, and who will be or may be exposed to the hazards at an emergency response scene, are not required to meet the training required in this paragraph for the employer's regular employees. However, these personnel shall be given an initial briefing at the site prior to their participation in any emergency response. The initial briefing shall include instruction in the wearing of appropriate personal protective equipment, what chemical hazards

are involved, and what duties are to be performed. All other appropriate safety and health precautions provided to the employer's own employees shall be used to assure the safety and health of these personnel.

(5) Specialist employees. Employees who, in the course of their regular job duties, work with and are trained in the hazards of specific hazardous substances, and who will be called upon to provide technical advice or assistance at a hazardous substance release incident to the individual in charge, shall receive training or demonstrate competency in the area of their specialization annually.

(6) Training. Training shall be based on the duties and function to be performed by each responder of an emergency response organization. The skill and knowledge levels required for all new responders, those hired after the effective date of this standard, shall be conveyed to them through training before they are permitted to take part in actual emergency operations on an incident. Employees who participate, or are expected to participate, in emergency response, shall be given training in accordance with the following paragraphs: (I) First responder awareness level. First responders at the awareness level are individuals who are likely to witness or discover a hazardous substance release and who have been trained to initiate an emergency response sequence by notifying the authorities of the release. First responders at the awareness level shall have sufficient training or have had sufficient experience to objectively demonstrate competency in the following areas: (A) An understanding of what hazardous substances are, and the risks associated with them in an incident. (B) An understanding of the potential outcomes associated with an emergency created when hazardous substances are present. (C) The ability to recognize the presence of hazardous substances in an emergency. (D) The ability to identify the hazardous substances, if possible. (E) An understanding of the role of the first responder awareness individual in the employer's emergency response plan including site security and control and the U.S. Department of Transportation's Emergency Response Guidebook. (F) The ability to realize the need for additional resources, and to make appropriate notifications to the communication center. (ii) First responder operations level. First responders at the operations level are individuals who respond to releases or potential releases of hazardous substances as part of the initial response to the site for the purpose of protecting nearby persons, property, or the environment from the effects of the release. They are trained to respond in a defensive fashion without actually trying to stop the release. Their function is to contain the release from a safe distance, keep it from spreading, and prevent exposures. First responders at the operational level shall have received at least eight hours of training or have had sufficient experience to objectively demonstrate competency in the following areas in addition to those listed for the awareness level and the employer shall so certify: (A) Knowledge of the basic hazard and risk assessment techniques. (B) Know how to select and use proper personal protective equipment provided to the first responder operational level. (C) An understanding of basic hazardous materials terms. (D) Know how to perform basic control, containment and/or confinement operations within the capabilities of the resources and personal protective equipment available with their unit. (E) Know how to implement basic decontamination procedures. (F) An understanding of the relevant standard operating procedures and termination procedures. (iii) Hazardous materials technician. Hazardous materials technicians are individuals who respond to releases or potential releases for the purpose of stopping the release. They assume a more aggressive role than a first responder at the operations level in that they will approach the point of release in order to plug, patch or otherwise stop the release of a hazardous substance. Hazardous materials technicians shall have received at least 24 hours of training equal to the first responder operations level and in addition have competency in the following areas and the employer shall so certify: (A) Know how to implement the employer's emergency response plan. (B) Know the classification, identification and verification of known and unknown materials by using field survey instruments equipment. (C) Be able to function within an assigned role in the Incident Command System. (D) Know how to select and use proper specialized chemical personal protective equipment provided to the hazardous materials technician. (E) Understand hazard and risk assessment techniques. (F) Be able to perform advance control, containment, and/or confinement operations within the capabilities of the resources and personal protective equipment available with the unit. (G) Understand and implement decontamination procedures. (H) Understand termination procedures. (I) Understand basic chemical and toxicological terminology and behavior. (iv) Hazardous materials specialist. Hazardous materials specialists are individuals who respond with and provide support to hazardous materials technicians. Their duties parallel those of the hazardous materials technician, however, those duties require a more directed or specific knowledge of the various

substances they may be called upon to contain. The hazardous materials specialist would also act as the site liaison with Federal, state, local and other government authorities in regards to site activities. Hazardous materials specialists shall have competency in the following areas and the employer shall so certify: (A) Know how to implement the local emergency response plan. (B) Understand classification, identification and verification of known and unknown materials by using advanced survey instruments and equipment. (C) Know the state emergency response plan. (D) Be able to select and use proper specialized chemical personal protective equipment provided to the hazardous materials specialist. (E) Understand in-depth hazard and risk techniques. (F) Be able to perform specialized control, containment, and/or confinement operations within the capabilities of the resources and personal protective equipment available. (G) Be able to determine and implement decontamination procedures. (H) Have the ability to develop a site safety and control plan. (I) Understand chemical, radiological and toxicological terminology and behavior. (v) On scene incident commander. Incident commanders, who will assume control of the incident scene beyond the first responder awareness level, shall receive at least 24 hours of training equal to the first responder operations level and in addition have competency in the following areas and the employer shall so certify: (A) Know and be able to implement the employer's incident command system. (B) Know how to implement the employer's emergency response plan. (C) Know and understand the hazards and risks associated with employees working in chemical protective clothing. (D) Know how to implement the local emergency response plan. (E) Know of the state emergency response plan and of the Federal Regional Response Team. (F) Know and understand the importance of decontamination procedures.

(7) Trainers. Trainers who teach any of the above training subjects shall have satisfactorily completed a training course for teaching the subjects they are expected to teach, such as the courses offered by the U.S. National Fire Academy, or they shall have the training and/or academic credentials and instructional experience necessary to demonstrate competent instructional skills and a good command of the subject matter of the courses they are to teach.

(8) Refresher training. (I) Those employees who are trained in accordance with paragraph (q)(6) of this section shall receive annual refresher training of sufficient content and duration to maintain their competencies, or shall demonstrate competency in those areas at least yearly. (ii) A statement shall be made of the training or competency, and if a statement of competency is made, the employer shall keep a record of the methodology used to demonstrate competency.

(9) Medical surveillance and consultation. (I) Members of an organized and designated HAZMAT team and hazardous materials specialist shall receive a baseline physical examination and be provided with medical surveillance as required in paragraph (f) of this section. (ii) Any emergency response employees who exhibit signs or symptoms which may have resulted from exposure to hazardous substances during the course of an emergency incident either immediately or subsequently, shall be provided with medical consultation as required in paragraph (f)(3)(ii) of this section.

(10) Chemical protective clothing. Chemical protective clothing and equipment to be used by organized and designated HAZMAT team members, or to be used by hazardous materials specialists, shall meet the requirements of paragraphs (g)(3) through (5) of this section.

(11) Post-emergency response operations. Upon completion of the emergency response, if it is determined that it is necessary to remove hazardous substances, health hazards and materials contaminated with them (such as contaminated soil or other elements of the natural environment) from the site of the incident, the employer conducting the clean-up shall comply with one of the following: (I) Meet all the requirements of paragraphs (b) through (o) of this section; or (ii) Where the clean-up is done on plant property using plant or workplace employees, such employees shall have completed the training requirements of the following: 29 CFR 1910.38(a); 1910.134; 1910.1200, and other appropriate safety and health training made necessary by the tasks that they are expected to be performed such as personal protective equipment and decontamination procedures. All equipment to be used in the performance of the clean-up work shall be in serviceable condition and shall have been inspected prior to use.

UNIT 2:

RECOGNITION, IDENTIFICATION AND DETECTION

LEARNING OBJECTIVES

By the end of this section, participants will be able to:

- List four basic clues for identifying hazardous materials
- Describe the DOT system of placarding
- Describe the NFPA 704 Marking System
- Identify highway cargo tanks that may carry hazardous materials by shape, and list at least one commodity carried in each
- Identify rail tank cars that may carry hazardous materials by shape, and list at least one commodity carried in each
- List other resources that can be used to further identify hazardous materials

INSTRUCTOR NOTES

Purpose of Unit:

This unit examines the four basic clues that will help First Responders recognize the presence of a hazardous material when they arrive at an incident scene.

Materials and Supplies:

Chalkboard or flip chart
Overhead transparency projector and transparencies 2-1 and 2-2
Slide projector and slides 12 through 57
Examples of DOT placards and labels
Examples of NFPA placards and labels

Instructor Preparation:

Obtain a set of DOT placards and labels, and an NFPA 704 marker in advance of class. If you cannot locate samples, use slides 12 through 35.

Copy sample bills of lading, rail consists, and way bills to discuss with your students. These items can be obtained through local shippers and railroads.

RECOGNITION AND IDENTIFICATION

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

Your ability to recognize and identify the presence of hazardous materials is essential for your safety. Only after you identify – or at least classify – the material, can you decide on the appropriate action. Dispatch information may give you an initial warning, but this information is often incomplete or inaccurate. This unit describes how to detect the presence of hazardous materials by looking for four basic clues:

- Occupancy and location of a fixed facility
- Placards, labels, and markings
- Container shape and design
- Shipping papers or facility documents

You can also use your vision, aided by binoculars, and your hearing to detect the presence of hazardous materials.

Activity

Verbally conduct the Recognition and Identification quiz in the Instructor Materials section (Transparencies). Discuss the correct answers and write them on the transparency.

Questions

???

Ask the students the following questions:

- **Name some occupancies in your area that have hazardous materials on site**
- **What chemicals do these occupancies use?**
- **Would you know how to protect yourself from exposure if you responded to a fire at the location?**
- **Do any of these companies use radioactive materials?**

Activity

Have the students name some types of businesses that use hazardous materials. Write these on the chalkboard. Under each business, have them list the specific chemicals that might be used.

OCCUPANCY AND LOCATION

The occupancy and location of an emergency site can provide valuable clues. If the processes, materials used, and products manufactured at a particular site are known, First Responders can begin to make some determinations about the hazards that are likely to be involved.

Radioactive waste stored in drums at DOE facility

Remember, you may find hazardous materials incidents in sites other than industrial settings. A shopping center, dry cleaning facility, hardware store, or automobile repair shop could be the site of a chemical spill or fire involving hazardous materials.

Virtually any industry or business can store or use hazardous materials

Often, the people who use these materials are not aware of the potential hazards unless they work with the fire department to prepare for an emergency situation.

Use pre-incident planning as a way to educate yourself and the community about the safe use and storage of hazardous materials.

PLACARDS, LABELS, AND MARKINGS

Placards, labels, and markings provide information about the types and hazards of products being transported or stored. There are a number of marking systems required or strongly recommended where hazardous materials are present. The most common ones are discussed in this section.

The DOT System

The Department of Transportation (DOT) regulates the type of labels and placards that must be attached to hazardous materials containers and the vehicles that carry them.

DOT Hazard Classes

DOT placards are based on nine hazard classes:

- **Class 1** = explosives
- **Class 2** = gases (compressed, liquefied, or dissolved under pressure)
- **Class 3** = flammable/combustible liquids
- **Class 4 =** flammable solid/dangerous when wet/spontaneous combustible
- **Class 5 =** oxidizers/organic peroxides
- **Class 6** = toxic (poisonous)/infections
- **Class 7** = radioactive materials
- **Class 8** = corrosive materials
- **Class 9** = miscellaneous dangerous goods

DOT Placards and Labels

DOT **placards** are diamond-shaped signs (10-3/4 inches on each side) that are required to be affixed on each side and each end of vehicles carrying hazardous materials. Placarding requirements are very specific. Placards indicate the **primary hazard**—the most dangerous property—associated with the material being transported. Some materials also require subsidiary (secondary) placards, which do not carry class numbers.

DOT **labels** are 4-inch diamonds (or smaller, for cylinders) affixed to non-bulk packages of hazardous materials. Generally, they are required for the same materials for which placards are required. Unlike placarding, labeling is not limited to the material's primary hazard. So a package containing a material that meets the definitions of more than one hazard class must be labeled for each of those classes.

UN Identification Numbers

The corresponding UN (United Nations) 4-digit identification number must appear in the center of the placard or beside the placard. The 4-digit identification number may replace the class name in the center of the placard for bulk shipments of hazardous materials. However, it cannot replace the DANGEROUS placard or the class name for Radioactive materials or any class of Explosives.

UN numbers can be incorporated into a placard, or posted on a separate orange marker next to the placard.

Activity

Tell the students to refer to their resources and list at least three specific chemicals for each hazard class.

DOT Table I Materials

Certain categories of materials must always be placarded with their primary hazard placards, regardless of the amount being transported. These are referred to as **Table 1** materials because they appear in Table 1 of the placarding section of the Code of Federal Regulations (49 CFR 172.500).

DOT Table 2 Materials

Table 2 includes all other placardable hazardous materials. However, these materials do not become “placardable” unless 1,001 pounds or more are being carried (of any one, or a combination of Table 2 materials). In other words, any quantity of Table 1 material must be placarded. Table 2 materials must be placarded only if the gross weight is 1,001 pounds or more.

Activity

Show the examples of the DOT placards and labels you have obtained.

Mixed Loads

When the total weight of two or more materials from Table 2 is 1,001 pounds or more, a Dangerous placard may be used. If 5,000 pounds (2,205 pounds as of October, 1997) or more of any of these materials are loaded at one location, the corresponding placard must be used, along with a Dangerous placard or the class placard for the other materials.

The materials in Tables 1 and 2 are listed on the following page.

Slides

Show slides 12 through 35 as you discuss the DOT placarding system.

Transparency

Show Transparency 2-1 and discuss Table 1 materials.

Transparency

Show Transparency 2-2 and discuss Table 2 materials.

TABLE 2.1 HAZARDS CHECKLIST
NON-STRUCTURAL AND TRANSPORTATION ALARMS
DOT TABLE 1 MATERIALS

IF A VEHICLE CONTAINS A MATERIAL CLASSED AS:	THE VEHICLE MUST BE PLACARDED AS:
Explosives (Division 1.1)	Explosive
Explosives (Division 1.2)	Explosive
Explosives (Division 1.3)	Explosive
Poison gas (Division 2.3)	Poison gas (Toxic Gas)
Dangerous when wet (Division 4.3)	Dangerous when wet
Toxic Materials and Infectious Substances (Class 6)	Poison (Toxic)
Radioactive (Class 7, those substances in Radioactive III packaging only)	Radioactive

DOT TABLE 2 MATERIALS
(1,001 LBS. OR MORE)

IF A VEHICLE CONTAINS A MATERIAL CLASSED AS:	THE VEHICLE MUST BE PLACARDED AS:
Explosives (Division 1.4)	Explosive
Explosives (Division 1.5)	Blasting agent
Explosives (Division 1.6)	Explosive
Non-flammable gas (Division 2.2)	Non-flammable gas
Oxygen (Division 2.2)	Oxygen
Flammable gas (Division 2.1)	Flammable gas
Combustible liquid (Class 3)	Combustible
Flammable liquid (Class 3)	Flammable
Flammable solid (Division 4.1)	Flammable solid
Oxidizer (Division 5.1)	Oxidizer
Organic peroxide (Division 5.2)	Organic peroxide
Toxic Materials and Infectious Substances (Class 6)	Toxic
Corrosive (Class 8)	Corrosive
Irritating	Dangerous

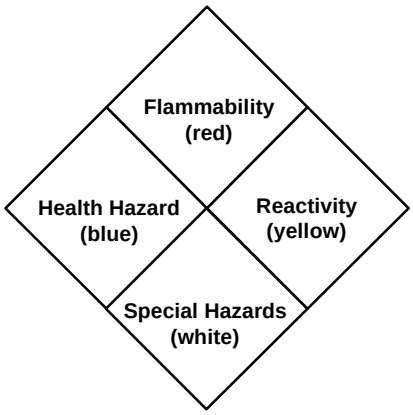
Activity

Show the students examples of NFPA placards for specific but common chemicals. Have the students identify the hazards and, if possible, the specific chemical. Give them hints as needed.

NFPA Marking System

The National Fire Protection Association (NFPA) has developed a marking system for fixed sites to indicate the dangers associated with various hazardous materials handled at a location. This marking system is not used in transportation, and is not federally regulated or required. Local jurisdictions, however, may require the use of the system at fixed sites.

The NFPA marking system (detailed in NFPA 704) uses a diamond divided into color-coded quadrants. Each quadrant is a specific color and indicates a material's health hazard (left), flammability hazard (top), reactivity hazard (right), or special hazards (bottom).



The health, flammability, and reactivity hazards are ranked from **0** to **4**, with 0 indicating no risk and 4 indicating the greatest risk. The specific hazard area may contain a special symbol or letter indicating a specific danger. For example, **OX** indicates an oxidizer, a trefoil (or propeller) indicates a radioactive material, and a ₩ indicates a water reactive material. The NFPA marker for sulfuric acid is shown on the next page. The numbers indicate a fairly significant health hazard (3), no flammability hazard (0), and moderate reactivity (2). The ₩ indicates that sulfuric acid is water-reactive.

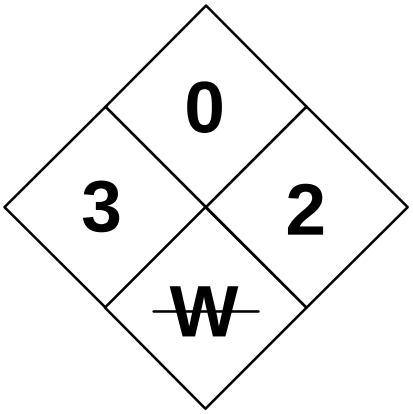


Table 2.2 on the following page describes the rating system for the degree of hazard.

Hazardous Materials Information System

The Hazardous Materials Information System is very similar to the NFPA marking system. HMIS uses the same color coding and number indicators, but the marker is in bar form rather than diamond-shaped.

TABLE 2.2
NFPA 704 MARKING SYSTEM

#	HEALTH HAZARD	FLAMMABILITY	REACTIVITY
4	Very short exposure could cause death or major residual injury	Will rapidly and completely vaporize at atmospheric pressure and normal temperature, or will readily disperse in air and burn	Capable of detonation or explosive reaction at normal temperatures and pressures; sensitive to mechanical or localized thermal shock
3	Short exposure could cause serious temporary or residual injury	Can ignite under almost all normal temperature conditions	Capable of detonation or explosive reaction if exposed to a strong ignition source or if heated under confinement; may react explosively with water
2	Intense or continued (but not chronic) exposure could cause temporary incapacitation or possible residual injury	Capable of ignition when exposed to relatively high temperatures	Readily undergoes violent chemical change at elevated temperatures and pressures; may react violently with water
1	Exposure could cause irritation, but only minor residual injury	Must be heated before ignition will occur	May become unstable when exposed to heat and pressure; may react with water, but not violently
0	Exposure under fire conditions would present no hazard beyond that of ordinary combustible material	Will not burn	Normally stable, even under fire conditions; not water reactive

Key Points

The military has its own marking system with four numbered classes:

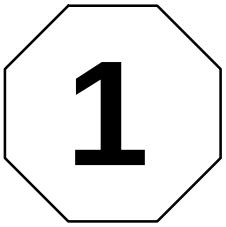
- **Class 1: Mass Detonation Hazard**
- **Class 2: Explosion with Fragmentation Hazard**
- **Class 3: Mass Fire Hazard**
- **Class 4: Moderate Fire Hazard**

Military Marking System

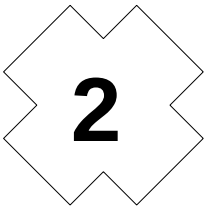
The military has developed its own marking system which is used on military shipments at fixed site facilities. This system consists of four numbered classes as well as three special hazards.

The four military classes are:

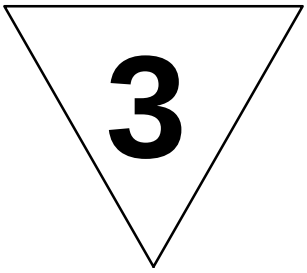
Class 1: Mass Detonation Hazard



Class 2: Explosion with Fragmentation Hazard



Class 3: Mass Fire Hazard



Class 4: Moderate Fire Hazard

The three special hazard symbols are:

Chemical Hazard

Apply No Water

Wear Protective Breathing Apparatus

CONTAINER SHAPES AND DESIGNS

Key Points

Container size and shape help you identify:

- **The presence of hazardous material**
- **The type of material**
- **Specific materials**

Specific materials

The shape, size and design of containers used in transportation and storage may give you other clues that hazardous materials are present. Shape and design may also indicate the general type of material in the container – a compressed gas, for example, is easily identifiable by a cylindrical container with rounded ends. Container shapes are often specific for certain materials, and many are regulated by federal law.

Wooden crates carrying LSA radioactive material

Bulk and Non-Bulk Containers

Key Points

Bulk containers hold:
- **119 gal. (liquid)**
- **882 lbs. (solids)**
- **1,001 lbs. (gases)**

Both bulk and non-bulk containers are used to transport hazardous materials. **Bulk containers** hold hazardous materials without an intermediate form of containment. These types of containers include highway cargo tanks, tank cars that transport materials by rail, and other containers (except watercraft) with:

- A maximum capacity of more than 119 gallons (450 liters) for containers of liquids
- A maximum net capacity of more than 882 pounds (401 kilograms) for containers of solids
- A water capacity greater than 1,001 pounds (454 kilograms) for containers of gases

Non-bulk packaging such as 5-gallon drums, bottles, and dewars include all containers with capacities less than these.

Highway Carriers

Key Points

Cargo tanks are built to either:
- **MC (motor carrier) specs, or**
- **DOT specs**

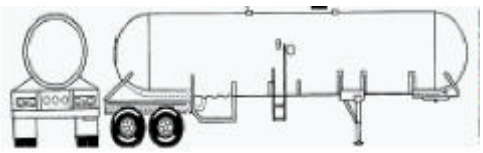
Most cargo tanks in service today were built to MC (motor carrier) specifications, and they are often identified by the specifications to which they were built, such as MC 306, MC 307, etc. Those cargo tanks which were built after August 31, 1993, must conform to new DOT specifications (DOT 406, DOT 407, and DOT 412). However, many tanks built to the older MC specifications will remain in service for several years.

Each type of cargo tank is shown on the following pages, along with a general description of the tank and its common cargo.

Pressure Cargo Tank (MC 331)

Slides

Show slide 36 and discuss pressure cargo tanks.

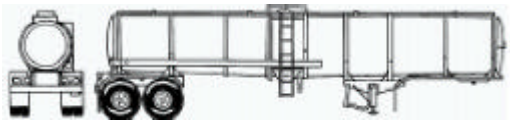


- Rounded ends
- Transports gases liquefied through compression (propane, butane, anhydrous ammonia, and chlorine)

Low Pressure Cargo Tank (MC 307 or DOT 407)

Slides

Show slides 37-38 and discuss low pressure cargo tanks.

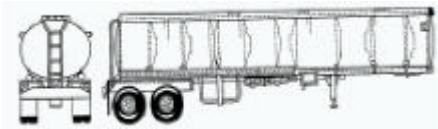


- Circular or horse-shoe shaped cross sections and flat ends
- May have rollover protection
- Transports flammable or combustible liquids, mild corrosives, poisons, and almost all other types of liquid chemicals

Non-Pressure Cargo Tank (MC 306 or DOT 406)

Slides

Show slide 39 and discuss non-pressure cargo tanks.



- Elliptical cross sections and flat ends
- Usually compartmented
- Transports petroleum products such as gasoline and fuel oil

Corrosive Liquid Cargo Tank (MC 312 or DOT 412)

Slides

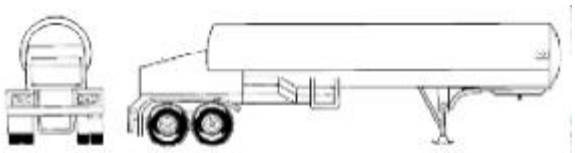
Show slide 40 and discuss corrosive liquid cargo tanks.

- Circular cross-sections and flat ends
- Relatively small diameter with visible stiffening rings
- Transports corrosives such as sodium hydroxide, hydrochloric acid, and sulfuric acid as well as other high-density liquids

Cryogenic Liquid Cargo Tank (MC 338)

Slides

Show slide 41 and discuss cryogenic liquid cargo tanks.



- Circular cross sections and rounded ends
- Heavily insulated with piping and valves in a rear cabinet
- Transports gases liquefied through temperature reduction, such as liquid oxygen (LOX), liquid nitrogen, liquid hydrogen, and liquid helium

Other types of highway carriers that might transport hazardous cargo include :

- Covered hopper trucks
- Tube trailers
- Tractor trailers
- Box trailer
- Vans, step-vans, and flatbed pickup trucks

Slides

Show slides 42-45 and discuss other types of highway carriers.

Railroad Tank Cars

Tank cars are bulk containers used to carry both hazardous and non-hazardous materials by rail. The specific type of materials carried in a tank car determines how the tank is constructed, as well as its size, fittings, linings, and other features.

When a rail incident occurs, railroad personnel are often the best source of information. They are the experts on rail car design and use, and can provide you with information that could save your life. Becoming familiar with the railroad companies operating in the community before an incident occurs is essential.

Although there are exceptions, most tank cars carry only a single commodity. In general, they all look very similar, with circular cross sections and rounded heads. Because of their similar design, you must learn to identify specific tank car characteristics for clues about the nature of the commodity being transported.

Key Points

The specific cargo in a tank car depends on the car's

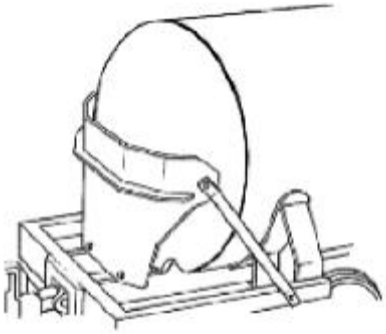
- **Construction**
- **Size**
- **Fittings**
- **Linings and other features**

One feature that is added to pressure tank cars and to certain non-pressure tank cars transporting hazardous materials is a **head shield.** Head shields are required for non-pressure tank cars transporting ethylene oxide. Head shields protect the heads of tank cars from puncture by the coupling mechanism. Half-head
or trapezoid-shaped plates of steel are added to the lower half of each head. Some tank cars incorporate either full or bottom half-head shields into a protective jacket that covers the entire tank car. This makes the head shield difficult to see.

Key Points

Head shields:

- **Protect heads on pressure tank cars from coupling punctures**
- **Used on non-pressure tank cars carrying ethylene oxide**



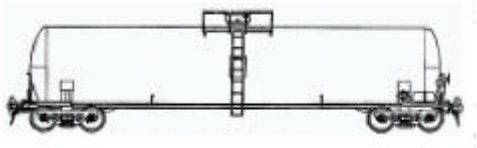
Head Shield

Tank cars can be divided into several different categories, each with its own distinct characteristics. The most common are discussed in this section.

Pressure Tank Car

Slides

Show slides 46-48 and discuss pressure tank cars.



- Designed for pressures from 100 psig to 600 psig
- Fittings inside a protective housing on top of tank
- Housing distinguishes pressure from non-pressure tanks
- Transports flammable and non-flammable compressed gases or poisonous compressed gases

Non-Pressure Tank Car

Slides

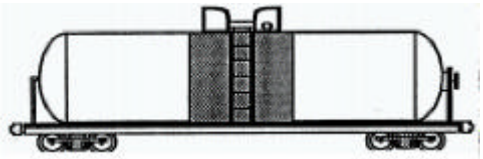
Show slides 49-50 and discuss non-pressure tank cars.

- Designed for pressures below 100 psig at 105°F-115°F
- Distinguished from pressure tank cars by manway and visible fittings
- May be compartmented with fittings and manways for each compartment
- Transports flammable liquids, flammable solids, oxidizers and organic peroxides, poisons, corrosives, and non-hazardous materials

Corrosive Liquid Tank Car

Slides

Show slide 51 and discuss corrosive liquid tank cars.



- Similar to non-pressure tank cars
- Can be distinguished by staining around manway
- Some painted with vertical stripe of corrosion-resistant paint

Cryogenic Liquid Tank Car

Slides

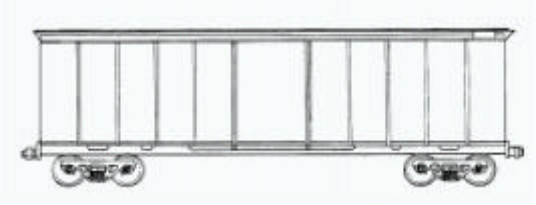
Show slides 52-53 and discuss cryogenic liquid tanks cars.

- Carry low pressure refrigerated liquids (minus 130°F and below)
- Designed as a tank-within-a-tank for insulation
- Product may vent under normal conditions

Box Car

Slides

Show slide 54 and discuss box cars.



- Enclosed cars with steel or wooden interiors
- Used for general freight
- Carries drums, boxes, cylinders or other non-bulk containers

Gondola Car

Slides

Show slide 55 and discuss gondola cars.

- Uncovered, with low sides and ends
- Transport bulk ores and other solid materials
- Often used to carry radioactive materials

Other Types of Containers

Ton Containers

When shipped by rail, ton containers are carried on special flat cars, in boxcars or gondola cars, and in trailer-on-flat-cars or container-on-flat-cars.

Ton Container

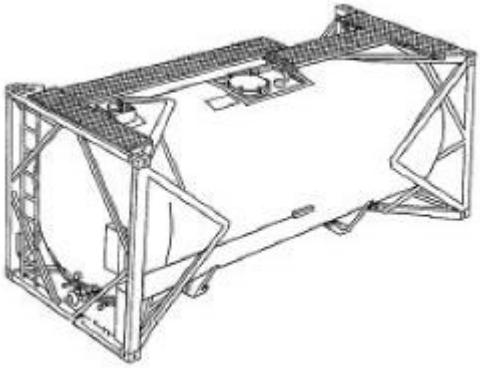
All fittings are located in the heads, including fusible plugs and/or spring-loaded safety relief valves. Safety relief devices are prohibited for certain poisonous or noxious materials.

Ton containers transport gases like anhydrous ammonia, butadiene, chlorine, phosgene, refrigerant or dispersant gases, or sulfur dioxide.

Tank Containers

Tank containers consist of a single metal tank mounted inside a sturdy metal supporting frame. This unique frame structure, built to rigid international standards, makes tank containers intermodal. This means that they can be used in two or more modes of transport, such as rail, highway, or water.

The tank is generally built as a cylinder enclosed at the ends by heads. Its capacity is generally less than 6,340 gallons (about 24,000 liters). Other tank shapes and configurations are rare, as are tanks with multiple compartments.



Tank Container

Slides

Show slides 56-57 and discuss intermodal containers.

Intermodal Containers

Intermodal containers are used to transport liquid and solid materials. Fifty-five gallon drums or other large non-bulk containers are often grouped together in intermodal containers. The advantage to these types of containers is that they can be shipped via ground, air, or water without the contents being unloaded.

SHIPPING PAPERS AND FACILITY DOCUMENTS

Activity

If you have obtained sample shipping papers, distribute them to the students and reference them as you cover the information in this section.

All shipments of hazardous materials, as defined by DOT, must be accompanied by shipping papers. The type of shipping paper varies depending on the mode of transportation. Table 2.3 lists the type of shipping paper that corresponds to each mode of transportation. Subsequent pages show samples of the different types of shipping papers.

Shipping papers provide detailed information about the contents of the shipment. They may alert you to the presence of hazardous materials through a variety of required entries. As valuable as shipping papers are, keep in mind that they are not always complete, and sometimes even required entries are missing.

Shipping papers may include the following information:

- Proper shipping name, hazard class and division, DOT Identification Number, total quantity by weight or volume
- EPA waste stream number, EPA waste characteristic or “D” number—this may indicate that waste is hazardous, even if it cannot be identified as a particular chemical (only required for Class 9 materials – see 40 CFR 262.20)
- Placard notation, placard endorsement (by rail and highway)
- RQ (reportable quantity) notation indicating that a hazardous material is being shipped in an amount exceeding a federally specified level
- POISON or POISON—INHALATION HAZARD or INHALATION HAZARD notation
- Other notations such as CORROSIVE, EXPLOSIVE, etc.
- Descriptions of the type of hazard such as marine pollutant or subsidiary hazard

TABLE 2.3

SHIPPING PAPERS AND MODES OF TRANSPORTATION

MODE OF TRANSPORTATION	TITLE OF SHIPPING PAPER	LOCATION OF SHIPPING PAPERS	RESPONSIBLE PERSON
Highway	Bill of Lading or Freight Bill	Cab of vehicle within reach of the driver	Driver
Rail	Waybill and/or Consist	Member of train crew (conductor or engineer) Shipper	Conductor
Water	Dangerous Cargo Manifest	Warehouse or pipe-like container on barge	Captain or master
Air	Air Bill with Shipper's Certification for Restricted Articles	Cockpit (may also be found attached to the outside of packages)	Pilot

Activity

Have the students use their *Emergency Response Guidebooks* to research the hazards of one of the materials listed in the shipping papers on the following pages.

In emergencies you may not have ready access to shipping papers. However, federal regulations require the driver of a cargo tank to carry shipping papers in the cab of the vehicle or on his/her person. But in an emergency, you may not be able to approach the vehicle, or the driver may be unconscious or otherwise unavailable. In these cases, you may be able to obtain shipping paper information from at least two other sources: the shipper/generator, and/or the carrier. If the cargo is hazardous waste, the disposal facility will also have copies. In case of an accident, you may be able to see the name of the carrier on the exterior of the cab or the vehicle itself.

STRAIGHT BILL OF LADING - SHORTFORM

ORIGINAL NOT-NEGOTIABLE

DATE 05/02/96

NAME OF CARRIER WILCO DELIVERY

NCH Shipper's No. 123874

RECEIVED, subject to the classifications and lawfully filed tariffs or contracts in effect on the date of issue of this Bill of Lading, provided however, when the carrier and shipper have agreed to an individually-determined rate, classification, rule or practice, shipment shall be governed by the rate and rules to which the parties agreed.

To:	From:			
[redacted] 3302 RICHARDSON ST BLDG 6 HOUSTON TX 77001	NATIONAL CHEMSEARCH 2730 CARL ROAD IRVING, TEXAS 75062 Shipper's No. 123874			Freight Charges PREPAID Send Bill To: P.O. Box 152120 Irving TX 75062-2120
P. O. 110466		CUSTOMER A0079115	SALES REP. 013A	ORDER NO. 0274P	03-E0

Carrier Instructions:

Line No.	No. Items BX	DR	HM	Description of Articles Special Marks & Exceptions	Weight LBS	Class	Quantity / Package	Product Desc.	EPA
076		1	X	CAUSTIC ALKALI LIQUIDS, N.O.S., (SODIUM HYDROXIDE), 8, UN1719 PGIII NMFC48580 SUB 3	364	055	1 X35	076-SHINY-SIDE 105150400	
078	1			PUMPS, HAND., NMFC127700	2	085	1 EACH	078-DRUM PUMP MR50-XL-PLASTIC 180562500	
239	2			SPRAYERS, HAND HELD 8 BUT LESS THAN 10 LBS., NMFC177670 SUB 6	16	100	2 EACH	239-MAXI-BLASTER 188322500	
	3	1		TOTAL TOTAL	382				

*** EMERGENCY PHONE (214) 438-1381 ***

Shipper hereby certifies that he is familiar with all the bill of lading terms and conditions in the governing classification and terms and conditions are hereby agreed to by shipper and accepted for himself and his assigns. This is to certify that the above named materials are properly classified, described, packaged, marked and labeled and in proper condition for transportation according to the Department of Transportation.

Driver hereby acknowledges that a current copy of the DOT emergency response guidebook is in the cab of the vehicle in accordance with 49 C.F.R. Part 172, Subpar G. Driver acknowledges that he has been offered appropriate hazardous material placards.

SHIPPER: NATIONAL CHEMSEARCH	CARRIER	TRAILER NO.
PER [signature] MAY 02 1996	PER	DATE PAGE 1

STRAIGHT BILL OF LADING - SHORT FORM - ORIGINAL - Not Negotiable

Shipper: FLUOR DANIEL FERNALD, INC. C/O USDOE
7400 WILLEY ROAD
FERNALD OH 45030-

Shipper No. 2143

Purchase/ Customer Order No.

Date: 04/09/97

RECEIVED, subject to the classifications and tariffs in effect on the date of the issue of this Bill of Lading, the property described below in apparent good order, except as noted (contents and condition of contents of packages unknown) marked, consigned, and destined as shown below, which said carrier (the word carrier being understood throughout this contract as meaning any person or corporation in possession of the property under the contract) agrees to carry to its usual place of delivery at said destination, if on its route, otherwise to deliver to another carrier on the route to said destination. It is mutually agreed, as to each carrier of all or any of said property over all or any portion of said route to destination, and as to each party at any time interested in all or any of said property, that every service to be performed hereunder shall be subject to all the terms and conditions of the Uniform Domestic Straight Bill of Lading set forth (1) in Uniform Freight Classification in effect on the date hereof, if this is a rail or rail-water shipment, or (2) in the applicable motor carrier classification or tariff if this is a motor carrier shipment.

Shipper hereby certifies that he is familiar with all the terms and conditions of the said bill of lading, including those on the back thereof, set forth in the classification or tariff which governs the transportation of this shipment, and the said terms and conditions are hereby agreed to by the shipper and accepted for himself and his assigns.

Consignee
BECHTEL NEVADA CORPORATION FOR USDOE
WASTE MANAGEMENT DEPARTMENT MANAGER
NEVADA TEST SITE - ZONE 2
MERCURY NV 89023-

CARRIER LRGR / LANDSTAR RANGER

* * * L R G R *

CAR OR VEHICLE INITIALS & NO.
716733

SEAL # 00355

Route: Ranger Transportation, Inc.

Carrier No.

Section 13713
Tender, No.: 305SUP21

No. PKGS	HM	Description of Articles (Subject to Correction), Kind of Package, Special Marks and Exceptions (See NMFC Item (Rule) 360)	Weight (Subject to Correction)	Class	Rate	Charges
8 BOXES	RQ	Radioactive Material, Low Specific Activity, n.o.s., 7, UN2912, LSA-II, Radionuclides - Thorium Natural Th-228, Th-230, Ra-228 Material Form - Solid Chemical Form - Oxide Total Activity - 41.75226557 GBq (1.12843961 Curies) (Gross Weight - 15,408 Kg)	33970			
1 BOX	RQ	Radioactive Material, Low Specific Activity, n.o.s., 7, UN2912, LSA-II Radionuclides - U-Depleted Th-230, Th-228, Pb-210 Material Form - Solid Chemical Form - Oxide Total Activity - 6.06706945 GBq (0.16397485 Curies) (Gross Weight - 2,339 Kg)	5156			
		TOTALS:	39126	LBS	9 Boxes	

Subject to Section 7 of conditions, if this shipment is to be delivered to the consignee without recourse on the consignor, the consignor shall sign the following statement: The carrier shall not make delivery of this shipment without payment of freight and all other lawful charges.

FDF
Signature of Consignor

If freight charges are to be prepaid, write or stamp here "TO BE PREPAID"
PREPAID

Note: Where the rate is dependent on value, shippers are required to state specifically in writing the agreed or declared value of the property. The agreed or declared value of the property is hereby specifically stated by the shipper to be not exceeding

$ _____ per lb.

Job order, reference, account, or work order number
Charge BAGAP

Savings:
$

IN THE EVENT OF AN EMERGENCY, PHONE COLLECT (513)648-4444 - 24 HOURS.

ITEM NO.	NMFC 180- ITEM NO.	COMMODITY NO. FOR SMAC REPORTING	PACKAGING TYPE	NFM NO.
1				
2				

Label(s) applied

Placard(s) Required
Radioactive

Remarks:
****EMERGENCY RESPONSE GUIDE #162****

EXCLUSIVE USE SHIPMENT
ETA: 7:00 a.m. Monday, April 14, 1997

For curies per container, see Page 4 of 4
741 No. GVC-VAB-160 SS-SO No. 5764

TECHNICAL CONTACT: Donna J. Allen

This is to certify that the above named materials are properly classified, described, packaged, marked, and labeled, and are in proper condition for transportation according to the applicable regulations of the Department of Transportation. (Applicable for Hazardous Materials Only.)

Shipper: USDOE, C/O FLUOR DANIEL FERNALD
Acting under the authority of DE-AC24-92OR21972 with U.S. Dept. of Energy
Per: Donna Allen Date: 04/10/97
P.O.Box 538704 Cincinnati OH 45253
TRANSPORTATION DEPT. - Permanent Post Office Address of Shipper

*This shipment is for U.S. Department of Energy and the actual total transportation charges paid to the carrier(s) by the consignor or consignee are assignable to, and shall be reimbursed by, the U.S. Government and is subject to the terms and conditions set forth in the standard form of the U.S. Government Bill of Lading and to any available special rates or charges. (41 CFR 109-40.50 and 41 CFR 40.3)

X YES NO

*The delivery on the face hereof and to the terms and conditions are here by noted:

Carrier: Ranger Transportation, Inc.
Per: [signature] Date: 4/10/97

Page 1 of 4

Loading Manifest (Highway)

```
1 IB 6  ON 05/13/96   LOADING MANIFEST  START: _____      END: _____
                                  *** GATOR FREIGHTWAYS INC. ***
                                                                  TIME: 12:36:30AM     DATE: 05/13/96
                                                                  PRINTED BY: sunnje
      LOAD ON UNIT: SNA174280        DRIVER: HSTLM-MELTON, LEROY      CHECKER #: 1301     SEAL #:  474021
FROM: HOUSTON, TX                    FROM: HOUSTON, TX                FROM: HOUSTON, TX
 TO: SAN ANTONIO, TX                   TO: SAN ANTONIO, TX              TO: SAN ANTONIO, TX

<*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*>      CAPACITY: FUL
   This is to certify that the below-named materials are properly      DOLLY 1:
   classified, described, packaged, marked and labeled, and are
   in proper condition for transportation according to the applicable
   regulations of the Department of Transportation.

          **** R. L.  ROBERTS  ****
                      PRESIDENT
<*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*><*>

   * * * * *  TRAILER REPORT  * * * * *                          *** SUPERVISOR --- If Repairs Required **
____ SWEPT              ____ PLACARDS REMOVED      CHECKER NAME _____________________   SHOP NOTIFIED -DATE/TIME _____________
____ NAILS PULLED       ____ ROOF, WALLS, FLOOR & DOOR OK
 REPAIR NOTES:                                     SUPERVISOR _____________________   CONTACT NAME _____________________

LOAD   F/B      PCS.  WEIGHT      ORIGIN/DEST          SHIPPER          CONSIGNEE NAME/      CITY          DES  REVENUE  LOAD
POS.  NUMBER                                                             ADDRESS                            TRM           TO

 6 IB10025101     12  4640   DLS/AREA  80          W E INDUSTRIES     WACKENHUT CORRECTNS  SAN ANTONIO    TX SNA    269.41 838-U
                            ENTER: 05/10 @ 7:47PM   DALLAS           TX 218 S LAREDO      78205

            1.      348   PHOSPHORIC ACID, 8, CORROSIVE, UN1805, PGIII
            1.      344   SODIUM HYDROXIDE SOLUTION, 8, CORROSIVE,
                          UN1824, PGII
            1.      344   HYPOCHLORITE SOLUTIONS WITH MORE THAN
                          5 PERCENT BUT LESS THAN 16 PERCENT
                          AVAILABLE CHLORINE, 8, CORROSIVE, UN1791,
                          PGIII
            2.     1162   HYPOCHLORITE SOLUTIONS WITH MORE THAN
                          5 PERCENT BUT LESS THAN 16 PERCENT
                          AVAILABLE CHLORINE, 8, CORROSIVE, UN1791,
                          PGIII
            2.     1026   SODIUM HYDROXIDE SOLUTION, 8, CORROSIVE,
                          UN1824, PGII
                          CHEMICAL EMERGENCY #800-424-9300
     4WAY SKIDS FOR PRO IB10025101 ARE 0

 8 IB10025119     12  3752   DLS/AREA  80          W E INDUSTRIES     WACKENHUT CORRECTNS  SAN ANTONIO    TX SNA    269.41 838-U
                            ENTER: 05/10 @ 7:42PM   DALLAS           TX 218 S LAREDO      78205

            1.      348   PHOSPHORIC ACID, 8, CORROSIVE, UN1805, PGIII
            1.      344   SODIUM HYDROXIDE SOLUTION, 8, CORROSIVE,
                          UN1824, PGII
            1.      344   HYPOCHLORITE SOLUTIONS WITH MORE THAN
                          5 PERCENT BUT LESS THAN 16 PERCENT
                          AVAILABLE CHLORINE, 8 CORROSIVE, UN1791,
                          PGIII
            2.     1162   HYPOCHLORITE SOLUTIONS WITH MORE THAN
                          5 PERCENT BUT LESS THAN 16 PERCENT
                          AVAILABLE CHLORINE, 8, CORROSIVE, UN1791,
                          PGIII
         ********* MORE DETAILS FOR THIS PRO ON NEXT PAGE *********
```

DANGEROUS CARGO MANIFEST PAGE 1 of 1

VESSEL: CARIBBIA — OFF. NO.: [illegible]

VOYAGE: 0305 — DATE: 9/5/89

MASTER: CAPT. COST — PORT DEPARTURE: [illegible]

FLAG: U.S. — FINAL PLAN: SAN JUAN, P.R.

NO.	COMMODITY (TRUE SHIPPING NAME)	CLASSIFICATION	LABEL	CONTAINER NO.	STOWAGE	QTY.	TYPE	WT.
1	SODIUM PERSULPHATE(WATER TREATMENT COMPOUND)							
2		OXIDIZER	UN1505	SINU 104214	090304	10	PAIL	620
3	CALCIUM HYPOCHLORITE MIXTURE DRY							
4		OXIDIZER	UN1748	SINU 132816	090304	20	PAILS	214
5	HYDROCHLORIC ACID	CORROSIVE MATERIAL	UN1789	SINU 132818	030207	3	CBIS	72
6	ACETIC ACID GLACIAL	CORROSIVE MATERIAL	UN2789	SINU 132818		6	CTNS	304
7	FLAMMABLE LIQUID NOS	FLAMMABLE LIQUID	UN1993	PRMU 220218		1	SKID	1200
8	XYLENE(XYLOL)	FLAMMABLE LIQUID	UN1307	PRMU 220218		1	DRM	398
9	ETHYL ALCOHOL	FLAMMABLE LIQUID	UN1170	PRMU 220218	060407	48	PAIL	1920
10	METHYL ETHYL KETONE	FLAMMABLE LIQUID	UN1193	PRMU 220218		1	PAIL	50
11	ETHYL ALCOHOL	FLAMMABLE LIQUID	UN1170	PRMU 220218		15	PAIL	600
12	BATTERIES WET FILLED WITH ACID							
13		CORROSIVE MATERIAL	UN2794	PRMU 220413	030305	713	PKG.	2-852
14	CORROSIVE SOLID NOS	CORROSIVE MATERIAL	UN1759	TTLU 450088		1	DRM	505
15	CORROSIVE LIQUID NOS(CLEANING LIQUID)				020407			
16		CORROSIVE MATERIAL	UN1760	TTLU 450088		4	DRMS	2260
17	ETHANOL	FLAMMABLE LIQUID	UN1170	LYNU 450103	060204	5	DRMS	2500
18	CEMENT LIQUID	FLAMMABLE LIQUID	UN1133	LYNU 450145		8	BXS	300
19	INK	FLAMMABLE LIQUID	UN1210	LYNU 450145	060105	1	CTN	18
20	INK	FLAMMABLE LIQUID	UN1210	LYNU 450145		1	CTN.	8
21	CAUSTIC ALKALI LIQUID NOS(DIETHYLENE TRIAMINE 20%)							
22		CORROSIVE LIQUID	UN1719	LYNU 450573		150	CTNS	1170
23	CAUSTIC ALKALI LIQUID NOS(N,N,N-TRIMETHYL PIPERAZINE 20%)				060807			
24		CORROSIVE MATERIAL	UN1719	LYNU 450573		15	CTNS	375
25	INK	FLAMMABLE LIQUID	UN1263	SCNU 450724	080202	3	PAILS	165
26	ADHESIVE	FLAMMABLE LIQUID	UN1133	PRMU 435438	030707	2	BRMS	874
27								
28								
29								
30								

I, B.C. GOFF, acknowledge the correction of this manifest to the best of my knowledge and belief.

MASTER OR LICENSED DECK OFFICER

I, CHESTER P. STILLING, ASST. CLERK, the undersigned certify that, the above information based on information furnished by the shipper, is true and correct, to the best of my knowledge and belief.

SUPERVISOR OF PERSON PREPARING MANIFEST

Activity

Refer the students to the MSDSs in the Appendix to Unit 3, and explain that while the information is standard, the format may vary by chemical and from manufacturer to manufacturer.

Material Safety Data Sheets

Documents for fixed facilities include **material safety data sheets** (MSDSs) and related reports. The owner or manager of the facility is required to keep MSDSs for all hazardous materials (above an established quantity) handled or stored at the facility. These should be made available to you during pre-planning. An MSDS can provide information on the physical and chemical properties of the material, the hazards associated with it, and basic directions for response actions.

Your pre-incident plan should include information on where the facilities in your community keep MSDSs. For example, MSDSs may be kept in an office some distance from the affected area of the building. MSDSs and other facility documents may be kept in a container that is set aside for use by emergency responders. MSDSs may look very different from one another, as you can see from the samples provided in the appendix.

You may not have preplanned the facility. Or, you may find that a previously preplanned site has been storing or using chemicals not included in your preplan. In either situation, you will have to look elsewhere for the appropriate MSDS.

Like all documents, the information that you find on an MSDS should be verified with other sources of information. The information on an MSDS may be incorrect, incomplete, or not applicable to your situation. A blank MSDS is shown on the following pages.

MATERIAL SAFETY DATA SHEET

SECTION I

MANUFACTURER'S NAME	EMERGENCY TELEPHONE NUMBER	DATE
ADDRESS		
CHEMICAL NAME AND SYNONYMS	TRADE NAME AND SYNONYMS	
CHEMICAL FAMILY	FORMULA	

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY

HAZARDOUS COMPONENT(S) (Chemical and Common Name(s))	%	OSHA PEL	ACGIH TLV	CAS NUMBER

SECTION III - PHYSICAL AND CHEMICAL CHARACTERISTICS

BOILING POINT	VAPOR DENSITY (Air = 1)	SPECIFIC GRAVITY (H_2O = 1)	VAPOR PRESSURE (mm Hg)
SOLUBILITY IN WATER		REACTIVITY IN WATER	
APPEARANCE AND ODOR			MELTING POINT

SECTION IV - FIRE AND EXPLOSION DATA

FLASH POINT (°F or °C)	METHOD USED	FLAMMABLE LIMITS	LEL (LOWER)	UEL (UPPER)
AUTO-IGNITION TEMPERATURE	EXTINGUISHING MEDIA			
SPECIAL FIRE FIGHTING PROCEDURES				
UNUSUAL FIRE AND EXPLOSION HAZARDS				

SECTION V - HEALTH HAZARD DATA			
THRESHOLD LIMIT VALUES	8 HOUR TWA	STEL	
EFFECTS OF OVEREXPOSURE	ACUTE		
	CHRONIC		
PRINCIPAL ROUTES OF ABSORPTION			
IS CHEMICAL A CARCINOGEN?	IS CHEMICAL A MUTAGEN?		
EMERGENCY AND FIRST AID PROCEDURES			

SECTION VI - PHYSICAL HAZARDS (REACTIVITY DATA)			
STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE		
INCOMPATABILITY (Materials to Avoid)			
HAZARDOUS DECOMPOSITION PRODUCTS			
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR		

SECTION VII - SPECIAL PRECAUTIONS AND SPILL/LEAK PROCEDURES
PRECAUTIONS TO BE TAKEN IN HANDLING AND STORAGE
STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED
WASTE DISPOSAL METHODS (Consult Federal, State, and Local Regulations)

SECTION VIII - SPECIAL PROTECTION INFORMATION		
RESPIRATORY PROTECTION (Specify Type)	PROTECTIVE GLOVES	
EYE PROTECTION	OTHER PROTECTIVE CLOTHING OR EQUIPMENT	
VENTILATION	LOCAL EXHAUST	SPECIAL
	MECHANICAL (General)	OTHER
WORK/HYGIENIC PRACTICES		

UNIT 2
APPENDIX

Information Sources

After you have looked for clues and found that a hazardous material is present, you can draw on a number of resources to identify the specific material and hazards involved. Identification of the hazard will help you decide the appropriate course of action.

The resources available to you will depend on your jurisdiction, equipment, training, and standard operating procedures. Those resources commonly used to provide additional information about hazardous materials include reference books, telephone hotlines, and detection devices.

Reference Books

There are several reference books available to assist in identifying hazardous materials. Two commonly-used references are the North American Emergency Response Guide-book and the NIOSH Pocket Guide to Hazardous Materials. Using both of these references, you can find basic information about the physical properties of chemicals and initial response actions.

The *North American Emergency Response Guidebook* can assist you in making decisions about response actions. However, it has advantages as well as disadvantages. For example, it includes clear instructions for use, but the information is very general.

In addition, it is only one source of information. You should always check the recommendations for actions with at least two other sources, including your jurisdiction's standard operating procedures.

The *NIOSH Pocket Guide to Chemical Hazards* lists materials by their chemical name and provides descriptions of the chemical and exposure limits, along with first aid procedures in the event of exposure.

You must become familiar with the Pocket Guide prior to using it so that you can use it quickly and understand the abbreviations used throughout the book.

Telephone Hotlines

Telephone hotlines can provide general information about hazards and, possibly, responder actions. When calling a hotline in an emergency, be prepared to give all the information you can regarding the situation.

Hotlines frequently used by emergency response personnel include the following:

The **National Response Center** maintains an emergency hotline for transportation incidents involving hazardous materials. Their number is found in the North American Emergency Response Guidebook: (800) 424-8802; or in the Washington, D.C. area (202) 267-2675.

CHEMTREC, The Chemical Transportation Emergency Center, provides 24-hour information for transportation incidents. This organization carries MSDSs for all chemicals manufactured in the United States.

CHEMTREC is funded by the chemical industry. It provides information on fixed sites and transportation hazardous materials emergencies, and will give you immediate advice on the nature of the product and the steps you should take to handle the early stages of a problem. They will not, however, give you specific tactical advice. Tactical measures are specific to your department depending on personnel skills, knowledge, and resources.

CHEMTREC also maintains a current list of state and federal radiation authorities who provide information and technical assistance on handling incidents involving radioactive materials.

Calls to CHEMTREC should be limited to emergencies only.

CHEM-TEL, INC. is another emergency response communication service.

CANUTEC provides a similar service in Canada. CANUTEC is the Canadian Transport Emergency Centre. It is located in Ottawa and is operated by the Transport Dangerous Goods Directorate of Transport Canada.

CANUTEC provides a national bilingual advisory service and is staffed by professional chemists experienced and trained in interpreting technical information and providing emergency response advice.

CHEMTREC, CHEM-TEL, INC., and CANUTEC will assist one another in providing information to emergency responders. Their telephone numbers are listed near the front of the North America Emergency Response Guidebook.

SETIQ and **CECOM** Serve similar functions in Mexico. SETIQ is the Emergency Transportation System for the chemical industry. CECOM is the National Center for Communications of the Civil Protection Agency. Telephone numbers for SETIQ and CECOM can be located in the North American Emergency Response Guidebook.

ATSDR, the Agency for Toxic Substances and Diseases, provides technical assistance via telephone and can be reached at (404) 639-0615.

Your local **poison control center** can provide information to assist in the treatment of exposed individuals. Check the front cover of your local telephone book for this number.

In addition, you can maintain a list of **regional, state, and local emergency resource numbers**. These may include regional response teams from the Environmental Protection Agency, response teams from the Department of Energy, or regional and local resources in your area.

Many **manufacturers and shippers** maintain telephone help lines. You should contact the chemical manufacturers in your area to learn if they have hotlines or resources that you can use in an emergency.

It may also be helpful to contact other local facilities to find out the names of chemical shippers with whom they have contracted.

You also may be able to obtain information on hazardous materials through **software** and computer **databases.** Many systems carry chemical information very similar to that found on the manufacturer's MSDS, as well as additional data.

Software

CAMEO II TM is a software package developed by the National Oceanic and Atmospheric Administration. This system is designed to help emergency planners and first responders plan for and respond to incidents involving chemical emergencies. It contains information on thousands of commonly transported chemicals and an air dispersion model to assist in evaluating release scenarios and evacuation options. In addition, it contains several databases and computation programs to assist in meeting the planning provisions of SARA Title III. The program is available through the National Safety Council at (312) 527-4800, extension 6900.

The **Emergency Information System/Chemical version** (EIS/C), by Research Alternatives, Inc., provides information on chemicals, maps to plot spills, facility plans, and chemical inventories for businesses, as required by SARA Title III. Brochures, a demonstration disk, and additional information can be obtained by calling (800) 999-5009; in the Washington, DC area: (301) 424-2803.

Databases

Medline is an on-line program that consists of bibliographic citations from thousands of health-related journals. It is accessed through the National Library of Medicine (NLM). Call (800) 638-8480 or inside Maryland: (301) 496-6193 for more information. **Toxline** and **TOXLIT** are the NLM's on-line interactive collections of toxicological information, referencing materials in such areas as chemically-induced diseases, environmental pollution, occupational hazards, and pesticides. **Chemline** is an on-line chemical dictionary maintained by NLM.

Toxicology Data Network (Toxnet) is a computerized system of toxicologically-oriented data banks. Within this system, Hazard Substances Data Bank, Chemical Carcinogenesis Research Information Systems, and the Registry of Toxic Effects of Chemical Substances are available.

The **Hazardous Materials Incident Reporting System**, developed by the National Fire Information Council (NFIC) provides a collection of detailed information on reportable incidents.

The **TRANSCOM** system combines satellite communications, computerized database management, user networks, and ground communications to follow the progress of en-route shipments of some radioactive materials (usually fissile materials). The primary objective of TRANSCOM is to provide a central monitoring and communications center for DOE shipments of spent fuel, high-level waste, and other high visibility shipping campaigns. With this system, DOE can continuously monitor the location and status of these shipments within the continental United States.

TRANSCOM provides authorized users with TRANSCOM software to use with their personal computers, modems, and telephone lines. Authorized users can access the TRANSCOM system to obtain unclassified information concerning current and upcoming shipments.

In the event of an emergency, the vehicle operator can contact the TRANSCOM control center. If necessary, DOE is notified and decides on appropriate response measures. Information on key emergency response contacts for DOE-headquarters (HQ), the shipper, the state, and the appropriate DOE Operations Office is also available on-line in TRANSCOM.

UNIT 3:
CHEMICAL PROPERTIES

LEARNING OBJECTIVES

By the end of this section, participants will be able to:

- Recognize the three states of matter
- Define the following terms:
    - Vapor pressure
    - Flash point
    - Lower and upper explosive limits
    - Specific gravity
    - Solubility
    - Vapor density
    - Chemical reactivity
    - Ignition temperature
    - pH
- Describe how the pH scale can be used to assess the hazards of acids and bases
- Describe the following types of chemical reactions:
    - Oxidation
    - Explosion
    - Gas Compression
    - BLEVE

INSTRUCTOR NOTES

Purpose of Unit:

This unit reviews some basic chemistry every First Responder should know. The unit is intended to provide a basis for a practical, rather than theoretical, application of chemical principles.

Materials and Supplies:

Chalkboard or flip chart

For the vapor pressure demonstration:
- Water
- Acetone
- Two shallow aluminum pans

For the explosive limit demonstration:
- Two-gallon plastic jug, with a 2” hole in top and a 2” hole in the side
- Acetone
- Long-stemmed lighter

For specific gravity demonstration:
- Two clear glass or plastic beakers
- Water
- Liquid rinsing agent for automatic dishwashers (e.g. Jet Dry)
- Food coloring
- Vegetable oil

For the solubility demonstration:
- One clear glass or plastic beaker
- Water
- Food coloring
- Alcohol

For the vapor density demonstration:
- Block or pellets of dry ice
- Large plastic tub
- Candles (e.g. votive candles)
- Warm water

For the pH demonstration:
- pH papers
- A variety of common acidic and caustic products (vinegar, juice, lye)

Instructor Preparation:

Secure the materials and supplies listed above. Also, conduct all the demonstrations to make sure they serve your purpose and can be done safely.

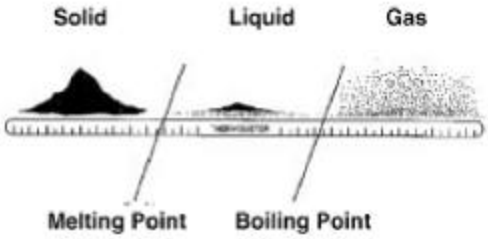
STATES OF MATTER

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

All elements exist in nature in one of three states: **solid**, **liquid**, or **gas**. Substances can change from one state to another as changes occur in temperature or pressure, or both. A change in a material's state is likely to affect the degree of hazard posed by the material, as well as the tactics for controlling the situation. For example, a toxic substance may be more hazardous in the gaseous state than in the liquid state because it is easier to inhale as a gas and more difficult to control.



Key Points

- **All elements exist as a solid, liquid, or gas**
- **A chemical can become more dangerous as it changes from one state to another**
- **Changes in a chemical's state may affect your tactics as well**

Solids

A solid is a substance that retains a definite size and shape under normal conditions. When most solids melt, they change to liquid. The temperature at which this occurs is called the **melting point**. When solids change directly to gas, the process is called **sublimation**. Carbon dioxide (dry ice) is a well-known example of a solid that sublimates.

Liquids

Liquids are substances that flow easily and have a specific volume but no specific shape. The temperature at which a liquid freezes is called the **freezing point**. The temperature at which a liquid changes to a gas is its **boiling point**. At this temperature, which is unique to each liquid, bubbles of the liquid rise to the surface and enter the surrounding air. The boiling point of a liquid is related to its vapor pressure.

Gases

Activity

Tell the students to look up carbon dioxide, dimethylamine, and hydrogen fluoride in the NIOSH Pocket Guide. Briefly explain IDLH, then discuss which of the three is the most toxic.

A gas is a substance that expands or compresses readily and has no independent shape or volume. Gases may condense to form liquids; this change occurs when a gas is cooled to or below its boiling point. Substances that occur naturally as gases have low boiling points compared to solids and liquids.

To evaluate the hazard posed by a gas, you must know (or estimate) its concentration in air. Explosive limits are one way to evaluate the concentration of flammable gases and vapors. Concentration of gas can also be expressed in terms of percent, parts per million (ppm), and parts per billion (ppb). These terms are typically used in reference materials when listing the concentration of a gas or vapor that causes health effects. One part per million is equal to 1/1,000,000.

IDLH

(Immediately Dangerous to Life and Health) is a reference frequently mentioned in resource material. IDLH is the maximum level of exposure, without irreparable effects, within 30 minutes.

CHEMICAL PROPERTIES

Vapor Pressure

Activity

Demonstrate vapor pressure by pouring a small amount of water in one pan and an equal amount of acetone in another. Show the students how the acetone evaporates much more quickly than water.

Vapor pressure is a measure of the ability to evaporate, that is, to change from a liquid to a gas. (A liquid in the gas state is a vapor.) Vapor pressure is often measured in millimeters (mm) of mercury (Hg), but other units may be used. The higher the vapor pressure, the more likely a liquid is to evaporate. For example:

Material	Approximate Vapor Pressure at Room Temperature
Rock	0 mm Hg
Water	25 mm Hg
Acetone	250 mm Hg
Any gas	>760 mm Hg
Acetylene	2,500 mm Hg

Activity

Tell the students to look up methyl alcohol, chlorobenzene, and styrene in the NIOSH Pocket Guide. Discuss which chemical is most likely to ignite in air.

As temperature increases, the vapor pressure of a liquid increases. For example, look at the effect of temperature on the vapor pressure of water on the following chart.

Vapor Pressure of Water	Temperature of Water
25 mm Hg	72° F
93 mm Hg	122° F
760 mm Hg	212° F

If the temperature is high enough, the vapor pressure rises until it equals atmospheric pressure. At this point, the liquid boils and becomes vapor. Because liquids expand when they vaporize, the effect of temperature on a liquid's vapor pressure can be catastrophic if the liquid is in a closed vessel. If there is no mechanism for venting, the vapors generated as the liquid is heated will exert increasing amounts of pressure on the vessel, possibly leading to container failure.

Flash Point

Flammable liquids with high vapor pressures are generally more dangerous than those with low vapor pressures. This is because they more readily form ignitable mixtures in air and are more easily inhaled. **Flash point** is the temperature at which a liquid generates enough vapors to create an ignitable mixture near the surface of the liquid.

A **flammable liquid** is a liquid that has a flash point below 100°F (38°C). Liquids that have flash points of 100°F or more are classified as **combustible liquids.**

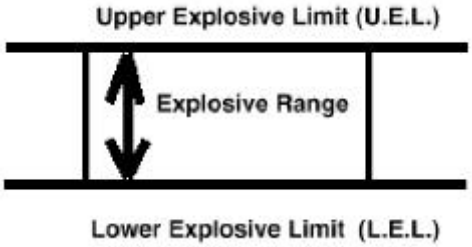
Explosive Limit

Explosive or **flammable limit** refers to the concentration of a flammable vapor or gas in air. Below the lower explosive limit (LEL), the mixture is "too lean" to ignite. This means that there are not enough flammable vapors in the air. Above the upper explosive limit (UEL), the mixture is "too rich" to ignite. That is, there is too little oxygen to support combustion. Between the LEL and UEL, the mixture is explosive or flammable. Remember that sources of electricity such as lights, motors, traffic, and static electricity can ignite mixtures between the LEL and UEL.

Flammable gases have an LEL of less than 13%, or a flammable range greater than 12%. Most flammable gases have LEL ranges of 3% to 6%.

Activity

Obtain a large (2-gallon) plastic jug. Cut a hole about 2" in diameter in the lid and one in the side of the jug. Demonstrate explosive limit by placing a few drops of acetone in the jug. Shake the jug, then insert a long-stemmed lighter through the side hole cut in the side of the jug. If the atmosphere doesn't ignite, add a few more drops and try lighting it again. Repeat until you reach the explosive limit and the mixture ignites. (CAUTION: Add the acetone *gradually* and be *extremely careful* when you conduct this demonstration.)

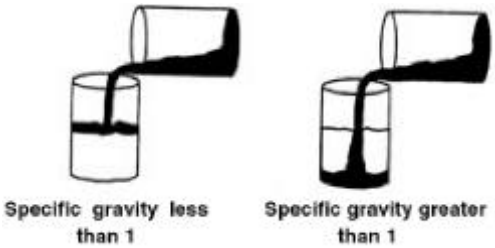


Activity

Fill two beakers about half-way with water. Add a few drops of food coloring to the vegetable oil, then add about 1/4 cup to the water in one beaker. The oil, with a specific gravity less than 1, will float on top of the water. Add about 1/4 cup of rinsing agent to the water in the second beaker. The rinsing agent will sink because its specific gravity is greater than 1.

Specific Gravity

Specific gravity is a concept used to measure the weight of solids and liquids in comparison to an equal volume of water. Water has a specific gravity of one. Solids and liquids that are heavier than an equal volume of water have specific gravities greater than one. Similarly, solids and liquids that are lighter than water have specific gravities less than one.



Specific gravity has no unit of measure. It is only a relative value (relative to water). The specific gravity of a substance indicates whether it will sink or float in water. This property can also determine your response activity (for example, the type of dam you build to control a liquid spill in water).

Solubility

Activity

Fill a beaker about half-way with water. Add a few drops of food color to about 1/4 cup of alcohol, then pour the alcohol into the water. The water and alcohol form a solution because alcohol is miscible.

Solubility refers to the degree that one substance mixes with another substance. The mixture is called a **solution**. The substance presenting greater amount is called the **solvent**. Water can be a solvent, though in common usage the term refers to petroleum-based chemicals. The substance present in lesser amount is called the **solute**. A solute may be a gas, a liquid, or a solid.

If a solute mixes completely in a solvent, it is said to be **miscible** with that solvent. For example, alcohols such as methyl, ethyl, and propyl alcohol are miscible with water. **Water miscible** means that the liquid is infinitely soluble in water. Regardless of the amount of methyl alcohol added to water, it will all mix. All other liquids (and all solids) are either very soluble, soluble, sparingly soluble, or insoluble. Some references may also list solubility data in terms of a percentage, indicating the weight of the material that will dissolve in a certain amount of water.

Activity

Demonstrate vapor density with a small block of dry ice. Place the ice in a tub on a raised surface and place lighted candles on the floor nearby. Add warm water to the dry ice and tip the pan. The vapors should flow to the floor and extinguish the candles.

Vapor Density

The concept of **vapor density** is used to measure the weight of a gas compared to an equal volume of air. Air has a vapor density of one. Substances with vapor densities less than one are lighter than an equal volume of air and will rise in air. Those with vapor densities greater than one will sink in air, and often collect in low lying areas or close to the ground. This is important when sampling the air, identifying safe areas during an emergency, and predicting how a gas will spread.

There are a couple of shortcuts in determining whether a gas or vapor has a vapor density less than air. One method is to use the **molecular weight** of the chemical. The molecular weight is the mass that is assigned to atoms or molecules that make up a chemical. This unit may be found in references such as the NIOSH Pocket Guide to Chemical Hazards. Vapors and gases with molecular weights greater than 29 (the molecular weight of air) tend to sink in air. Vapors of flammable liquids also tend to sink in air. (Flammable gases may rise or sink, depending on the gas; for example, propane sinks, and methane rises.)

Chemical Reactivity

Key Points

The speed of a chemical reaction depends on:

- **Temperature**
- **Concentration**
- **Pressure**
- **Catalysts**

Chemical reactions result when two or more substances combine to form new chemicals and energy is absorbed or released. Polymerization, combustion, and ionization are examples of chemical reactions. The rate at which a chemical reaction occurs depends on a number of factors, including:

- **Temperature**—increasing temperature usually speeds reactions
- **Concentration**—increasing the concentrations of the reacting materials usually increases the rate of reaction
- **Pressure**—increasing pressure, especially on reacting gases and vapors, may speed reactions, though this is not always true
- **Presence of catalysts**—a catalyst is a substance that increases the rate of chemical reactions, but is not changed by the reaction

Activity

Ask the students to list other water-reactive or pyrophoric materials. Allow them to use their reference books to look up examples.

In addition to the factors listed above, the physical and chemical properties of the reactive materials can influence the reaction. For example, gases and vapors react more readily than liquids and solids; and highly reactive materials can spontaneously explode or ignite when exposed to another substance.
Some materials react when exposed to water. For example, sodium metal is extremely **water-reactive** and may explode when in contact with water. It is stored dry or in mineral oil or kerosene. **Air reactive** materials react when exposed to air. White and yellow phosphorous spontaneously ignite in air; a related term, pyrophoric, is used to describe a material (liquid or solid) that spontaneously ignites in air at or below 130°F.

Ignition Temperature

Key Points

The ignition temperature is the temperature at which a material burns.

References may list the **ignition temperature** of a chemical (also called the auto-ignition temperature). This is the temperature at which a material starts to burn without a flame or other ignition source present. At this temperature, gases or vapors are consumed in fire as rapidly as they are formed, and the material continues self-sustained combustion. Many flammable solids have ignition temperatures greater than 400°F, much higher than flash points of flammable liquids. One notable exception is phosphorus (white or yellow), with an ignition temperature of 86°F.

pH

Activity

Demonstrate pH with several acidic and caustic products such as vinegar, orange juice, and lye. Tell the students to guess the pH, then test each liquid with a pH strip.

The pH scale is a reference scale indicating the acidity or alkalinity of materials. The scale ranges from 0 to 14, with 7 considered neutral. Values lower than 7 indicate increasing acidity, while those higher than 7 indicate increasing alkalinity. The pH scale is a logarithmic scale, with 7 at the center of the scale. This means that the difference in acidity from pH 6 to pH 7 is small, while the difference from pH 3 to pH 4 is greater, and the difference in acidity between pH 1 and pH 2 is very great. When dealing with acids and bases, it is also important to obtain information about the **concentration** of the acid or base. Concentration indicates the percentage of the material in water. Both acids and alkalis can cause injury. Materials with a very low or very high pH are the most hazardous, and any highly concentrated acids or bases should be carefully assessed before action is taken. Caustics are particularly dangerous because the chemical seeks out the acids in the body.

Other Chemical Reactions

Other chemical reactions may affect the way you respond to an incident involving a hazardous material.

Oxidation

Activity

On the flip chart or chalkboard list oxidization, explosion and gas compression and ask the students to name common chemicals that can:

- **Oxidize or promote oxidation**
- **Detonate or explode**
- **Be compressed**

Oxidation is a chemical reaction that enables a substance to burn. In a fire, the presence of an oxidizer will make the fire burn hotter and faster, and may cause explosions. Oxygen is a powerful oxidizer, but by itself it is non-flammable. When added to other materials (even non-flammable protective clothing) it dramatically accelerates combustion.

Explosions

Explosions are chemical reactions that suddenly release a tremendous amount of energy. Explosions can be loosely categorized according to reaction time. High explosives react quickly — within millionths of a second — while low explosives react more slowly. High explosives (such as dynamite) **detonate**; that is, they create and almost instantaneously release gas. Low explosives (such as black powder) **deflagrate** in that they create gas a little more slowly.

Gas Compression

Gas compression can also lead to chemical reactions. Compared with other states of matter, gases are the least dense. They can be compressed by increasing pressure or decreasing temperature to force the gas into a smaller volume. Certain gases are classified as cryogenic because of their low temperatures and extremely low boiling points.

Unlike other compressed gases, you must consider the extreme coldness of a cryogenic gas during a fire. Cryogenic containers always carry safety relief devices. Applying water may freeze these devices and cause the container to rupture.

A hazard common to all compressed gases is the potential for the expansion of the gas when it is warmed or no longer under pressure. Containers may fail, releasing large amounts of the gas. The expansion ratio refers to the comparison of a volume of the gas to its liquefied form. For example, liquefied natural gas (LNG) has an expansion ratio of 600 to 1. This means that one cubic foot of LNG will expand to 600 cubic feet when warmed or no longer under pressure.

BLEVE

Flammable gases that are transported or stored in their liquefied form are particularly hazardous because there is the potential for a **boiling liquid expanding vapor explosion (BLEVE).** This is the term for an uncontrolled fire and explosion of vapor as it escapes from a ruptured container of liquefied flammable gas. A BLEVE occurs when a container is exposed to fire. The liquid inside begins to boil and vaporize. The vapor is vented from the relief valve and the level of liquid begins to drop. As this happens, the flames impinge on the vapor space of the tank. Heat and pressure build, and the container weakens and ruptures, resulting in an explosion.

Conclusion

Briefly review the key points covered in this section.

UNIT 3
APPENDIX

MSDS Exercise

Material Safety Data Sheets (MSDSs) contain standard information about hazardous chemicals at fixed locations. They are published by chemical manufacturers. The format of an MSDS, including the order in which information appears, may be different for each chemical. It may also vary among manufacturers of the same chemical. Review the three MSDSs on the following pages for methyl ethyl ketone, carbon disulfide, and muriatic acid. Then answer the questions below.

Which of these chemicals is/are flammable?

Methyl ethyl ketone (LEL 1.8%)
Carbon disulfide (evaporates readily; LEL 1.3%)

Which is/are required to have a Flammable Liquid and Poison label?

Carbon disulfide
(Note that there is no transportation data for muriatic acid.)

Which will evaporate the fastest at room temperature?

Carbon disulfide
(Note that although no reference temperature is given for the vapor pressure of methyl ethyl ketone, it is assumed to be 68-70°).

Which is the most toxic?

These chemicals are difficult to compare in toxicity. The MSDS for methyl ethyl ketone indicates the TLV/TWA as 200ppm, the STEL as 300ppm, and the PEL as 200ppm. Lethal doses are given in kilograms. The MSDS for carbon disulfide lists only the TLV, at 10ppm to the skin. The MSDS for muriatic acid lists the OSHA PEL at 5ppm and "Other Recommended Limit" as 7ppm. As a general rule, however, you can assume that the lower the ppm, the more toxic the chemical.

1 - PRODUCT IDENTIFICATION

PRODUCT NAME:	METHYL ETHYL KETONE
FORMULA:	CH3COCH2CH3
FORMULA WT:	72.11
CASE NO.:	78-93-3
NIOSH/RTECS NO.:	EL6475000
COMMON SYNONYMS:	2-BUTANONE; MEK; ETHYL METHYL KETONE; METHYLACETONE
PRODUCT CODES:	9214,9323,9211,5385,9319,Q531
EFFECTIVE:	08/27/86
REVISION #02	

PRECAUTIONARY LABELING
BAKER SAF-T-DATA(TM) SYSTEM

HEALTH - 2 MODERATE
FLAMMABILITY - 3 SEVERE (FLAMMABLE)
REACTIVITY - 2 MODERATE
CONTACT - 1 SLIGHT

HAZARD RATINGS ARE 0 TO 4 (0 = NO HAZARD; 4 = EXTREME HAZARD).

LABORATORY PROTECTIVE EQUIPMENT

SAFETY GLASSES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER

PRECAUTIONARY LABEL STATEMENTS

WARNING
EXTREMELY FLAMMABLE
CAUSES IRRITATION
HARMFUL IF INHALED
KEEP AWAY FROM HEAT, SPARKS, FLAME.
AVOID BREATHING VAPOR. KEEP IN TIGHTLY CLOSED CONTAINER. USE WITH ADEQUATE VENTILATION. WASH THOROUGHLY AFTER HANDLING. IN CASE OF FIRE, USE ALCOHOL FOAM, DRY CHEMICAL, CARBON DIOXIDE - WATER MAY BE INEFFECTIVE. FLUSH SPILL AREA WITH WATER SPRAY.

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

2 - HAZARDOUS COMPONENTS

COMPONENT	%	CASE NO.
METHYL ETHYL KETONE	90-100	78-93-3

3 - PHYSICAL DATA

BOILING POINT: 80 C (176 F) VAPOR PRESSURE(MM HG): 78

MELTING POINT: -87 C (-125 F) VAPOR DENSITY(AIR=1): 2.5

SPECIFIC GRAVITY: (H2O=1) 0.81 EVAPORATION RATE: (BUTYL ACETATE=1) 5.7

SOLUBILITY(H2O): APPRECIABLE (MORE THAN 10 %) % VOLATILE BY VOLUME: 100

APPEARANCE & ODOR: CLEAR COLORLESS, LIQUID WITH ACETONE-LIKE ODOR.

4 - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (CLOSED CUP -7 C (20 F) NFPA 704M RATING: 1-3-0

FLAMMABLE LIMITS: UPPER - 11.4 % LOWER - 1.8 %

FIRE EXTINGUISHING MEDIA
USE ALCOHOL FOAM, DRY CHEMICAL OR CARBON DIOXIDE. (WATER MAY BE INEFFECTIVE.)

SPECIAL FIRE-FIGHTING PROCEDURES
FIREFIGHTERS SHOULD WEAR PROPER PROTECTIVE EQUIPMENT AND SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN POSITIVE PRESSURE MODE. MOVE CONTAINERS FROM FIRE AREA IF IT CAN BE DONE WITHOUT RISK. USE WATER TO KEEP FIRE-EXPOSED CONTAINERS COOL.

UNUSUAL FIRE & EXPLOSION HAZARDS
VAPORS MAY FLOW ALONG SURFACES TO DISTANT IGNITION SOURCES AND FLASH BACK. CLOSED CONTAINERS EXPOSED TO HEAT MAY EXPLODE. CONTACT WITH STRONG OXIDIZERS MAY CAUSE FIRE.

TOXIC GASES PRODUCED
CARBON MONOXIDE, CARBON DIOXIDE

5 - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE (TLV/TWA): 590 MG/M3 (200 PPM)

SHORT-TERM EXPOSURE LIMIT (STEL): 885 MG/M3 (300 PPM)

PERMISSIBLE EXPOSURE LIMIT (PEL): 590 MG/M3 (200 PPM)

TOXICITY: LD50 (ORAL-RAT)(MG/KG) - 2737
LD50 (IPR-MOUSE)(MG/KG) - 616
LD50 (SKN-RABBIT) (G/KG) - 13

CARCINOGENICITY: NTP: NO IARC: NO Z LIST: NO OSHA REG: NO

EFFECTS OF OVEREXPOSURE
INHALATION OF VAPORS MAY CAUSE HEADACHE, NAUSEA, VOMITING, DIZZINESS, DROWSINESS, IRRITATION OF RESPIRATORY TRACT, AND LOSS OF CONSCIOUSNESS.
CONTACT WITH SKIN OR EYES MAY CAUSE IRRITATION.
PROLONGED EXPOSURE MAY CAUSE DERMATITIS.
LIQUID MAY CAUSE PERMANENT EYE DAMAGE.
INGESTION MAY CAUSE NAUSEA, VOMITING, HEADACHES, DIZZINESS, GASTROINTESTINAL IRRITATION.

TARGET ORGANS
NASAL SEPTUM, LUNGS

MEDICAL CONDITIONS GENERALLY AGGRAVATED BY EXPOSURE
NONE IDENTIFIED

ROUTES OF ENTRY
INHALATION, INGESTION, EYE CONTACT, SKIN CONTACT

EMERGENCY AND FIRST AID PROCEDURES
CALL A PHYSICIAN.
IF SWALLOWED, DO NOT INDUCE VOMITING.
IF INHALED, REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE ARTIFICIAL RESPIRATION. IF BREATHING IS DIFFICULT, GIVE OXYGEN.
IN CASE OF CONTACT, IMMEDIATELY FLUSH EYES WITH PLENTY OF WATER FOR AT LEAST 15 MINUTES. FLUSH SKIN WITH WATER.

6 - REACTIVITY DATA

STABILITY: STABLE HAZARDOUS POLYMERIZATION: WILL NOT OCCUR

CONDITIONS TO AVOID: HEAT, FLAME, OTHER SOURCES OF IGNITION

INCOMPATIBLES: STRONG OXIDIZING AGENTS, STRONG BASES, CAUSTICS, MINERAL ACIDS, AMINES AND AMMONIA, HALOGENS

DECOMPOSITION PRODUCTS: CARBON MONOXIDE, CARBON DIOXIDE

7 - SPILL AND DISPOSAL PROCEDURES

STEPS TO BE TAKEN IN THE EVENT OF A SPILL OR DISCHARGE
WEAR SELF-CONTAINED BREATHING APPARATUS AND FULL PROTECTIVE CLOTHING. SHUT OFF IGNITION SOURCES; NO FLARES, SMOKING OR FLAMES IN AREA. STOP LEAK IF YOU CAN DO SO WITHOUT RISK. USE WATER SPRAY TO REDUCE VAPORS. TAKE UP WITH SAND OR OTHER NON-COMBUSTIBLE ABSORBENT MATERIAL AND PLACE INTO CONTAINER FOR LATER DISPOSAL. FLUSH AREA WITH WATER.

J. T. BAKER SOLUSORB(R) SOLVENT ADSORBENT IS RECOMMENDED FOR SPILLS OF THIS PRODUCT.

DISPOSAL PROCEDURE
DISPOSE IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, STATE, AND LOCAL ENVIRONMENTAL REGULATIONS.

EPA HAZARDOUS WASTE NUMBER: U159 (TOXIC WASTE)

8 - PROTECTIVE EQUIPMENT

VENTILATION: USE GENERAL OR LOCAL EXHAUST VENTILATION TO MEET TLV REQUIREMENTS.

RESPIRATORY PROTECTION: RESPIRATORY PROTECTION REQUIRED IF AIRBORNE CONCENTRATION EXCEEDS TLV. AT CONCENTRATIONS UP TO 1000 PPM, A CHEMICAL CARTRIDGE RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE IS RECOMMENDED. ABOVE THIS LEVEL, A SELF-CONTAINED BREATHING APPARATUS IS RECOMMENDED.

EYE/SKIN PROTECTION: SAFETY GOGGLES, UNIFORM, APRON, RUBBER GLOVES ARE RECOMMENDED.

9 - STORAGE AND HANDLING PRECAUTIONS

SAF-T-DATA(TM) STORAGE COLOR CODE: RED (FLAMMABLE)

SPECIAL PRECAUTIONS
BOND AND GROUND CONTAINERS WHEN TRANSFERRING LIQUID. KEEP CONTAINER TIGHTLY CLOSED. STORE IN A COOL, DRY, WELL-VENTILATED, FLAMMABLE LIQUID STORAGE AREA.

10 - TRANSPORTATION DATA AND ADDITIONAL INFORMATION

DOMESTIC (D.O.T.)

PROPER SHIPPING NAME	METHYL ETHYL KETONE
HAZARD CLASS	FLAMMABLE LIQUID
UN/NA	UN1193
LABELS	FLAMMABLE LIQUID
REPORTABLE QUANTITY	5000 LBS.

INTERNATIONAL (I.M.O.)

PROPER SHIPPING NAME	METHYL ETHYL KETONE
HAZARD CLASS	3.2
UN/NA	UN1193
LABELS	FLAMMABLE LIQUID

MATERIAL SAFETY DATA SHEET
FSC: 6810
NIIN: 012090692
Manufacturer's CAGE: 62910
Part No. Indicator: A
Part Number/Trade Name: CARBON DISULFIDE,4351-030
==========
General Information
==========
Item Name: CARBON DISULFIDE, ANALYZED REAGENT
Company's Name: MALLINCKRODT INC., SCIENCE PRODUCTS DIVISION
Company's Street: PARIS BYPASS
Company's P. O. Box: M
Company's City: PARIS
Company's State: KY
Company's Country: US
Company's Zip Code: 40361
Company's Emerg Ph #: 314-982-5000
Company's Info Ph #: 800-354-2050
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SE
Date MSDS Prepared: 06APR89
Safety Data Review Date: 08FEB95
Supply Item Manager: KX
MSDS Preparer's Name: UNKNOWN
MSDS Serial Number: BGQQG
Specification Number: NONE
Spec Type, Grade, Class: NONE
Hazard Characteristic Code: F5
Unit Of Issue: BT
Unit Of Issue Container Qty: 1 PT
Type Of Container: BOTTLE
Net Unit Weight: 1.3 LBS
NRC/State License Number: NOT RELEVANT
==========
Ingredients/Identity Information
==========
Proprietary: NO
Ingredient: CARBON DISULFIDE (SARA 302/313) (CERCLA)
Ingredient Sequence Number: 01
Percent: 100
NIOSH (RTECS) Number: FF6650000
CAS Number: 75-15-0
OSHA PEL: 20 PPM
ACGIH TLV: S, 10 PPM; 9495
Other Recommended Limit: NOT RECOMMENDED
==========
Physical/Chemical Characteristics
==========
Appearance And Odor: CLEAR COLORLESS LIQUID, ODORLESS (PURE)/STRONG
GARLIC-LIKE ODOR
Boiling Point: 115F,46C
Melting Point: -148F,-100C
Vapor Pressure (MM Hg/70 F): 300 @ 68F
Vapor Density (Air=1): 2.6

Specific Gravity: 1.26
Decomposition Temperature: UNKNOWN
Evaporation Rate And Ref: 22.6 (N-BUTYL ACETATE=1)
Solubility In Water: 0.2 %
Percent Volatiles By Volume: 100
Viscosity: UNKNOWN
Corrosion Rate (IPY): UNKNOWN
Autoignition Temperature: 194F
==========
Fire and Explosion Hazard Data
==========
Flash Point: -22F,-30C
Lower Explosive Limit: 1.3
Upper Explosive Limit: 50
Extinguishing Media: USE CARBON DIOXIDE, SAND, FOAM/DRY CHEMICAL. WATER SPRAY MAY BE USED TO KEEP FIRE EXPOSED CONTAINERS COOL.
Special Fire Fighting Proc: WEAR FULL PROTECTIVE CLOTHING AND NIOSH-APPROVED SELF-CONTAINED BREATHING APPARATUS WITH FULL FACEPIECE OPERATED IN THE POSITIVE PRESSURE MODE.
Unusual Fire And Expl Hazards: VAPOR IS HEAVIER THAN AIR AND CAN TRAVEL CONSIDERABLE DISTANCE TO A SOURCE OF IGNITION AND FLASH BACK. CONTAINERS MAY RUPTURE DUE TO VAPOR PRESSURE BUILDUP.
==========
Reactivity Data
==========
Stability: YES
Cond To Avoid (Stability): HEAT, IGNITION SOURCES, SPARKS, STATIC ELECTRICITY, HOT SURFACES, LIGHT
Materials To Avoid: STRONG OXIDIZING AGENTS, CHEMICALLY ACTIVE METALS (POTASSIUM, ZINC), AZIDES, ORGANIC AMINES
Hazardous Decomp Products: CARBON MONOXIDE, CARBON DIOXIDE, OXIDES OF SULFUR
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NOT RELEVANT
==========
Health Hazard Data
==========
LD50-LC50 Mixture: TLV 10 PPM (SKIN)
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: TARGET ORGANS: EYES, SKIN, CNS, LIVER, KIDNEYS, RESPIRATORY & GI TRACTS. ACUTE- TOXIC. MAY BE FATAL IF SWALLOWED OR INHALED. HARMFUL IF ABSORBED THROUGH SKIN. REPRODUCTIVE HAZARD. A POTENTIAL NEUROTOXIN. EYE CONTACT MAY CAUSE SEVERE PAIN. INHALATION CAUSES CNS DEPRESSION. CHRONIC- LIVER, RENAL & REPRODUCTIVE DISORDERS.
CARCINOGENICITY - NTP: NO
CARCINOGENICITY - IARC: NO
CARCINOGENICITY - OSHA: NO
Explanation CARCINOGENICITY: NONE
Signs/Symptoms Of Overexp: HEADACHE, DIZZINESS, FATIGUE, GARLIC BREATH, NAUSEA, VOMITING, ABDOMINAL PAIN, UNCONSCIOUSNESS, DEATH, CONVULSION; REDDENING, BURNING, CRACKING AND PEELING OF SKIN; SEVERE EYE PAIN AND BLURRED VISION
Med Cond Aggravated By Exp: INDIVIDUALS WITH PRE-EXISTING DISEASES OF THE EYE, SKIN, RESPIRATORY TRACT, LIVER, KIDNEYS, CNS MAY HAVE INCREASED SUSCEPTIBILITY TO THE TOXICITY OF EXCESSIVE EXPOSURES. IMMEDIATELY FLUSH WITH WATER FOR 15 MINUTES. HOLD EYELIDS OPEN. WIPE OFF EXCESS FROM SKIN BEFORE WASHING. INHALED: REMOVE

TO FRESH AIR. PROVIDE CPR/OXYGEN IF NEEDED. ORAL: IF CONSCIOUS, INDUCE VOMITING IMMEDIATELY BY GIVING TWO GLASSES OF WATER AND STICKING FINGER DOWN THROAT. NEVER GIVE ANYTHING BY MOUTH TO AN UNCONSCIOUS PERSON.

==========

Precautions for Safe Handling and Use

==========

Steps If Matl Released/Spill: WEAR PROTECTIVE EQUIPMENT. VENTILATE AREA. REMOVE IGNITION SOURCES. KEEP OUT OF SEWER. ABSORB SMALL SPILL WITH PAPER TOWELS. EVAPORATE UNDER HOOD & BURN PAPER IN SUITABLE PLACE. USE SAND FOR LARGE SPILLS. TRANSFER TO PROPER CONTAINER FOR DISPOSAL.

Neutralizing Agent: NOT RELEVANT

Waste Disposal Method: ATOMIZE IN A RCRA APPROVED COMBUSTION CHAMBER OR DISPOSE OF AS HAZARDOUS WASTE IN A RCRA APPROVED FACILITY. DO NOT FLUSH TO SEWER. ENSURE COMPLIANCE WITH FEDERAL, STATE & LOCAL LAWS. REPORTABLE QTY (RQ) (CWA/CERCLA):5000LB

Precautions-Handling/Storing: STORE IN COOL, DRY, WELL-VENTILATED AREA, AWAY FROM IGNITION SOURCES & INCOMPATIBLE MATERIALS. OUTSIDE STORAGE PREFERRED.

Other Precautions: POISON AND FLAMMABLE. EMPTY CONTAINERS RETAIN RESIDUE AND CAN BE DANGEROUS. DO NOT CUT, WELD, SOLDER OR DRILL ON OR NEAR CONTAINER. AVOID BREATHING VAPORS. DO NOT GET IN EYES, SKIN OR CLOTHING. DO NOT SMOKE. KEEP OUT OF REACH OF CHILDREN.

==========

Control Measures

==========

Respiratory Protection: IF TLV IS EXCEEDED OR FOR SYMPTOMS OF OVER EXPOSURE, WEAR NIOSH-APPROVED SUPPLIED AIR-RESPIRATOR OR A NIOSH-APPROVED POSITIVE-PRESSURE SELF-CONTAINED BREATHING APPARATUS.

Ventilation: MECHANICAL (GENERAL AND/OR LOCAL EXHAUST, EXPLOSION-PROOF) VENTILATION TO MAINTAIN EXPOSURE BELOW TLV(S).

Protective Gloves: PVA

Eye Protection: GOGGLES AND/OR FULL FACE SHIELD

Other Protective Equipment: FULL PROTECTIVE CLOTHING, SAFETY SHOWER, EYE WASH STATION, BOOTS, LAB COAT. DO NOT WEAR CONTACT LENSES.

Work Hygienic Practices: OBSERVE GOOD INDUSTRIAL HYGIENE PRACTICES AND RECOMMENDED PROCEDURES. WASH THOROUGHLY BEFORE EATING, DRINKING/SMOKING.

==========

Transportation Data

==========

Trans Data Review Date: 95039

DOT PSN Code: CVR

DOT Proper Shipping Name: CARBON DISULFIDE

DOT Class: 3

DOT ID Number: UN1131

DOT Pack Group: I

DOT Label: FLAMMABLE LIQUID, POISON

IMO PSN Code: DOT

IMO Proper Shipping Name: CARBON DISULPHIDE

IMO Regulations Page Number: SEE 3109

IMO UN Number: 1131

IMO UN Class: 3.1

IMO Subsidiary Risk Label: TOXIC

IATA PSN Code: FIQ

IATA UN ID Number: 1131

IATA UN Class: 3

IATA Subsidiary Risk Class: 6.1

AFI PSN Code: ZZY

AFI Prop. Shipping Name: FORBIDDEN BY THIS MODE OF TRANSPORTATION
==========
Disposal Data
==========
Disposal Data Review Date: 88270
Rec # For This Disp Entry: 01
Tot Disp Entries Per NSN: 001
Landfill Ban Item: YES
Disposal Supplemental Data: MSDS FM MFR DATED 12 JULY 85 & CONFORMS TO OSHA HAZ COMM STD IN CASE OF ACCIDENTAL EXPOSURE OR DISCHARGE, CONSULT HEALTH AND SAFETY FILE FOR PRECAUTIONS.
1st EPA Haz West Code New: P022
1st EPA Haz West Name New: CARBON DISULFIDE; CARBON BISULFIDE
1st EPA Haz Wst Char New: ACUTELY TOXIC (H)
1st EPA Acute Hazard New: YES
2nd EPA Haz Wst Code New: D001
2nd EPA Haz Wst Name New: IGNITIBLE
2nd EPA Haz Wst Char New: IGNITABILITY
2nd EPA Acute Hazard New: NO
==========
Label Data
==========
Label Required: YES
Technical Review Date: 08FEB95
MFR Label Number: UNKNOWN
Label Status: F
Common Name: CARBON DISULFIDE,4351-030
Signal Word: DANGER!
Acute Health Hazard-Severe: X
Contact Hazard-Severe: X
Fire Hazard-Severe: X
Reactivity Hazard-None: X
Special Hazard Precautions: TARGET ORGANS: EYES, SKIN, CNS, LIVER, KIDNEYS, RESPIRATORY & GI TRACTS. ACUTE- TOXIC. MAY BE FATAL IF SWALLOWED/INHALED. HARMFUL IF ABSORBED THROUGH SKIN. EYE CONTACT MAY CAUSE SEVERE PAIN. INHALATION CAUSES CNS DEPRESSION. CHRONIC- LIVER, RENAL & REPRODUCTIVE DISORDERS. STORE IN COOL, WELL-VENTILATED AREA, AWAY FROM IGNITION SOURCES & INCOMPATIBLES. USE SAND TO REMOVE SPILL. FIRST AID- GET IMMEDIATE MEDICAL ATTENTION. EYE/SKIN: IMMEDIATELY FLUSH WITH WATER FOR 15 MINUTES. HOLD EYELIDS OPEN. INHALED: REMOVE TO FRESH AIR. PROVIDE CPR/OXYGEN IF NEEDED. ORAL: IF CONSCIOUS, INDUCE VOMITING BY GIVING TWO GLASSES OF WATER & STICKING FINGER DOWN THROAT.
Protect Eye: Y
Protect Skin: Y
Label Name: MALLINCKRODT INC.,SCIENCE PRODUCTS DIVISION
Label Street: PARIS BYPASS
Label P.O. Box: M
Label City: PARIS
Label State: KY
Label Zip Code: 40361
Label Country: US
Label Emergency Number: 314-982-5000

==========
T & R CHEMICALS — MURIATIC ACID - ACID
MATERIAL SAFETY DATA SHEET
FSC: 6810
NIIN: 00F032922
Manufacturer's CAGE: TRCHE
Part No. Indicator: A
Part Number/Trade Name: MURIATIC ACID
==========
General Information
==========
Item Name: ACID
Company's Name: T & R CHEMICALS, INC
Company's Street: 700 CELUM ROAD
Company's P. O. Box: 330
Company's City: CLINT
Company's State: TX
Company's Country: US
Company's Zip Code: 79836
Company's Emerg Ph #: 915-851-2761
Company's Info Ph #: 915-851-2761
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 001
Status: SE
Date MSDS Prepared: 27JAN89
Safety Data Review Date: 14FEB94
Preparer's Company: T & R CHEMICALS, INC
Preparer's St Or P. O. Box: 700 CELUM ROAD
Preparer's City: CLINT
Preparer's State: TX
Preparer's Zip Code: 79836
MSDS Serial Number: BTBJB
==========
Ingredients/Identity Information
==========
Proprietary: NO
Ingredient: HYDROCHLORIC ACID, HYDROGEN CHLORIDE, MURIATIC ACID HYDROCHLORIDE
Ingredient Sequence Number: 01
Percent: 35.2
NIOSH (RTECS) Number: MW4025000
CAS Number: 7647-01-0
OSHA PEL: 5 PPM
ACGIH TLV: C 11 MG/CUM
Other Recommended Limit: 7 PPM
==========
Physical/Chemical Characteristics
==========
Appearance And Odor: CLEAR LIQUID, COLORLESS TO PALE YELLOW, PUNGENT, IRRITATING ACIDIC ODOR
Vapor Pressure (MM Hg/70 F): 30
Specific Gravity: 1.18
Solubility In Water: COMPLETE

==========
Fire and Explosion Hazard Data
==========
Flash Point: NONE
Special Fire Fighting Proc: WEAR SELF-CONTAINED BREATHING APPARATUS & FULL PROTECTIVE CLOTHING. USE WATER SPRAY TO COOL NEARBY CONTAINERS/ STRUCTURES EXPOSED TO FIRE.
Unusual Fire And Expl Hazrds: FLAMMABLE GAS (HYDROGEN) WILL BE LIBERATED FROM CONTACT W/SOME METALS.
==========
Reactivity Data
==========
Stability: YES
Materials To Avoid: ALKALIS/OXIDIZING OR REDUCING MATERIALS/CYANIDES/ SULFIDES/COMBUSTIBLE MATERIALS/METALS/METAL OXIDES/AMINES/VINYL ACETATE
Hazardous Decomp Products: HYDROGEN & CHLORINE UNDER CERTAIN OXIDIZING OR REDUCING CONDITIONS
Hazardous Poly Occur: NO
==========
Health Hazard Data
==========
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: INHALATION: VAPORS/MISTS ARE EXTREMELY CORROSIVE TO NOSE, THROAT & MUCOUS MEMBRANES; MAY BE FATAL. EYES: EXTREMELY CORROSIVE. SKIN: SEVERE BURNS, DERMATITIS; FATAL W/DEATH IF LARGE AREAS EFFECTED, DESTROY SURROUNDING TISSUE. INGESTION: EXTREMELY CORROSIVE TO MOUTH & THROAT W/BURNS, SEVERE ABDOMINAL PAIN; MAY BE FATAL.
CARCINOGENICITY - NTP: NO
CARCINOGENICITY - IARC: NO
CARCINOGENICITY - OSHA: NO
Explanation CARCINOGENICITY: NONE
Signs/Symptoms Of Overexp: INHALATION: IRRITATION, COUGHING, CHEST PAIN, BREATHING DIFFICULTY. INGESTION: VOMITING, NAUSEA, COLLAPSE; MAY CAUSE DEATH.
Med Cond Aggravated By Exp: RESPIRATORY ILLNESS W/ATTENDANT TISSUE DAMAGE & DESTRUCTION
Emergency/First Aid Proc: EYES: FLUSH W/PLENTY OF WATER FOR AT LEAST 30 MINS. SKIN: FLUSH W/PLENTY OF WATER. INHALATION: REMOVE TO FRESH. IF BREATHING STOPS, GIVE ARTIFICIAL RESPIRATION. INGESTION: DON’T INDUCE VOMITING. IF CONSCIOUS, GIVE PLENTY OF WATER. IF UNCONSCIOUS, DON’T GIVE ANYTHING BY MOUTH. OBTAIN MEDICAL ATTENTION IN ALL CASES.
==========
Precautions for Safe Handling and Use
==========
Steps If Matl Released/Spill: WEAR ACID-RESISTANT PROTECTIVE CLOTHING & SCBA. NEUTRALIZE. SMALL: EFFECTIVE MOP-UPS W/DISPOSAL OF WASTES IN DOT APPROVED WASTE CONTAINERS AFTER LIME OR SODA ASH NEUTRALIZATIONS HAVE BEEN MADE ARE ACCEPTABLE.
Neutralizing Agent: LIME OR SODA ASH
Waste Disposal Method: DISPOSE OF WASTE IN ACCORDANCE W/FEDERAL, STATE & LOCAL REGULATIONS.
Precautions-Handling/Storing: STORE IN COOL, DRY, WELL-VENTILATED PLACE.
KEEP CONTAINERS TIGHTLY CLOSED WHEN NOT IN USE & CHECK PERIODICALLY FOR ANY ESCAPED MATERIAL.
Other Precautions: DON’T APPLY PRESSURE TO REMOVE CONTENTS FROM ANY CONTAINER.

DON'T CUT, GRIND, WELD OR DRILL ON OR NEAR CONTAINERS OF ACIDS. EMPLOY STANDARD SAFETY PRACTICES APPLIED WHEN AROUND ACIDIC MATERIALS.
==========
Control Measures
==========
Respiratory Protection: NIOSH APPROVED RESPIRATOR FOR VAPOR/MIST CONCENTRATION AT POINT OF USE; FULL FACEPIECE OR HALF MASK AIR-PURIFYING CARTRIDGE RESPIRATOR EQUIPPED FOR ACID GASES/MISTS, SCBA IN PRESSURE DEMAND MODE, OR SUPPLIED-AIR RESPIRATORS
Ventilation: REQUIRED
Protective Gloves: ACID-RESISTANT RUBBER
Eye Protection: CHEMICAL GOGGLES & FULL FACE SHIELD
Other Protective Equipment: ACID-RESISTANT RUBBER SLICKER SUIT W/RUBBER APRON BOOTS W/PANTS OUTSIDE & RUBBER GLOVES W/GAUNTLETS
Work Hygienic Practices: REMOVE/LAUNDER CONTAMINATED CLOTHING/SHOES BEFORE REUSE. WASH THOROUGHLY AFTER HANDLING.
==========
Transportation Data
==========
==========
Disposal Data
==========
==========
Label Data
==========
Label Required: YES
Technical Review Date: 14FEB94
Label Date: 10FEB94
Label Status: F
Common Name: MURIATIC ACID
Chronic Hazard: YES
Signal Word: DANGER!
Acute Health Hazard-Severe: X
Contact Hazard-Severe: X
Fire Hazard-None: X
Reactivity Hazard-Slight: X
Special Hazard Precautions: INHALATION: VAPORS/MISTS ARE EXTREMELY CORROSIVE TO NOSE, THROAT & MUCOUS MEMBRANES; MAY BE FATAL. EYES: EXTREMELY CORROSIVE. SKIN: SEVERE BURNS, DERMATITIS; FATAL W/DEATH IF LARGE AREAS EFFECTED, DESTROY SURROUNDING TISSUE. INGESTION: EXTREMELY CORROSIVE TO RESPIRATORY & DIGESTIVE TRACTS, EYES, SKIN.
Protect Eye: Y
Protect Skin: Y
Protect Respiratory: Y
Label Name: T & R CHEMICALS, INC
Label Street: 700 CELUM ROAD
Label P.O. Box: 330
Label City: CLINT
Label State: TX
Label Zip Code: 79836
Label Country: US
Label Emergency Number: 915-851-2761
Year Procured: UNK
==========

UNIT 4:
INTRODUCTION TO
RADIOACTIVE MATERIALS

LEARNING OBJECTIVES

By the end of this section, participants will be able to:

- Describe the sources of radiation
- List at least five uses of radioactive materials
- Define radioactive terms
- Explain the basic principles of radiation
- Describe the health effects of radiation exposure and protective methods

INSTRUCTOR NOTES

Purpose of Unit:

This unit is designed to cover some of the basics of radiation, including the sources and uses of radiation, basic principles, and health effects.

Materials and Supplies:

Chalkboard or flip chart
Overhead transparency projector and transparencies 4-1 through 4-7
Slide projector and slides 58-68
Videocassette recorder and *Training for Radiation Emergencies: First Responder Operations* videotape

Instructor Preparation:

Identify local industries that store or use radioisotopes or other radioactive materials. If possible, obtain samples of products that use these materials and provide an overview of the production process for your students. For example, many smoke detectors and some lantern mantles contain radioactive materials. Check with the manufacturers to find out the type and quantity of radioactive substances used in these products.

Hospitals or pharmaceutical companies may be able to supply containers, labels, dummy products, or other items related to the manufacture or transport of radioisotopes used in medicine. Also, construction companies may be willing to loan radiography devices for training purposes.

INTRODUCTION

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

Videotape

Show Part 1: *Awareness of Fernald Radiological Shipments* from the *Training for Radiation Emergencies: First Responder Operations* videotape to introduce this section. Emphasize that some of the information in this video is specific to the Fluor Daniel Fernald site.

Your jurisdiction is located at or near a Department of Energy (DOE) site or transportation route. DOE has developed comprehensive transportation and disposal plans designed to help prevent radiological accidents. Transportation of radioactive materials is well-regulated and very safe. Consequently, your chances of responding to such incidents are minimal.

Highway incident involving radioactive materials

However, you need to be prepared for all types of emergencies. So while this program covers all categories of hazardous materials and related safety and health issues, there is a special focus on radioactive hazards.

Background Radiation

Most of the 92 naturally occurring elements on earth are unstable and can change into other forms. Radiation begins in the center of the nucleus of these elements, where energetic parties or waves of energy are released as the atoms decay to stable forms.

More than 80% of the radiation we are exposed to comes from “background” radiation — natural sources like sunlight, soil and rocks. Most remaining exposures come from manmade sources, such as x-rays and common household appliances like smoke detectors and color televisions.

On the following page, Table 4.1 shows the average annual dose from natural background. Table 4.2 shows the average annual dose from manmade sources.

Transparency

Show Transparency 4-1 and discuss background radiation from natural sources.

Table 4.1	
Source	**mrem/year**
Cosmic rays (radiation from the sun and outer space)	**28**
The earth	**26**
Radon (in certain geographic areas)	**200**
The human body	**25**
Building materials	**4**

Transparency

Show Transparency 4-2 and discuss background radiation from manmade sources.

Table 4.2	
Source	**mrem/year**
Medical (primarily from diagnostic x-rays)	**90**
Fallout from atomic weapons	**5**
Consumer products (color television, computers)	**1**
Nuclear power	**0.3**

Activity

Have the students list other sources of radiation. Possible examples include:

- **X-rays**
- **Smoke detectors**
- **Cigarettes**
- **Headlights**
- **Human bodies**
- **Microwave ovens**
- **Building materials**

Exposure to radiation is generally measured in rems**.** Most human exposure is so small the dose can be measured in millirems. The average person's exposure is about 360 millirems a year, about 300 of which is from background radiation. An airplane trip across the country adds about 5 millirems, dental x-rays about 40 millirems. A person living just outside a nuclear power plant receives another millirem or so each year, while an employee of the same plant receives an additional 300 millirems or so per year.

How Radioactive Materials Are Used

Slides

Show slides 58-68 and discuss the uses of radioactive materials.

Radioactive materials are used in producing many of the products we use every day: plastic wrap, radial tires, coffee filters, and smoke detectors.

Many medical facilities contain radioactive hazards.

Radioactive materials are used for diagnostic radiology, radiation medicine, and radiopharmaceuticals. Radiation hazards also exist wherever radioactive materials are stored or radioactive waste products are discarded.

Fires involving radioactive materials can result in widespread contamination. Radioactive particles can be carried easily by smoke plumes, ventilation systems, and contaminated water runoff. While radiation exposure outside of medical and research facilities is not common, you should be alert to its presence in labs, hospitals, and other treatment facilities.

Table 4.3 lists some commonly-used radioisotopes, examples of their uses, the forms in which they're transported, and the most common mode of transport.

Activity

Have the students list some industries in their jurisdictions that might use radiography devices or radioisotopes. For example:

- **Steel mills use radiography to measure steel thickness and detect flaws in metal**
- **Construction companies use radiography to examine soil compaction**
- **Hospitals and doctors' offices use radioisotopes for disease detection and treatment**

TABLE 4.3 RADIOISOTOPES USED IN MEDICINE AND INDUSTRY

RADIOISOTOPE	EXAMPLES OF USES	FORM FOR SHIPPING	MODE OF TRANSPORT
AMERICIUM 241	Used in industry to: • Determine drilling locations for oil wells • Manufacture home smoke detectors • Measure lead in dried paint • Ensure uniformity in steel and paper production	Powder (enclosed in capsule)	Highway Rail Air
CALIFORNIUM 252	Used in medicine to: • Research and treat cancer (especially cervical, ovarian, and brain cancers) Used in industry to: • Detect explosives in luggage at airports • Measure moisture in soil and silos • Start up nuclear reactors	Solid	Highway Air
COBALT 60	Used in medicine to: • Treat cancer • Suppress immune reaction in transplants • Sterilize surgical instruments Used in industry to: • Test welds and casting • Check for internal structural flaws • Locate buried utility conduits Used in agriculture to: • Preserve poultry, fruits and spices	Solid	Highway Rail Air
IODINE 131	Used in medicine to: • Diagnose and treat medical disorders • Trace medical observations	Liquid	Highway Rail Air
IRIDIUM 192	Used in medicine to: • Treat prostate cancer Used in industry to: • Check the integrity of pipeline welds, boilers and aircraft parts	Solid	Highway Air
PLUTONIUM 238	Used in medicine to: • Power pacemakers	Solid	Highway Air
HYDROGEN 3 (TRITIUM)	Used in industry to: • Illuminate paint, exit signs and aircraft • Trace the flow of water • Identify molecules in scientific studies	Solid	Highway Rail

RADIOLOGICAL TERMS

In order to understand radiological hazards, you should first become familiar with some related terms:

Curie is a measurement of the activity of an isotope.

Rad (radiation absorbed dose) measures a quantity called "absorbed dose," which means the amount of energy actually absorbed in a material. The rad measures any type of radiation, but it does not describe the biological effects.

Rem (roentgen equivalent man) measures a quantity called "dose equivalent," which relates the absorbed dose in human tissue to the resulting biological damage. This measurement is necessary because not all radiation has the same biological effect. The rem measurement is obtained by multiplying the rad by a quality factor that is unique to a specific type of radiation.

Roentgen (R) measures the quantity of an exposure to a gamma or x-ray.

The terms above reflect traditional units of measuring radiation. However, SI (Systeme International) units are now being accepted in the U.S. The following table shows each traditional unit, the comparable SI unit, and the conversion factor from the smaller amount to the larger.

Traditional Unit	SI Unit	Conversion Factor (smaller unit to larger unit)
Curie (Ci)	Becquerel (Bq)	1 Ci = 37 billion Bq
rad	Gray (Gy)	1 Gy = 100 rad
rem	Sievert (Sv)	1Sv = 100 rem
Roentgen (R)	Coulombs per kilogram (C/kg)	1 C/kg = 3,876 R

For the purposes of this program, and for your response, you can assume all these terms mean essentially the same thing: a unit of measure of radiation.

Activity

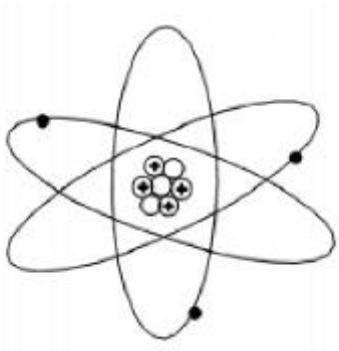
Write the terms *Curie, Rad, Rem* and *Roentgen* on the chalkboard and discuss their definitions. Opposite each traditional term, list the comparable SI unit.

Basic Principles of Radiation

The atom is a unit of matter. The three basic particles of the atom are protons, neutrons, and electrons. Each atom has a center called a **nucleus.** The nucleus contains protons, which carry a positive electrical charge, and neutrons, which are not charged. Negatively-charged electrons orbit the nucleus. Electrons are much lighter than protons and neutrons; 1,845 electrons have the mass of one proton.

Transparency

Show Transparency 4-3 and discuss the parts of an atom.



Parts of an Atom

The positive protons and the negative electrons hold the atom together. When there are equal numbers of protons and electrons, the charges are balanced and the atom is stable.

Atoms of the same element have the same number of protons, but can have a different number of neutrons. Atoms that have the same number of protons but different numbers of neutrons are called **isotopes.** Isotopes have the same chemical properties; however, the nuclear properties can be quite different.

Activity

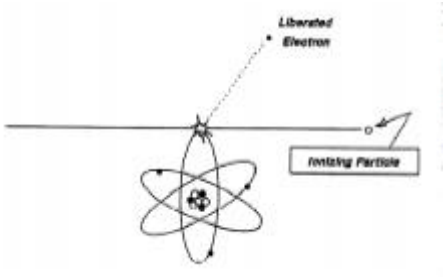
Have students list some examples of non-ionizing (stable) radiation such as microwaves or radio waves.

If there are too many or too few neutrons for a given number of protons, the nucleus will have too much energy and the atom will not be stable. The atom will try to become stable by giving off excess energy in the form of particles or waves (radiation). When we talk about radiation, we are usually referring to **ionizing** radiation rather than non-ionizing radiation.

Ionizing radiation has a tremendous amount of energy. When an ionizing particle interacts with an atom, it can remove an electron from the atom's orbit, causing the atom to become charged, or ionized.

Transparency

Show Transparency 4-4 and discuss how an atom becomes ionized.



Ionization

Non-ionizing radiation does not ionize the atoms around it. Most background radiation from the soil, for instance, does not ionize the atoms it contacts.

The type of radiation given off by the nucleus depends on how the nucleus changes. If protons and neutrons are rearranged, the atom emits gamma radiation. If an orbiting electron changes, the atom gives off x-rays. If the number of protons and neutrons changes, the atom emits one or more types of radiation.

Types of Radiation

Activity

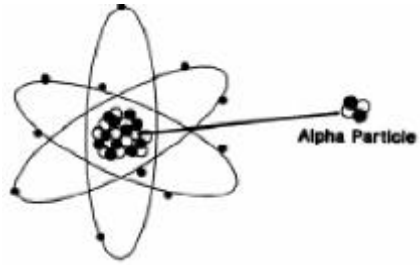
Draw five columns on the chalkboard and write Alpha, Beta, Gamma, X-ray and Neutron at the top of each column. As you discuss this information, note the key points under the appropriate columns.

There are several types of radiation present in nature and manmade sources:

- Alpha particles
- Beta particles
- Gamma rays
- X-rays
- Neutrons

Alpha Particles

Alpha particles are the slowest of the three types of radiation. They can travel only a few inches in the air, losing their energy almost as soon as they collide with anything. They can easily be shielded by a sheet of paper or the outer layer of a person's skin. An alpha particle has a large mass and two protons, two neutrons, and no electrons. Because it has two protons and no electrons, it is positively charged. When emitted from the nucleus, the positive charge causes the alpha particle to strip electrons from nearby atoms as it passes.



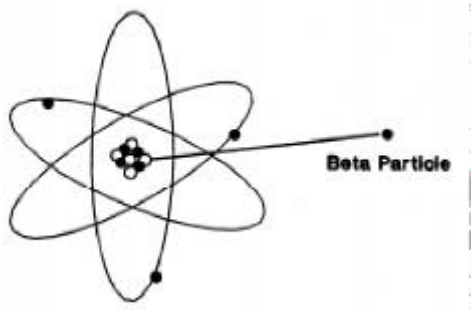
Alpha Radiation

Alpha particles are extremely hazardous to fire fighters because they can be inhaled and deposited in body tissues, where they can cause severe long-term health effects. Positive pressure SCBA is effective protection against inhaling alpha particles. These agents can affect the cells of the body in various ways, and each is capable of destroying cells.

Beta Particles

Beta particles are more energetic than alpha particles. They travel in the air for a distance of a few feet. Beta particles can pass through a sheet of paper but may be stopped by a sheet of aluminum foil or glass.

A beta particle has a small mass and is usually negatively charged. It is emitted from the nucleus of an atom with a charge of minus one. Beta radiation causes ionization by interfering with electrons in their orbits. Both have a negative charge, so the electrons are repelled when the beta particle passes.

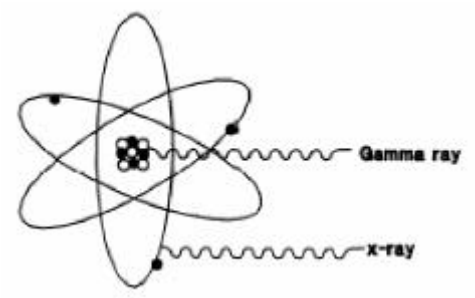


Beta Radiation

Beta particles can damage the skin or tissues of the eye. Internally, they can be extremely damaging if they concentrate in specific tissues.

Gamma Rays

Gamma rays (unlike alpha or beta particles) are waves of pure energy; they have no mass. They are emitted from the nucleus of an atom and travel at the speed of light (186,000 miles per second). Gamma radiation can be very penetrating and requires concrete, lead or steel to stop it.



Gamma Radiation

X-Rays

X-rays are essentially the same as gamma rays except that they are emitted from the electrons that orbit the atom's nucleus, rather than from the nucleus itself. Gamma rays and X-rays are also called **photons.** Because they have very high energy and penetrate deeply, gammas and X-rays can affect not only specific organs, but the surrounding tissues as well.

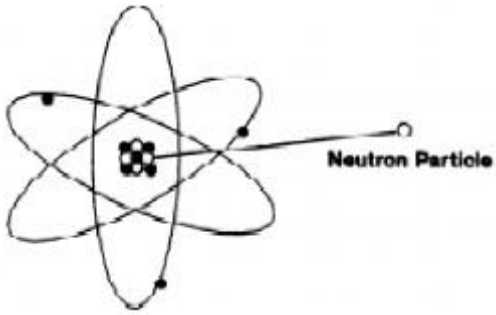
Gamma radiation and X-rays are electromagnetic waves or photons and have no electrical charge. The difference between the two is that gamma rays originate inside the nucleus and X-rays originate outside the nucleus. Both can ionize an atom by directly interacting with the electron.

Neutron Particles

Transparency

Show transparency 4-5 and conduct the exercise. Ask the students to answer the questions as a class.

Neutrons are particles normally contained in the nucleus of an atom. They can be released through certain manufacturing processes, such as nuclear fission (splitting an atomic nucleus).



Neutron Radiation

Activity

Draw three columns on the chalkboard or flip chart and label columns *Alpha, Beta,* and *Gamma*. For each type of radiation, ask the students to list protective measures they could take on the job.

Neutrons are considerably larger than beta particles but have only one-fourth the mass of alpha particles. Because they can penetrate even thick lead shields, they can be extremely damaging to humans. However, neutron radiation is very rare since it is generally emitted only when atomic weapons are detonated.

EXPOSURES

Key Points

- **Whole body exposure to more than 100 rem in a short time leads to acute radiation syndrome**
- **Gamma or X-rays usually cause acute radiation syndrome**
- **Acute radiation syndrome is extremely rare**

Transparency

Show Transparency 4-6 and discuss the stages of acute radiation syndrome.

Effects of Exposure

The effects of radiological exposures can be characterized two ways: as a result of **whole body exposure** or as a result of **local exposure**. These terms are discussed below.

Whole Body Exposure

Exposure of the entire body to a dose of 100 R or greater in a short time period (24 hours or less), results in signs and symptoms known as **acute radiation syndrome.** The radiation source in such cases is usually gamma or X-rays. Actual cases of unintentional whole-body radiation exposure have occurred only very rarely. Few symptoms are noted at doses under 100 R, but damage can be detected in white blood cells.

Doses greater than 100 R result in progressively more threatening consequences that tend to follow a predictable time course. Doses of 100 to 200 R usually cause nausea and vomiting within hours of the exposure. Typical results of laboratory tests include a decrease in certain blood components, especially white blood cells, within two days. This effect is important because white blood cells play a major role in the immune system.

At doses from 200 to 600 R, the most critical problem is maintaining sufficient levels of circulating blood cells. This dose range is life threatening, especially if no treatment is received. White blood cells are most severely affected.

At doses of 300 R or more, hair loss occurs after about two weeks.

With exposures between 600 and 1,000 R, chances for survival are decreased. Death may result from infection, hemorrhage, and other results of decreased bone marrow functioning, but may take months to occur.

At doses greater than 1,000 R, cells of the small intestine lining are damaged and do not recover, resulting in infections and loss of fluid and electrolytes through the wall of the intestine. Death occurs within days.

Key Points

The EPA recommends "lifetime" exposures no more than:

- **5 rem for general monitoring**
- **10 rem for protection of a large population**
- **25 rem for life saving**

The Environmental Protection Agency (EPA) recommends dose limits for emergency workers in various situations. The rem dosage noted below reflects the Total Effective Dose Equivalent (TEDE) lifetime exposures.

rem	Condition
5	General monitoring (no life safety involved)
10	Protection of a large population
25	Life saving (once in lifetime)
>25	Life saving (authorization required)

Source: U.S. EPA

For exposures above 25 rem, responders must be made fully aware of the risks involved, and the person or agency in command must authorize the exposure in writing.

Local Exposure

The effects of partial body exposure to radiation depend on the dose and site of the exposure. Other organs frequently affected by local exposure include the skin and reproductive organs. Effects on bone marrow and the gastrointestinal system occur when these organs are the targets of the exposure. Signs and symptoms of exposure, such as nausea and decreased white blood cells and platelets, are also seen when radiation is used in the treatment of cancer.

The following photograph shows the right buttock of a man who had carried a 28-curie iridium radiography source in his back pocket for 45 minutes. When this photo was taken – about 31 days after exposure – the burn was 4" in diameter and about 1" deep.

Radiation burn from radiography source

Improper handling of gamma or beta sources or heavy exposure to X-ray, neutron, or other particle beams can result in radiation burns to the skin. These are classified like thermal burns – first, second, or third degree, depending on the extent of the injury. However, unlike thermal burns, they develop much more slowly, often taking days to become evident. Because of this, the cause of the burn is not always recognized.

Cancer and Radiation

Cancer is a major long-term health effect of ionizing radiation. The reasons for this effect are not yet fully understood, but are likely to be related to changes produced in the DNA, the genetic material of cells. These changes may involve several steps that take years to progress to the onset of cancer.

Many scientists who experimented with radiation at the turn of the century later developed skin cancer. This was the first link noticed between radiation exposure and cancer.

Other types of cancer are also thought to be associated with radiation exposure. Leukemia, a cancer affecting bone marrow, has been linked to several types of radiation exposure. Some risk for lung cancer has been attributed to radon gas, particularly among uranium mine workers.

Other types of cancer linked to radiation-exposed humans include bone (other than leukemia), breast, stomach, and thyroid. For example, workers who applied radium paint to watch dials ingested radium when they dabbed their paint brushes on their tongues. Radium is taken up by bone tissue. These workers have been shown to have higher than average rates of various bone cancers.

The following photograph shows two views of a right hand that belonged to a pioneer medical radiologist. The hand was amputated in 1932 and the radiologist died in 1933. Cancerous conditions like this were caused by repeated doses of radiation adding up to thousands of rems.

Key Points

Other potentially hazardous situations include:

- **Shipping radioactive materials with flammables or explosives**
- **Chemicals with other hazardous properties such as corrosivity or spontaneous ignition**

Sometimes the chemical properties of a material are much more hazardous than the radioactivity.

Other Hazards of Radioactive Materials

You should be aware of several multiple hazard situations involving radioactive materials. One of these is the presence of explosives or flammables with radioactive material. Radioactive material is forbidden from shipment with Class A explosives but may accompany other classes of explosives.

Also, many radioactive materials are shipped as compounds of acids or bases. Uranium hexafluoride (UF_6) is one example of an acidic radioactive material. Breached containers of this compound can release highly toxic and corrosive hydrogen fluoride gas.

The toxicity of this gas is far more hazardous than the radioactivity of the uranium, and emergency personnel should be alert to fumes, smoke, and irritating or noxious odors. Shipments of uranium hexafluoride must bear both RADIOACTIVE and CORROSIVE labels and placards.

Heavy elements such as uranium, thorium and plutonium may spontaneously ignite and burn when in finely divided metallic form. This will produce airborne radioactive material. Fire fighters should watch for smoking from these packages; although these elements are probably not shipped in this form.

Water-Sensitive Radioactive Materials

Some radiological materials are water-reactive. Uranium hexafluoride is probably the most common. For these materials, the chemical hazards are much more serious than the radiation hazards. Although these materials are shipped in protective overpacks, they may explode or react violently with fuels if the container is breached.

If you are responding to an incident that involves water-sensitive radioactive materials, keep these points in mind:

- Structural fire fighting gear will not protect you from contamination; only trained personnel in chemical protective clothing should respond.
- Use dry chemical, water spray, fog or foam on undamaged containers, but do not use water or foam if there is a release.

If a fire is not involved you may see a foaming residue or sense irritating vapors, indicating a release.

Transparency

Show Transparency 4-7 and discuss how students can protect themselves from radiation hazards.

PROTECTING YOUR HEALTH AND SAFETY

In an emergency situation, you may know only that a material is radioactive without knowing which type of radiation is being emitted.

Limiting Exposure

You can minimize your exposure to any type of radiation by:

- Limiting the **time** that you are near the source of radiation
- Increasing the **distance** between yourself and the source
- **Shielding** yourself with appropriate protective clothing

Time

The shorter the time you are exposed to radiation, the less your exposure. Work quickly and efficiently; rotate teams to keep individual exposures to a minimum.

Distance

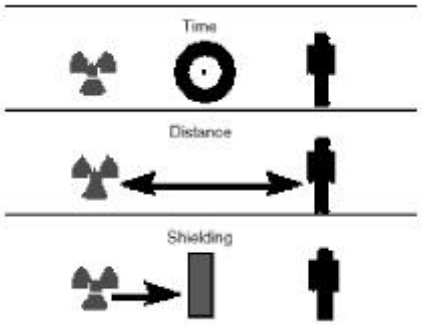
The farther you are from a source of radiation, the lower the dose you receive. If you must approach low level radioactive materials, do not touch them; use shovels or brooms and avoid physical contact.

Shielding

SCBA and bunker gear shields you from most alpha and beta radiation. Several inches of lead is necessary to shield you from gamma radiation. In the field, use clothing, vehicles, equipment, containers or natural barriers like hills, trees, and rocks to protect yourself from radiation exposure. However, be aware that your apparatus, depending on its profile and construction material, may not provide adequate shielding.

Shielding also includes covering the source itself. For example, you may be able to prevent exposure to alpha and some beta radiation if you cover the source with a drum or heavy material, such as a tarp.

Like other exposures, if your clothing or skin is contaminated with a radioactive substance, exposure will continue until you are decontaminated.



Hazardous materials incidents often place First Responders in uncontrolled and potentially hazardous environments. You may be exposed to a range of chemical, biological, and physical hazards. It makes sense, then, to monitor every responder's health through periodic medical examinations. Such examinations are designed to detect any changes in your health so that early treatment can prevent irreversible disease processes. These medical examinations are usually performed within a medical surveillance program and monitored by a licensed health care practitioner with expertise in occupational health.

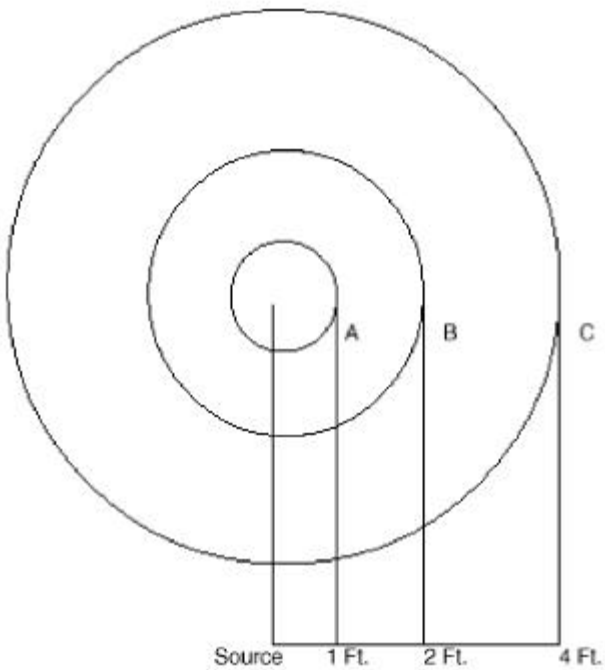
Inverse Square Law

The inverse square law is based on the principle that the farther a person is from a source of radiation, the lower the dose will be. By measuring the radiation exposure rate at a given distance from a source, then doubling the distance from the source, the intensity of the radiation is reduced by one-fourth. For example, radiation that measures 8mR/hr at 2 feet from a source would measure only 2mR/hr at 4 feet from the source.

Conversely, when the distance from the source of radiation is reduced by half–for example, from 2 feet to 1 foot–the exposure rate increases four times, from 8mR/hr to 32 mR/hr. The diagram on the following page illustrates this principle.

The inverse square law is valid only for small point sources such as those used in radiography. It does not apply in accident situations where radioactive materials are released and scattered.

Exposure Rate At Point	Example
A = 4x B = x C = 1/4x	32 mR/hr 8 mR/hr 2 mR/hr



The Inverse Square Law

The Inverse Square Law means that as distance from a source *increases*, the rate of exposure *decreases*; essentially, the *further* you are, the *safer* you are.

PPE and Radiation

Clothing that covers skin also offers protection from some forms of radiation. However, it will not keep you from becoming exposed. A fire fighter dressed in full structural fire fighting clothing (helmet, SCBA, coat, pants, boots and gloves) is well protected from surface contamination. If you should become contaminated by a liquid or solid (not airborne) hazardous material, taking off your outer clothing should remove most of the contamination.

Airborne contamination is more dangerous. If a radioactive contaminant enters your body through a cut in your skin, or if you inhale radioactive particles, the material will remain inside your body and continue to expose the surrounding tissue. The best protection against internal contamination is SCBA. Always wear your SCBA when airborne radiation (or any other airborne hazard, for that matter) is suspected.

Remember that alpha particles will not penetrate the skin, so your regular protective clothing will offer sufficient skin protection. However, alpha radiation can cause very serious problems if it is inhaled.

Although beta radiation can be stopped by a thin piece of metal, structural fire fighting gear (with a duck shell and Nomex liner) offers little protection. Furthermore, inhalation of particles can cause extensive damage.

Gamma rays can penetrate lead, so your fire fighting gear will not keep you from exposure to this type of radiation.

Key Points

- **PPE offers only limited protection against hazardous materials**
- **The best protection from inhalation hazards is your SCBA**
- **PPE & SCBA protects you from alpha particles, but will not shield against beta particles or gamma rays**
- **Internal uptake of radioactive materials leads to organ-specific doses**

Conclusion

Briefly review the key points covered in this section.

UNIT 5:
PACKAGING, TRANSPORTATION AND STORAGE

LEARNING OBJECTIVES

By the end of this section, participants will be able to:

- Identify three types of packaging for radioactive materials
- Describe package testing procedures for radioactive materials containers
- Describe the type of information required on radioactive placards and labels
- List five types of radioactive shipments
- Explain how radioactive materials are transported
- Identify six types of radioactive waste
- Explain how radioactive materials are stored

INSTRUCTOR NOTES

Purpose of Unit:

This unit explains how radioactive waste is packaged and how containers are tested for strength. Two methods of transportation, both highway and rail, are examined in detail. The unit also covers the storage of radioactive waste.

Materials and Supplies:

Chalkboard or flip chart
Slide projector and slides 69 through 99
Overhead transparency projector and transparencies 5-1 through 5-4
Videocassette recorder and Training for Radiation Emergencies: First Responder Operations videotape

Instructor Preparation:

Identify the types of radioactive materials that are likely to be shipped through your community (e.g., spent fuel or low level waste), and their termination point.

PACKAGING

All shipments of radioactive materials, whether from industry or government, must be packaged and transported according to strict Federal regulations. These regulations protect the public, transportation workers, and the environment from potential exposure to radiation.

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

Types of Packaging

The most effective way to reduce the risks associated with transporting radioactive material is to follow the appropriate packaging standards specified by DOT and, when required, NRC regulations. The type of packaging used is determined by the activity, type, and form of material to be shipped. Depending on these factors, radioactive material is shipped in one of three types of containers:

- Industrial packaging
- Type A packaging
- Type B packaging

Industrial Packages

Materials that present little hazard from radiation exposure, due to their low level of radioactivity, are shipped in **industrial** packages. These are also known as **strong, tight** packages. This type of container will retain and protect the contents during normal transportation activities. Slightly contaminated clothing, laboratory samples, and smoke detectors are examples of materials that may be shipped in industrial packages.

Slides

Show slides 69-71 and discuss industrial packaging for radioactive materials.

Industrial containers can range from cardboard boxes to sturdy wooden or steel crates

Key Points

- **Radioactive materials with higher activity levels are shipped in Type A packages**
- **These packages pass strength tests**
- **Type A packages usually carry radiopharmaceuticals**

Type A Packages

Radioactive materials with higher specific activity levels are shipped in Type A packages. These packages must demonstrate their ability to withstand a series of tests without releasing the contents. Regulations require that the package protect its contents and maintain sufficient shielding under conditions normally encountered during transportation. Typically, Type A packages are used to transport **radiopharmaceuticals** (radioactive materials for medical use) and certain regulatory-qualified industrial products.

Type A packages are made of fiberboard, wood, or steel and often have some shielding material for LSA radioactive materials

Slides

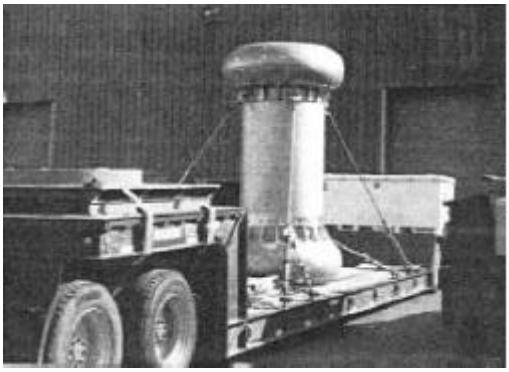
Show slides 72-74 and discuss Type A containers for radioactive materials.

Type B Packages

Radioactive materials that exceed the limits of Type A package requirements must be shipped in Type B packages. Shippers use this type of package to transport materials that would present a radiation hazard to the public or the environment if there were a major release. For this reason, a Type B package design must not only demonstrate its ability to withstand tests simulating normal shipping conditions, but it must also withstand severe accident conditions without releasing its contents.

Key Points

- **Radioactive materials that need the most protection are shipped in Type B packages**
- **These packages pass extreme strength and accident testing**
- **Type B packages carry spent nuclear fuel**



Type B cask used for transporting spent reactor fuel

Slides

Show slides 75-78 and discuss Type B containers for radioactive materials.

Type B cask specifically designed for rail transportation

Type B packages are used to transport materials with high levels of radioactivity, such as spent fuel from nuclear power plants. These large, heavy packages provide shielding against the radiation. The size of Type B packages can range from small containers to those weighing over 100 tons.

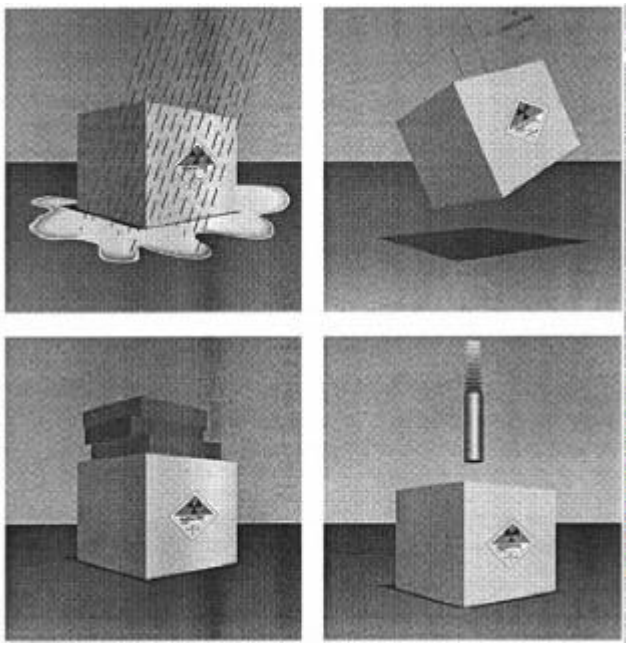
Package Testing

Radioactive materials are packaged according to their form, quantity, and concentration. DOE ensures that when radioactive materials are transported, they are packaged carefully to protect the public, transportation workers, and the environment. DOT and NRC regulate the testing of radioactive material package designs. DOT is responsible for specifying the required test conditions for packages. NRC certifies that packages designed for materials with higher levels of radioactivity, such as spent fuel, meet DOT's test requirements.

Type A Packaging Testing

Type A package designs must withstand four tests simulating normal transport conditions. These tests include:

- Water spray for one hour to simulate rainfall of two inches per hour
- Free-fall drop test onto a hard, flat surface
- Compression of at least five times the weight of the package
- Penetration test by dropping a 13 pound, 1.25 inch diameter bar vertically onto the package from a height of 3.3 feet



Type A package designs must withstand four tests simulating conditions of normal transport, including water spray (rain), drop, compression, and penetration tests (handling conditions)

Videotape

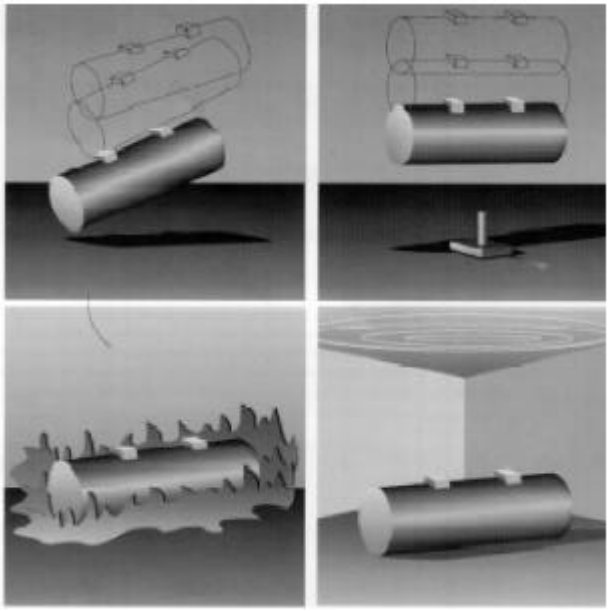
Show Part 2: Package Testing from the videotape and discuss testing methods for Type B containers.

The NRC has established strict performance standards and testing requirements for Type B package designs. Computer analyses and scale model testing demonstrate the structural integrity of the design.

Type B Packaging Testing

Type B packaging must withstand Type A packaging and four additional tests:

- A 30-foot drop onto a flat, unyielding surface so that the package's weakest point is struck
- A 40-inch free drop onto a 6-inch diameter steel rod at least 8 inches long, striking the package at its most vulnerable spot
- Exposure of the entire package to 147 $_{o}$F for 30 minutes
- Immersion of the package under 15 feet of water for at least 8 hours



Type B packages must withstand four more tests simulating severe accident conditions: impact, puncture, heat, and water immersion

Crash tests using actual spent fuel package prototypes have been used to verify the accuracy of the computer models. For example, a truck carrying a prototype shipping package was crashed into a 900-ton concrete wall at 81 miles an hour. The truck was demolished, but the package was damaged only slightly.

Special Form and Fissile Materials

Special form materials are radioactive isotopes enclosed in sealed capsules. They are designed to withstand a fire and a high degree of damage, so they are rarely a problem unless the source is removed from the capsule. If you suspect that a source has been removed from the capsule, stay away from the area and notify the appropriate radiation authorities.

Containers for fissile materials are also designed to withstand a great deal of stress, so it is not likely these materials will present a hazard. These materials are not flammable. In addition, the packaging is designed to withstand total engulfment by fire at temperatures of 1475° Fahrenheit for a period of 30 minutes.

Placards and Labels

Transparency

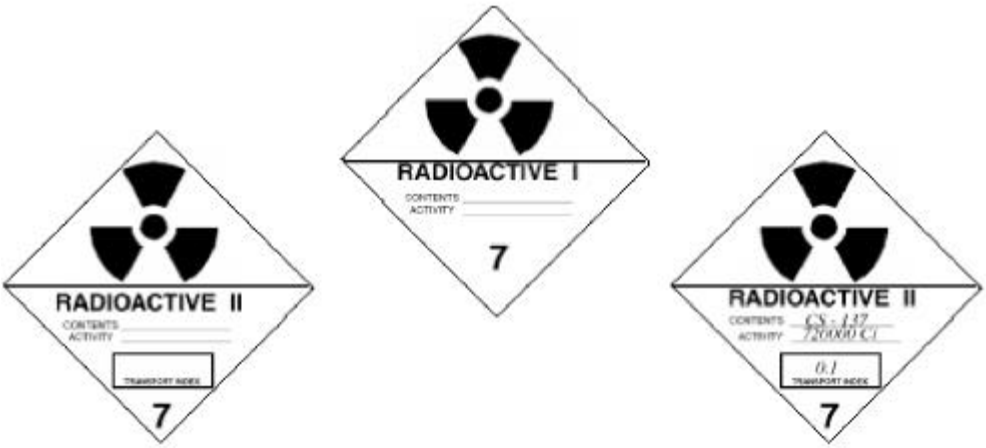
Show Transparency 5-1 and discuss placards and labels for radioactive materials.

Placards are required on vehicles transporting one or more packages bearing Radioactive - Yellow III labels, even if the cargo is in Type A packages. High level radioactive materials, such as spent nuclear fuel, require a diamond-shaped placard within a larger white square with a black border.

Non-bulk containers of radioactive materials must be marked with the shipping names, product identification, and shipper's name and address. Labels identify the contents and radioactivity level according to three categories:

- **Radioactive - White I:** almost no radiation. The maximum allowable radioactivity is 0.5 mrem/hr on the package surface.
- **Radioactive - Yellow II:** low radiation levels. The maximum allowable radioactivity is 50 mrem/hr on the package surface, and one mrem/hr at three feet from the package.
- **Radioactive - Yellow III:** higher levels. Maximum allowable radioactivity is 200 mrem/hr on the package surface, and 10 mrem/hr at three feet from the package. This is required for fissile Class III materials or large quantity shipments of any radiation level. (Fissile refers to elements in which a fission reaction can be induced. This reaction will cause fissile atoms to become unstable and release energy and radiation.) Vehicles carrying packages with Yellow III labels must have a radioactive placard on both sides and both ends of the vehicle.

Each of these labels also includes lines on which the contents are identified and the level of radioactivity is stated in terms of curies. The Yellow II and Yellow III labels have additional items called the **transport index box.** (The top of the diamonds for Radioactive II and III are actually yellow.) For the majority of shipments, the number in the transport index box indicates the maximum radiation level (measured in mrem/hr) at one meter (3.28 feet) from the surface of the package.



Transparency

Show Transparency 5-2 and discuss the transport index box.

In the examples above, a transport index of 0.1 on the Radioactive III label indicates that radiation measured 1 meter from the surface of the package should be less than 0.1 mrem/hr. With the exception of exclusive use shipments, the maximum transport index for any shipment is 10 mrem/hr. Packages that carry radioactive materials are designed to absorb radiation if it is
released from the container. There are other regulations pertaining to the transport index as well, though not as commonly used.

Regulations limit exposure by restricting the total of all the transport indexes on any one vehicle, usually to less than 50. Exposure is also limited by requiring tests for radioactive contamination on the outside of the packages before shipping.

If a total shipment exceeds 200 mrem/hr, the vehicle must be designated exclusively for the purpose of transporting that shipment.

Activity

Conduct Activity 5-1 when you finish discussing radiation placards and labels.

Above the transport index is the **contents** line, which identifies the material inside the package.

Under contents is the **activity** line, which gives the level of radiation in becquerels or curies.

Reusable shipping containers that are empty, but possibly contaminated inside, are labeled with the word “empty.”

TRANSPORTATION

Radioactive materials are shipped safely every day. DOE regulations covering these materials strictly control the types that can be carried, their quantities, and the packaging. In addition, hazard communication standards help ensure that those who handle or come into contact with these materials – including emergency responders – will be able to identify the cargo and understand the hazards.

Key Points

- **DOE strictly regulates the transportation of hazardous materials**
- **Only .0006% of all shipments contain radioactive materials**
- **Transportation accidents involving radioactive materials are very rare**

Types of Shipments

Radioactive materials that are shipped include:

- Uranium ores
- Nuclear fuel assemblies
- Spent fuel
- Radioisotopes
- Radioactive waste

Uranium ores and associated chemical products are shipped from mines and mills to purification processors. Irradiated material is shipped to manufacturers of metal and ceramic fuel assemblies.

Nuclear fuel assemblies are the source of energy for commercial nuclear power plants and their production of electricity. Fuel elements are also produced for research reactors and national defense programs.

Spent or "used" fuel is moved to a geologic repository for permanent disposal. Commercial spent fuel is now being temporarily stored at power plants, while Government-owned spent fuel from test or research reactors is stored at DOE sites.

Radioisotopes are transported from reactors to medical facilities, research laboratories and defense sites, as well as to a variety of industries and manufacturing facilities.

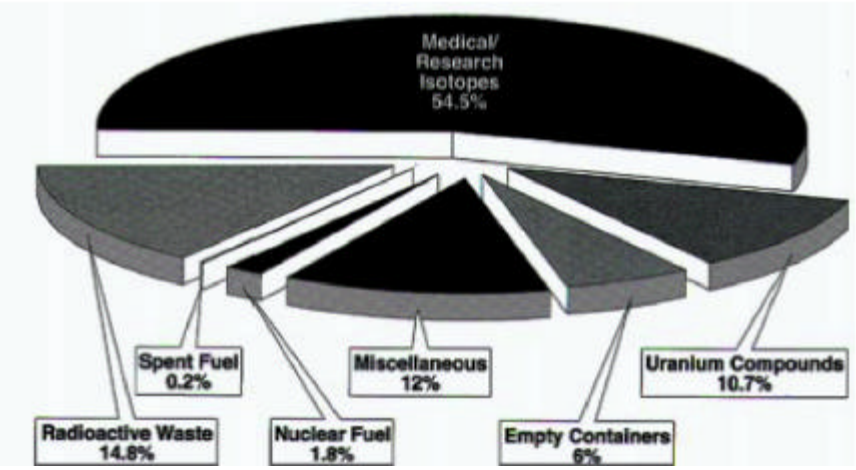
Radioactive waste results from processes that use radioactive materials and must be transported to storage or disposal sites.

Transparency

Show transparency 5-3 and discuss shipments by industry.

Transportation accidents involving radioactive materials are very rare. Of 500 billion total shipments in this country every year, 100 million (.02%) contain hazardous materials, and only 3 million (.0006%) contain radioactive materials.

Hospitals, factories, research facilities, nuclear power plants and other users of radioactive material are often at some distance from the locations that supply this material. In addition, they are often far from the waste storage and disposal sites.



Radiological Shipments by Industry

Strict federal regulations established and enforced by the Department of Transportation (DOT) and the Nuclear Regulatory Commission (NRC) govern the packaging, labeling, documentation and routing of shipments of radioactive materials. All modes of transportation (highway, rail, air or waterway) and all carriers (private or government) are covered by these regulations.

Slides

Show slides 79-83 and discuss transportation of radioactive materials by highway.

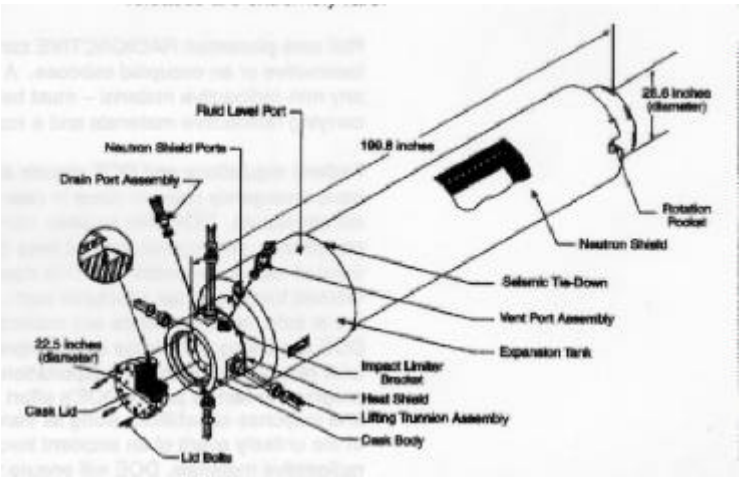
Transportation of Radioactive Materials by Highway

Most radioactive waste is shipped by highway cargo tanks. Trucks transport a wide variety of both low-level and high-level radioactive materials, including fission products used to manufacture nuclear fuel.

Tractor-trailer transporting radioactive cargo

Transportation of these materials is highly regulated. Among other restrictions, carriers are required to follow the most direct interstate route, bypassing heavily populated areas when possible.

When transportation incidents occur, they are most likely the result of a cargo tank accident. However, containers used for shipping high level radioactive materials are very strong, and releases are extremely rare.



Example of cask used to transport high-level spent reactor fuel

South Gate, CA, February 1993

A vial of potentially deadly radioactive cesium-137 was either lost or stolen while in transit along Interstate 5. The vial (measuring 3.5" by .75") was being shipped from northern California to South Gate. Cesium-137 is used to sterilize medical equipment. This material is usually encapsulated in two steel tubes and welded closed. Because of its high level of radioactivity, cesium-137 is stored underwater and must be remotely handled during use and loading for transport. Officials using a Geiger counter eventually found the small container beside an on-ramp to the Long Beach freeway. Had it not been for an anonymous tip, the container might not have been found. — "Hazardous Materials Emergencies," John R. Cashman, 1995

Slides

Show slides 84-87 and discuss transportation of radioactive materials by rail.

Transportation of Radioactive Materials by Rail

Rail is the second most frequent method of transporting radioactive materials. Generally, trains carry only large volumes of material, such as uranium hexafluoride.

Rail accidents can be particularly dangerous for two reasons. For one, extremely large quantities are involved. Secondly, a serious accident can damage several rail cars, resulting in combinations of hazardous materials.

The preferred method of shipping radioactive materials and waste is by unit train, which runs directly between its point of origin and its destination. It receives priority right-of-way and expedited switching, and does not receive or unload any additional cargo along the way. The radioactive loads are contained by a disposable liner and a hard cover and carried in gondola cars.

Rail cars placarded RADIOACTIVE cannot be placed next to a locomotive or an occupied caboose. A buffer car – loaded with any non-radioactive material – must be placed between a car carrying radioactive materials and a locomotive or caboose.

Federal regulations and DOE require shippers and carriers to have emergency plans in place in case an accident involving a rail car occurs. DOE also requires railroads to document their compliance with regulations and laws before and during shipment
of radioactive materials. This documentation ensures that railroad tracks and rail structures such as culverts and crossings are in safe condition before any materials are shipped. Also, DOE is working with states along shipment routes to train and brief responders on their transportation plans. This training program, in fact, is part of DOE's effort to increase awareness and response capabilities along its transportation routes. In the unlikely event of an accident involving DOE-regulated radioactive materials, DOE will ensure that any release is cleaned up, and that any other remedial actions are taken.

Transportation of Radioactive Materials by Air

DOT strictly limits air shipment of radioactive materials. One exception is radiopharmaceuticals. Radiopharmaceuticals are radioactive drugs used to diagnose or treat illnesses, and are frequently short-lived, small and light-weight. Often they must be delivered quickly to hospitals and medical laboratories, so air shipment is generally the best method.

Key Points

- **DOT limits air shipment of radioactive materials**
- **Most air shipments are radiopharmaceuticals**
- **Quantities shipped by air are generally very limited**

Air shipment of radioactive materials is not regulated by the Code of Federal Regulations, as are most other methods. Regulations for air transport are issued by the International Atomic Energy Agency (IAEA).

With the exception of nuclear weapons, large quantities of radioactive materials are rarely shipped by air. The military and its contract carriers are notable exceptions, however.

Transportation of Radioactive Materials by Water

Only a small percentage of radioactive materials are shipped by water, primarily because this type of transportation is slow and geographically limited. Materials that are occasionally transported via waterways include spent nuclear fuel, uranium metal, uranium hexafluoride, and low-level waste. When shipped by water, these materials are identified as “marine pollutants” and noted as such on the manifest.

Key Points

- **Only a small percentage of radioactive materials are shipped by water**
- **Water shipments include spent nuclear fuel, uranium metal, UF_6 and LLW**

International water transport of radioactive materials is governed by the IAEA and the International Marine Organization (IMO). Transportation in US waters is regulated by DOT and NRC. In addition, DOE has conducted extensive tests to ensure the safety of ships carrying radioactive cargo.

Shipments that exceed a certain level of radioactivity must be shipped exclusively on vessels hired specifically for that purpose.

STORAGE

When radioactive materials are depleted of their usefulness, they are considered waste and must be stored at a government-approved disposal facility.

Slides

Show slides 88-99 and discuss storage of radioactive waste.

Storing Radioactive Waste

Each type of waste is sent to a disposal site that is appropriate for its characteristics.

High Level Waste

High level waste results from the reprocessing of spent nuclear fuel in a commercial or defense facility. Reprocessing can recover the usable radioactive materials for research and defense programs. High level waste is currently stored in underground tanks and vaults at government sites. Some of this waste will be solidified in a glass form, packaged in stainless steel canisters, and placed in heavily shielded casks for transport to a permanent geologic repository.

Spent Fuel

Spent fuel results from producing electricity at nuclear power plants or from operating other reactors such as research reactors. After the usable fuel has been expended, highly radioactive fuel assemblies remain.

The U.S. does not reprocess spent fuel from power plants, but has reprocessed spent fuel from many types of reactors in the past. Spent fuel is shipped as a solid, and is packaged in casks for transport. Currently, spent fuel is stored in pools of water, aboveground vaults, or concrete casks onsite at reactor or commercial power plants.

Spent fuel from DOE-owned reactors is stored where it is produced or at other DOE sites. Like high-level waste, spent fuel will eventually be shipped to permanent geologic repositories.

Under the Nuclear Waste Policy Act, DOE is responsible for transporting spent fuel from power plants, as well as defense-related high-level radioactive waste, to permanent repositories.

Transuranic Waste

Transuranic waste contains manmade elements heavier than uranium, thus the name trans (or beyond) uranic. Transuranic waste results from defense production activities and includes contaminated protective clothing, tools, glassware, and equipment. Most is now stored at government sites throughout the country. Although most transuranic waste is no more radioactive than low-level waste, it is radioactive for a longer period of time.

In the past, transuranic waste was shipped in rail cars, but shipments to the Waste Isolation Pilot Plant (WIPP) in New Mexico will be made by truck in a specially-designed packaging called the TRUPACT-II. WIPP is designed to demonstrate the disposal of transuranic waste in deep, geologically stable salt beds. If the demonstration project is successful, the site will become a permanent disposal facility for transuranic waste.

Low-Level Waste

Low-level waste results from research, medical, and industrial processes that use radioactive materials. Commercial power plant operations and defense-related activities, including weapons disassembly and cleanup of production sites, also produce some low-level waste. Low-level waste consists of contaminated rags, papers, filters, tools, equipment, and discarded protective clothing.

Low-level radioactive scrap metal from a building demolition at uranium processing facility

Typically, low-level waste contains small amounts of short-lived radioactive material dispersed in large quantities of non-radioactive material. It is far less hazardous than high-level waste and is usually packaged in sturdy wooden or steel crates and steel drums for shipment to storage or disposal sites.

Low-level waste is sent to disposal sites licensed by the U.S. Nuclear Regulatory Commission. Several commercial sites accept waste from producers of low-level waste, and some states have formed regional compacts to dispose of low-level waste when these facilities close. Sites have been established throughout the DOE complex for disposal of DOE low-level waste.

Mixed Waste

Mixed waste is waste that contains both hazardous chemical components and radioactive components and is subject to the requirements of the Atomic Energy Act and the Resource Conservation and Recovery Act. Mixed waste is treated, packaged, and shipped offsite to DOE or commercial disposal sites by most DOE facilities that produce it. Envirocare of Utah, Inc., recently began accepting DOE mixed waste shipments for disposal. The waste is encapsulated in melted recycled plastic and disposed of in an onsite landfill.

Uranium Mill Tailings

Uranium mill tailings are radioactive rock and soil byproducts from uranium mining and milling. Mill tailings contain small amounts of naturally occurring radium that decays and emits a radioactive gas, radon. When radon gas is released into the atmosphere, it disperses harmlessly. However, radon gas might be dangerous if it is inhaled in high concentrations over a long period of time. Uranium mill tailings are transported to several disposal facilities specifically designed to accept them. When the disposal site reaches capacity, it is sealed to prevent dispersion of radon gas.

Conclusion

Briefly review the key points covered in this section.

UNIT 5
APPENDIX

Activity 5-1
Scenario

Time: 0930 Hours
Weather: Cloudy, wind out of the northeast.
Temperature 52°F

You receive a medical call from the dispatcher, a patient with difficulty breathing. You are sent to assist an ambulance enroute to a warehouse in an industrial park. You are to meet the caller at the loading dock on the east side of the warehouse.

Upon arrival, you notice very little activity. The company is Environmental Enterprises, Inc. This is a company which, among other things, cleans tanks and water blasts graffiti, provides deep well monitoring and does site clean-up and remediation.

On the loading dock you meet a mechanic who says he placed the emergency call for himself. His B/P is 162 over 98. Respirations are 18 and shallow. His chief complaint is respiratory distress and nausea.

He says he was working on the lighting in a trailer, trying to repair some fixtures and a short in the wiring. He has been at work since 0730 that morning, and in the trailer for about an hour. His ladder slipped while repairing the light on the ceiling of the trailer, causing him to fall against one of the containers. He landed on his side.

You send a fire fighter to the trailer to find out what is inside. The fire fighter returns and tells you no hazards are readily apparent. There is no product leaking onto the floor, nor are there any placards outside of the trailer. There are, however, several drums with hazardous waste stickers and what look like yellow and white labels. These containers were in the dark forward end of the trailer.

You decide to investigate a little further. On one of the drums, you can see the corner of a Radioactive-II label. You take a better look with your flashlight. The number .5 is written in the transport index box on the Radioactive-II label.

The ambulance is just pulling into the yard.

1. How would you characterize the scenario?

2. How would you treat the patient?

3. What hazards are involved?

UNIT 6:
RADIATION EMERGENCIES

LEARNING OBJECTIVES

By the end of this section, participants will be able to:

- Describe the basic types and functions of radiation survey instruments
- Identify the ways patients can become exposed/contaminated by radiation
- Explain how to control a situation involving a radiation release
- Identify the agencies that require reports when there is a radiation release

INSTRUCTOR NOTES

Purpose of Unit:

This unit describes the basic procedures for responding to an incident involving a radioactive material. However, remember that departmental procedures always take precedence. Use this unit as a foundation for training in your own SOPs.

Materials and Supplies:

Chalkboard or flip chart
Overhead transparency projector and transparencies 6-1 through 6-3
Videocassette recorder and Training for Radiation Emergencies: First Responder Operations videotape

Instructor Preparation:

Contact the local office responsible for dealing with radiation emergencies. This office may be affiliated with EPA, DOE, or some other federal, state or local agency. Arrange for an official to speak to your students and answer questions for about an hour at the end of the day. Topics to cover are noted in the Speaker Notes in the Instructor Material section.

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

INITIAL RESPONSE

In most cases, accident scenes involving radioactive materials are handled in the same way as any other hazardous materials incident. However, you may need to take different precautions, depending on the type and form of radiation, as well as the other hazards involved. The following information covers some of these issues.

When you arrive at a transportation incident scene, conduct a survey as you would with any other hazardous materials incident. If you see any indication that radioactive materials are involved (placards, labels, information from workers), look for the shipping papers, which will identify the radionuclides being transported. If radioactive contamination prevents you from searching, contact the carrier's dispatcher directly. Since you cannot see or feel radiation, never assume it is not present in these situations.

If you have radiation monitoring instruments and are trained in their use, survey the immediate area to find out if radiation is present. Monitor any accident victims if they do not have life-threatening injuries. Also, monitor the time in the hot zone. Remember that time, distance and shielding are your most effective protections against radiation hazards.

An initial radiation survey will only give you a preliminary estimate of radiological hazards. If you do not have access to the types of instruments that are used to take complete and detailed radiological readings, you should contact the appropriate authorities immediately.

DETECTING RADIATION HAZARDS

Because radiation cannot be detected by the human senses, you must rely on instruments to confirm its presence. Two categories of instruments are currently used to detect the presence of radiation. Survey meters detect the presence of radiation. Dosimeters measure an individual's exposure or dose. Both types of instruments require specific training in their use and the interpretation of results.

Activity

If you have contacted an official from a state or local agency, have that person present the information on survey meters. Or, show Part 3: Radiation Survey Meters from the videotape.

Survey Meters

Survey meters were originally designed to detect radiation in the event of a nuclear attack. Various types are available to detect alpha, beta, gamma, X-ray, and even neutron radiation, but the most commonly used types detect beta and gamma radiation. The others are more specialized and require more training in their use. A description of some of the more commonly used instruments is included in this section.

Two civil defense survey instruments are the **CD V-700** and the **CD V-715**. These instruments measure rate of exposure in roentgens per hour (R/hr) or milliroentgens per hour (mR/hr).

Activity

Show the students the radiation survey meters used in your department. Demonstrate how they work by using a calibration source. Stress that they must be trained how to use these devices.

CD V-700

This survey meter is known as the Geiger-Mueller counter or, more popularly, as the Geiger counter or GM meter. It detects beta radiation and measures gamma radiation in the low range up to 50mR/hr. If the radiation field is high, the instrument may become saturated and produce inaccurate readings.

The meter detects both beta and gamma radiation unless a special shield is placed over the probe. The shield stops beta radiation, so when it is in place only gamma radiation is detected. The only control on the CD V-700 is a selector switch that has an OFF position and three ranges labeled x100, x10 and x1. Remember, these meters measure gamma radiation but only detect beta radiation (they cannot measure beta radiation).

CDV-700

To use the CDV-700, follow these steps:

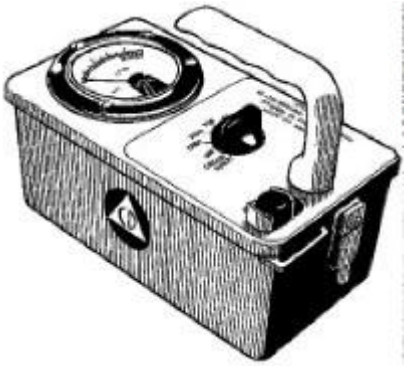
1. Check to see that fresh batteries are in place. If not, insert them.
2. Turn the range selector switch to the x10 range.
3. Allow 30 seconds for the instrument to warm up.
4. Open the probe shield and place the open area directly against the check source on the side of the instrument. The meter needle should deflect, indicating it is responding to radiation.
5. Determine the background radiation level by setting the instrument on the most sensitive scale (x1) and observing it for about 30 seconds. (Background radiation is usually less than 0.05 mR/hr or under 50 cpm when the selector switch is on the x1 range. The needle may jump randomly on this setting because of erratic background radiation).
6. Set the meter to the x100, x10, or x1 selection. On the x1 setting, the radiation exposure rate is as shown on the meter. On the x10 and x100 ranges, the meter readings must be multiplied by 10 and 100 respectively to obtain the correct reading. If the meter deflects full scale on the x1 or x10 ranges, select a higher range on the selector switch.

The CD V-700 will not give a correct reading if exposure rates are above 1 R/hr. Use a higher-range instrument when radiation exposure levels exceed 50 mR/h, the maximum that the CD V-700 can measure.

CD V-715

This survey meter measures high-level gamma radiation up to 500 R/hr. It cannot be used to detect background radiation, alpha or beta particles, or low-level gamma radiation (less than 50 mR/hr).

CD V-715



To use the CD V-715, follow these steps:

1. Check to see that a fresh battery is in place. If not, insert one.
2. Turn the selector switch to the zero position.
3. Allow approximately two minutes warm-up time.
4. Adjust the zero control so that the meter reads zero. Without proper zero adjustment, the instrument may not read correctly.
5. Turn the selector switch to CIRCUIT CHECK (the needle should point to this area).
6. Recheck the zero setting on all four ranges.
7. Begin surveying with the instrument set on the x0.1 range.
8. Slowly move the probe over the site of suspected contamination, avoiding contact between the surface and the probe. Hold the probe about one inch from the site being monitored. Survey the entire body, head to toe, paying particular attention to wounds and body orifices.

The selector switch on the CD-715 has seven positions: CIRCUIT CHECK, OFF, zero, x100, x10, x1, and x0.1. On the x1 range, the radiation exposure rate is as shown on the meter. On the x0.1, x10, and x100 settings, multiply the meter readings by factors of 0.1, 10 and 100 respectively to obtain an accurate measurement.

Alpha surveys are usually performed to detect surface contamination that may lead to exposure by inhalation, ingestion, or absorption through open wounds. Because alpha counters are difficult to use properly and may be misinterpreted, alpha surveys should be performed by experienced personnel.

If you are trained in the use of a CD-700 or CD V-715 survey meter, keep in mind that these instruments measure only radiation levels, *not contamination levels*. However, you can assume that if radiation is present, you may be exposed or contaminated.

Ludlum M3 Survey Meter

The Model 3 is a portable survey instrument with four linear ranges used in combination with dose rate or CPM meter dials.

Four linear range multiples of x0.1, x1, x10, and x100 are used in combination with the 0-2 mR/hr meter dial; 0-200 mR/hr can be read with a range multiplier.

To use the Ludlum M3 Survey Meter, follow these steps:

1. Open the battery lid and install two “D” size batteries. Note (+) (-) marks on the inside of the lid. Match the battery polarity to these marks.
2. Switch the range switch to BAT. The meter should deflect to the battery check portion of the meter scale. If the meter does not respond, recheck that the batteries have proper polarity.
3. Connect a detector to the M3.
4. Turn the instrument range switch to x100. Expose the detector to a check source. The speaker should click with the AUDIO ON-OFF switched to ON.
5. Move the range switch to the lower scales until a meter reading is indicated. The toggle switch labeled F-S should have fast response in “F” and slow response in “S”.
6. Depress the RES switch. The meter should zero.
7. Proceed to use the instrument.

To assure proper operation of the instrument between calibrations, an instrument operational check should be performed prior to use. A reference reading with a check source should be obtained at the time of initial calibration or as soon as possible afterwards, for confirming correct operation. Confirm the proper reading on each scale.

If the instrument fails to fall within + 20% of proper reading, it should be sent in to a calibration facility for recalibration.

Dosimeters

Activity

Show the students an example of a dosimeter and briefly explain how it works.

Each individual entering a suspected radiation area should wear a **personal dosimeter**. Personal dosimeters measure cumulative exposure, that is, the total amount of radiation exposure during the period of measurement. Personal dosimeters should be worn on the outside of personal protective equipment. The three most common types are described below:

- **Pocket Dosimeter:** This is a direct readout instrument that resembles a fountain pen and is worn clipped to the outside of personal protective equipment. An advantage of pocket dosimeters is their ability to provide an immediate dose reading in the field. There are models to detect both high and low levels of exposure.

Pocket Dosimeters

- **Film Badge**: Film badges contain photographic films sensitive to X-ray, gamma, and beta radiation, giving an approximate measure of cumulative exposure. Badges must be processed to obtain their results.

Film Badges

- **Thermoluminescent Detector (TLD)**: TLDs contain crystals of salts that can record beta, gamma, and X-ray radiation. They have a very wide range of detection. Like film badges, TLDs must be specially processed for results. TLDs are processed by heating the crystal and releasing the trapped electrons. Over time, TLDs lose their accuracy because electrons will be released from their “trapped” location.

TREATING PATIENTS

Key Points

If a patient is injured, treat the injury first. Do not waste time checking for radiation!

If victims are involved in a radiation incident, move them away from any potential area of contamination unless this increases the risk of injury. Remember to treat serious wounds first. Consequently, do not waste time measuring radiation levels. *Start first aid immediately*. You can do a quick initial radiation survey of the patient if you have the appropriate equipment and know how to use it. But remember that conventional life-saving first aid always has priority unless you suspect a high dose (400 to 600 rad). In these cases, victims need immediate treatment for radiation illness.

Identify contaminated parts of the victim's body using a disaster tag. If you take meter readings, note these readings on the tag. The tag will give hospital personnel important information about the patient's status.

There are a number of ways patients can be contaminated by or exposed to radiation. The patient may be:

- Exposed to an external source of radiation
- Contaminated externally
- Contaminated internally
- Have a contaminated wound

Activity

Show Part 4: Treating Patients from the videotape. Stop the tape after each scenario and before the outcome of the incident is described. Ask the students:

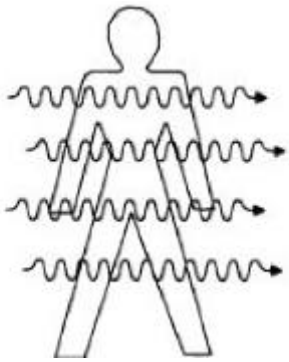
- **What are the primary hazards in this incident?**
- **What type of care should you give the patient?**
- **What information should you provide to the receiving hospital?**

Exposure to External Sources

Patients that have been exposed to external sources of gamma, x-ray, or neutron radiation do not pose contamination problems. The degree of radiation injury depends on the amount of the dose. If the whole-body exposure exceeds 100 rem, symptomatic treatment at a specialized hospital may be needed.

Transparency

Show Transparency 6-1 and discuss treatment of patients exposed to radiation from an external source.



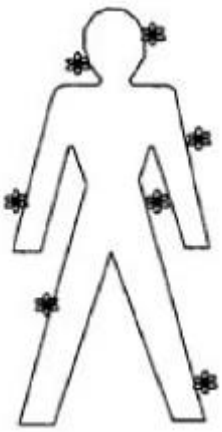
Patient exposed to radiation from external source

Transparency

Show Transparency 6-2 and discuss treatment of externally contaminated patients.

Externally Contaminated Patients

Contamination means that radioactive materials in the form of gases, liquids or solids are released into the environment and 1) come into contact with and 2) remain on a patient. Externally contaminated patients should be checked with a radiation survey meter because the radiation can be a hazard if it spreads. Even if external contamination is present, give lifesaving assistance immediately. Wear gloves, a gown, cap and mask and wrap the patient in a blanket or sheet for transport. Save all clothing, bedding and clothing in appropriate containers and mark them as RADIOACTIVE - DO NOT DISCARD.



Externally contaminated patient

Internally Contaminated Patients

Transparency

Show Transparency 6-3 and discuss treatment of internally contaminated patients.

Patients who are internally contaminated have inhaled or ingested radioactive materials. Once that happens, the radioactive material is distributed through the body based on its chemical properties. For example, radium targets bone, iodine the thyroid gland. Depending on the radioactive material, treatment can be given to prevent further uptake, or to promote removal of the material from the body. Medications used for this purpose are specific to the radioactive material and are given by the receiving hospital. There is little a First Responder can do in these cases. It's important to remember that patients may also be externally contaminated.

Key Points

Always prepare the hospital to receive an exposed patient by:

- **Identifying contaminated body parts**
- **Noting any meter readings**
- **Notifying the hospital of a radiation hazard**

Internally contaminated patient

Contaminated Wounds

In patients with contaminated wounds, your primary objective is to treat the wound, then prevent the further spread and absorption of radiation. Clean the wound and cover it with a self-adhering surgical drape. Flood adjacent skin with saline. Save and identify all particulates as well as irrigating fluid and tissue.

Be sure to notify the receiving hospital if you are bringing in patients who have been contaminated with or exposed to radioactive materials. For contaminated patients, the hospital may want to set up a decontamination area. After you transfer the patient, you and the other responders must be surveyed for contamination. Discard contaminated clothing in plastic bags and shower if necessary. Do not leave the area until you are released by a health physicist. You will also need to survey your unit and all the equipment used to treat the patient.

Activity

Conduct Activity 6-1 after you discuss patient treatment.

CONTROLLING AND REPORTING HAZARDS

Key Points

- **Low level radioactive materials are not usually a threat**
- **Rescue and first aid take priority over radiation concerns**
- **Always notify radiation authorities**
- **Isolate 80'-160'**
- **For large spills or fires, consider evacuation**

Conclusion

Briefly review the key points covered in this section.

Instruct the students to read the two case studies at the end of their manuals. Tell them to come prepared to discuss them during tomorrow's session.

Controlling Releases

Low level materials generally do not present a significant threat. However, your safety, as well as the safety of the public and other responders is still a concern. The primary points to remember when dealing with a radiation incident are:

- Remember that rescue, life-saving, first aid and control of a fire and other hazards take priority over measuring radiation levels
- Notify the appropriate radiation authority
- Isolate spills or leaks for at least 80 to 160 feet in all directions
- If the spill is large, consider downwind evacuation of 330 feet
- If a fire is involved, consider evacuation of 1,000 feet in all directions
- Move containers away from fire if you can do so safely, but do not move damaged packages
- Cover liquid spills with sand, earth or a noncombustible material; dike large spills
- Cover powder spills with a plastic sheet to reduce spreading

Reporting Releases

OSHA and NRC require extremely detailed and lengthy reports of all radiation incidents. A preliminary report may be issued months before a final document. Because the time between the incident and final report can be very long, it is critical that you keep good records of your initial response. Keep exact notes of:

- Date, time of day, and exact location
- Scene diagrams
- Atmospheric conditions
- Monitoring results
- Sequence of events
- Names of persons you contacted

UNIT 7:
PERSONAL PROTECTIVE EQUIPMENT

LEARNING OBJECTIVES

By the end of this unit, participants will be able to:

- Explain the advantages and limitations of various types of personal protective equipment
- Describe the types of respiratory equipment
- Explain the limitations of self-contained breathing apparatus (SCBA)
- Describe decontamination procedures

INSTRUCTOR NOTES

Purpose of Unit:

This unit reviews personal protective gear. Students should already be familiar with structural fire fighting gear, so this unit provides only a quick review. It also gives First Responders an opportunity to see and experience wearing vapor protective clothing. However, it is not intended to train First Responders in the use of chemical protective clothing. Students should have much more extensive training before attempting to use this type of clothing in an actual incident.

Materials and Supplies

Chalkboard or flip chart
One complete splash-protective ensemble
One complete set of structural fire fighting clothing
One complete fully-encapsulated vapor protective ensemble
Copies of your department's SOPs for decontamination
Decontamination equipment (optional)

Instructor Preparation

Secure the materials and supplies listed above and make sure they are working properly. If time permits, set up a decontamination area and have the students practice decontaminating one another. Use a relatively "adhesive" substance (e.g., chocolate syrup) as the hazardous material. You will need to arrange to have this decontamination equipment available well in advance of the class.

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

Activity

Draw two columns on the chalkboard or flip chart. Label one column *Radiation* and the other *Hazardous Materials*. As you discuss PPE, note the limitations and advantages of each when responding to both types of incidents.

Activity

Show the students the components of the vapor-protective ensemble. If time permits, allow one or two volunteers to don the suit and instruct other students to assist. Have the student(s) wearing the suit perform a simple activity, such as using a wrench or moving a 55-gallon drum. Then have the students discuss the limitations and disadvantages of using this type of PPE in incidents involving radiation and other hazardous materials. Note their comments under the correct column heading on the flip chart or chalkboard.

TYPES OF PROTECTIVE EQUIPMENT

Structural fire fighting clothing and equipment should not be used for hazardous materials incidents. The only possible exception to this may be incidents that involve gasoline spills. In this case, follow your own department's standard operating procedures.

NFPA Standards

The National Fire Protection Association (NFPA) has issued three standards on protective clothing for fire fighters. Each of these standards is described below.

NFPA 1991

NFPA 1991 is the standard on vapor-protective suits for hazardous chemical emergencies. It represents the highest level of protection and covers the use of vapor-protective suits that are generally used only by hazardous materials team members. Vapor-protective suits should not be used for fire fighting or in flammable or explosive situations. Nor should they be used where there are biological, cryogenic, or radioactive hazards.

Emergency responders in vapor-protective suits

NFPA 1992

NFPA 1992 defines performance criteria for suits that provide protection from chemical splashes only. Although liquid splash-protective suits can be used in the hot zone, they should not be used in situations where vapor or gas hazards are present. In many instances, liquid splash protective suits are also adequate for decontaminating entry personnel in vapor-protective suits.

Activity

Show the students the components of a liquid splash protective ensemble and discuss the limitations and advantages of this equipment when responding to radiation incidents and other types of hazardous materials emergencies.

Emergency responder in liquid splash protective suit, going through a decontamination process

Activity

Show the students the support function garments and discuss the limitations and advantages of this equipment when responding to radiation incidents and other types of hazardous materials emergencies.

NFPA 1993

This standard applies only to personnel working outside the hot zone in support functions. This type of protective clothing can be used only if the site has been characterized and chemical hazards are insignificant. For fire fighters, “support function” can refer to structural fire fighting gear. However, the standard does not cover the face shield, gloves or boots unless they are an integral part of the garment.

Typical structural fire fighting gear with SCBA

Activity

Show the bunker gear used in your department and discuss its limitations and advantages when responding to radiation incidents and other types of hazardous materials emergencies.

Structural Fire Fighting Gear

Structural fire fighting gear is designed to protect fire fighters from heat and flame. The coats are generally made of three layers.

- The outer layer provides durability, tear resistance, and some thermal protection, and is typically reinforced with Kevlar and Nomex
- The middle layer is usually made of a waterproof mate-rial, designed as a moisture barrier
- The inner layer is designed for thermal protection only, and may also be covered with Nomex or Kevlar

There is no layer or component designed to protect against any type of chemical.

Chemical protective clothing, on the other hand, typically provides no thermal protection. Instead, this clothing is resistant to specific chemicals, depending on the material that makes up the suit.

Protective suits may be constructed to keep out gases and vapors (fully encapsulated, vapor-protective) or to prevent exposure to liquids (liquid splash-protective).

RESPIRATORY EQUIPMENT

Because inhalation is one of the major routes of exposure to chemicals, respiratory protection is extremely important. Most First Responders use self-contained breathing apparatus (SCBA) as the primary means of respiratory protection.

SCBA usually consists of a facepiece connected by a hose to a regulator. The regulator is connected to an air source carried by the wearer. SCBAs offer protection against many types and levels of airborne contaminants.

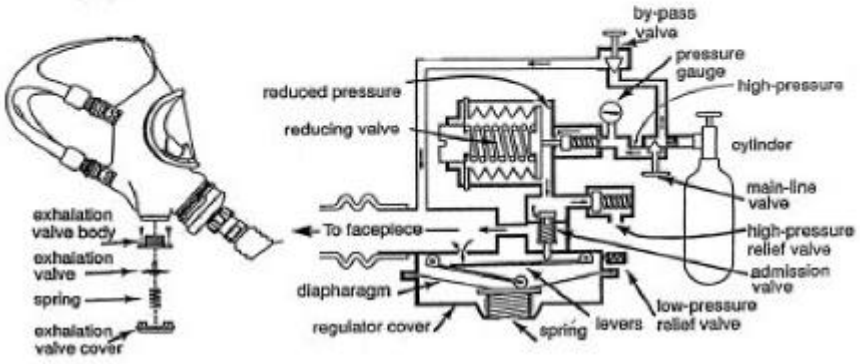
Only positive-pressure SCBAs and supplied air respirators (SARs) should be used in emergency response. SCBAs maintain a positive pressure in the facepiece during inhalation and exhalation. Some other types of breathing apparatus such as air purifying respirators do not. Both SCBA and SAR facepieces should be fit-tested before use.

Air purifying respirators are unsuitable for emergency response. While cartridges on the respirator's mask filter contaminants in the environment, there is no supply of air. If the environment is oxygen-deficient, then the air taken in through the mask is oxygen-deficient as well. This could be extremely hazardous in an environment where oxygen is being displaced or consumed, as in combustion. Also, the user must know the type and concentration of material present in order to select the appropriate cartridge for the atmosphere.

Self-Contained Breathing Apparatus

SCBAs are extensively regulated by federal legislation. Federal regulations require that these devices be tested and approved by the Mine Safety and Health Administration (MSHA) and by the National Institute of Occupational Safety and Health (NIOSH). The following diagram shows typical SCBA components.

Typical SCBA Components



Inspection and Storage

Inspect your PPE and store it properly to keep it in good condition. Good care minimizes repairs and extends the life of your equipment.

The sample inspection checklist on the following page can serve as an initial guide for developing more extensive procedures.

TABLE 7.1 SAMPLE PPE INSPECTION CHECKLIST

SCBA	TURNOUT GEAR

• Check that all connections are tight
• Check materials (including harness and straps) for pliability, signs of deterioration, and signs of distortion
• Check for proper setting and operation of regulators and valves (according to manufacturer's recommendations)
• Check that bottle is securely fastened to pack/holder and is full
• Check hydrostatic test date for bottle
• Check operation of alarm(s), check P.A.S.S. device if attached to SCBA
• Examine face shield and lenses for cracks and fogginess
• Inspect SCBAs: daily or at shift change; before and after each use; at least monthly when in storage; every time they are cleaned
	Coats and Trousers:
	• Examine outer shell, liner materials, wristlets, collars, and hoods for evidence of:
	  • Contamination: soiling, stains, discoloration, deterioration
	  • Physical damage: tears, cuts, punctures, abraded areas
	  • Thermal damage: brittleness, charring, stiffness, melted areas
	• Check stretch recovery of hood and wristlet materials
	• Examine condition of all seams, looking for loose stitching or lifted tape of moisture barrier seams
	• Examine hardware (snaps, hooks and dees, zippers) for signs of corrosion
	• Examine trim for loss of luster, abraded areas, and evidence of melting
	• Inspect after cleaning
	Helmets:
	• Examine shell for: discoloration, pitting, separation, impact/puncture damage, and evidence of melting
	• Examine face shield for: scratches, cloudiness, and evidence of melting
	• Examine retention/suspension system for discoloration, evidence of thermal damage, and physical defects
	• Examine helmet hardware for corrosion and trim for loss of luster, abraded areas, and evidence of melting
	• Inspect after cleaning
	Gloves:
	• Examine outer shell and liner materials and wristlets for evidence of damage and contamination
	• Examine condition of all seams, looking for loose stitching or lifted tape of moisture barrier seams; check to ensure that liner has not separated from outer shell
	Footwear:
	• Examine boot outer and liner materials for evidence of damage and contamination
	• Examine condition of soles for punctures, cuts, or embedded items (for example, nails)
	• Examine hardware (eyelets, stud posts, zippers) for signs of corrosion

DECONTAMINATION

Activity

If time permits, set up a decontamination line and have students practice decontaminating one another.

Decontamination or “contamination reduction” is the process of removing or neutralizing contaminants that have accumulated on personnel and equipment. This process is critical to health and safety at hazardous materials response incidents.

Fire fighter in liquid splash protective gear undergoing decontamination

Decontamination protects responders from hazardous substances that may contaminate and eventually permeate their protective clothing, respiratory equipment, tools, vehicles, and other equipment used at the emergency scene. It also minimizes the transfer of harmful materials into non-contaminated clean areas, helps prevent mixing of incompatible chemicals, and protects the community by preventing movement of contaminants from the site.

Preventing Contamination

To prevent contamination, you should establish work practices and standard operating procedures that minimize contact with hazardous substances. At an emergency scene, for example, avoid leaks, spills, and obvious sources of hazards, as well as indirect contact with potentially contaminated surfaces.

Questions

???

Ask the students to describe some of the ways they avoid contamination on the job.

Types of Contamination

Contaminants may be located on the surface of personal protective equipment or may have permeated into the PPE material. Surface contaminants are often easy to detect and remove; however, contaminants that have permeated a material are difficult or impossible to detect and remove. If contaminants that have permeated a material are not removed by decontamination, ongoing exposure may result.

Questions

???

Ask the students if they have assisted in decontamination, or if they have ever been decontaminated themselves. Find out what chemicals were involved, and how contamination occurred.

Activity

Distribute copies of your department's SOPs for decontamination and discuss the specific procedures with the students.

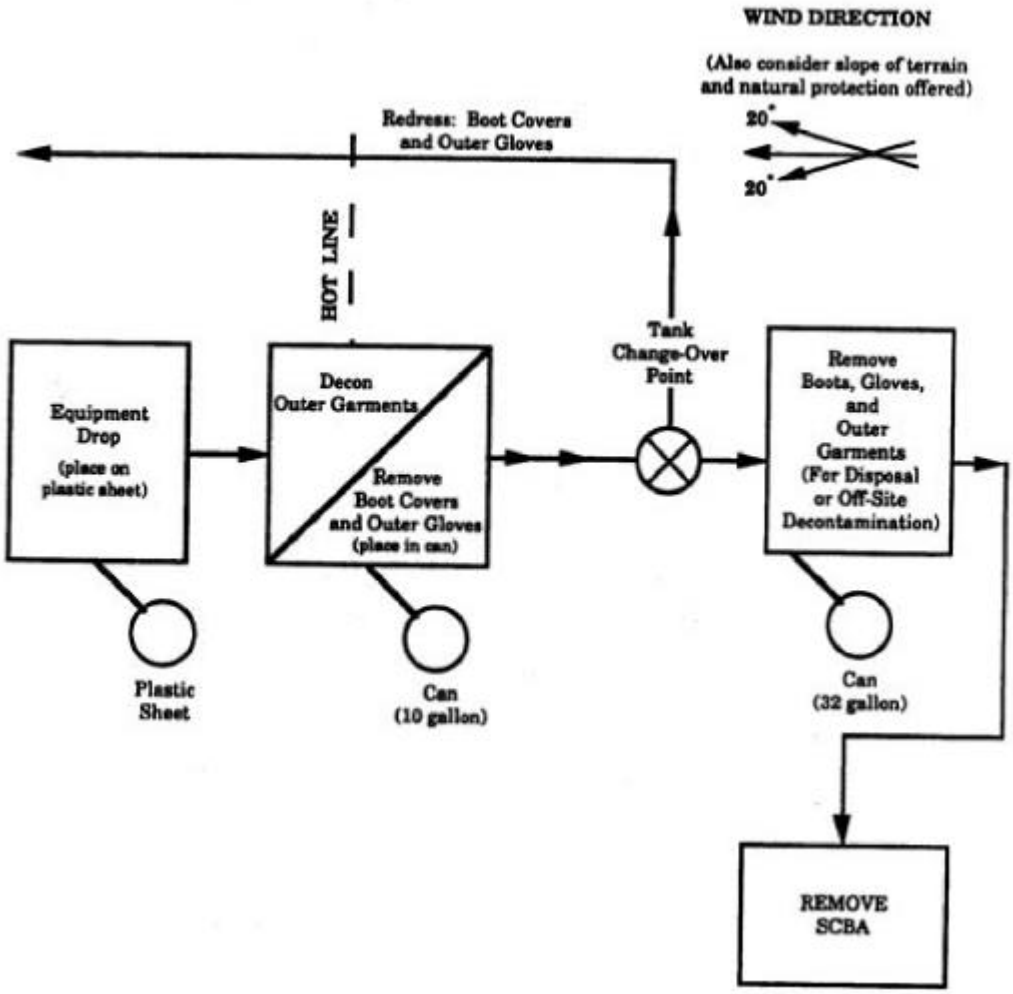
Decontamination Methods

All personnel, clothing, equipment, and samples leaving the Hot Zone (where there is potential exposure to hazardous materials) must be decontaminated to remove any harmful chemicals or infectious organisms. Decontamination methods physically remove contaminants, disinfect biologic contaminants, or remove contaminants by a combination of physical and chemical means. Decontamination allows the responder to safely remove the protective clothing.

Decontamination Plan

A decontamination area must be set up before any personnel or equipment enter areas where the potential for exposure to hazardous substances exists. Decontamination procedures provide an organized process by which levels of contamination are reduced. This process is a series of procedures performed in a specific sequence. For example, outer, more heavily contaminated items (e.g., outer boots and gloves) should be decontaminated and removed first, followed by decontamination and removal of inner, less contaminated items (e.g., jackets and pants). A *minimum* decontamination layout is shown on the following page.

Decontamination Plan



ll equipment used for decontamination must also be decontaminated and/or disposed of properly. Buckets, brushes, clothing, tools, and other contaminated equipment should be collected, placed in containers, and labeled. Also, all spent solutions and wash water should be collected and disposed of properly. Clothing that is not completely decontaminated should be placed in plastic bags pending further decontamination and/or disposal.

Activity

Conduct Activities 7-1 and 7-2 after you discuss decontamination and emergency decontamination.

Emergency Decontamination

In addition to routine decontamination procedures, emergency decontamination procedures must be established. In emergency decontamination, the primary concern is to prevent severe injury or loss of life. At the same time, contaminants must be removed to prevent ongoing exposure to the patient and exposure to response personnel through secondary contamination. Even in an emergency, decontamination should follow a specific sequence.

Outer, more heavily contaminated items are decontaminated and removed first, followed by less contaminated articles of clothing. Gloves and boots or shoes may require more extensive decontamination than shirts or jackets. In cases where the victim is wearing street clothing or other materials that are not easily decontaminated, the outer clothing should be removed.

Dry contaminants should be brushed off the skin. Liquid contaminants can be blotted dry. Care must be taken to keep all contaminants away from the face and open wounds. Affected skin and mucous membranes (including the eyes) should be flushed with lukewarm water for at least 15 minutes. Cold water can be used if lukewarm water is not available. Large amounts of water must be used when corrosives are involved.

Conclusion

Briefly review the key points covered in this section.

UNIT 8:
SCENE MANAGEMENT

Learning Objectives

By the end of this section, participants will be able to:

- List the components of an incident management system
- Briefly describe the functions of sections within the incident management structure
- Define hot, warm, and cold zones
- Describe the First Responder's initial actions on arriving at a hazardous materials incident
- Describe decontamination procedures
- Describe termination procedures
- Explain why post-incident analysis and evaluation is a necessary element of scene management

Instructor Notes

Purpose of Unit:

This unit describes the incident management system and explains how it can be applied to any type of emergency, including radiation accidents. Two case studies (one involves a potential radiation exposure, the other involves toxic chemicals) are compared and contrasted.

Materials and Supplies:

Chalkboard or flip chart
Videocassette recorder and Training for Radiation Emergencies: First Responder Operations videotape

Instructor Preparation:

This section compares and contrasts the Springfield, Massachusetts and Cleveland, Ohio case studies. If you have other incidents in mind, particularly incidents that your students might be familiar with, use them instead. The point is to assess how a scene management system can be, and should be, applied to every emergency.

As an option, and if you are limited by time, combine Activities 8-1 through 8-6 into a single 30-minute activity at the end of the unit. Have the students discuss incident management positions, command structure, response objectives, hazard area set-up, the media, and termination for each incident.

INCIDENT MANAGEMENT SYSTEMS

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

Effective scene management depends on a well-defined structure that is outlined in standard operating procedures, routinely practiced, and used at all incidents. An operation without an incident management system leads to poor use of resources and endangers the health and safety of response personnel.

In situations involving hazardous materials, incident management systems are not only useful, they are required by regulations established by the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA). The regulations that specify the use of an incident management system are 29 CFR 1910.120 and 40 CFR 311, respectively. All fire fighters not covered by federal OSHA are covered by EPA regulation.

Key Points

An incident management system:

- **Places one person in charge**
- **Organizes personnel and tasks**
- **Eases communication**
- **Applies to small incidents as well as large ones**

An incident management system places one person in charge of an incident and guides deployment of personnel and equipment. It organizes personnel and tasks so that the person in charge is not overwhelmed. It eases communication by identifying reporting relationships and establishing a chain of command among personnel.

This type of systems approach applies to small incidents involving one or two companies as well as large incidents involving agencies outside the fire department and crossing jurisdictional lines.

System Positions

Incident Commander

Activity

Conduct Activity 8-1 as you discuss incident management positions.

The Incident Commander is the sole person in charge and is accountable for the actions taken at the incident. He or she is the highest authority at an incident scene, whether this individual is a fire fighter, fire chief, or a representative of another organization. The Incident Commander is responsible for establishing strategic goals (determining whether offensive or defensive operations are appropriate) and the tactical objectives to meet those goals. The Incident Commander's roles and responsibilities are described in 29 CFR 1910.120 (q)(3).

Many departments assign command to the first officer of the first arriving fire department company. This ensures that an individual is in charge of the incident from the beginning.

The initial Incident Commander remains in command until command is transferred or the incident is stabilized and terminated. Command may be transferred to an officer with more
command experience, more knowledge of hazardous materials, or other unique qualifications.

Support Staff

The Command Staff assists the Incident Commander. Since these are staff functions, their purpose is to support incident operations. None of these positions is directly involved in rescue, fire suppression, or hazard control, but they are essential to successful operations.

Safety

The Safety Officer position should be implemented at every hazardous materials incident. Though the Incident Commander has overall responsibility for the safety and health of fire department members at the scene, an Incident Safety Officer is appointed to help manage this task. The Incident Safety Officer assesses hazardous and unsafe situations at emergency incidents. In order to function effectively, this individual must have authority to prevent or stop unsafe acts that present an immediate danger to life or health.

Liaison

Numerous government agencies and private firms may become involved in hazardous materials incidents. The task of coordinating responding agencies may become too great for the Incident Commander, and a Liaison Officer may be appointed to assist in this function. The Liaison Officer helps to keep resources at a manageable distance from the Command Post while coordinating their efforts.

Public Information

A Public Information Officer may be appointed if the Incident Commander requires assistance in providing information to the public and the news media. There may be a great demand for information regarding an incident, or the news media may be particularly helpful in supplying evacuation information to the public. Like other staff positions, the Public Information Officer must be trained and practiced in the role before an incident occurs.

Activity

Conduct Activity 8-2 as you discuss command structure.

Command Staff

There are four functions that may be established in an incident and each answers directly to the Incident Commander.

The **Planning Section** is responsible for collecting, evaluating, and disseminating information about the incident and available resources.

The **Logistics Section** assists the Incident Commander in providing facilities and services to support personnel at the incident.

The **Finance (Administration) Section** is responsible for tracking all costs related to an incident.

The **Operations Section** is the Section most often activated by the Incident Commander. It is the Section that is responsible for most of the tactical planning and direct action.

Divisions, Groups and Sectors

Divisions

Divisions refer to multiple resources operating in a geographic location. A large hazardous material incident may be divided into more than one area--Division A, Division B, Division C, etc. Generally, division A is assigned to a geographical location at the front of the incident. Then additional divisions are assigned in a clockwise direction.

Groups

Groups refer to multiple resources assigned a function that may transverse divisions. Groups may also carry out a specialized task within a division.

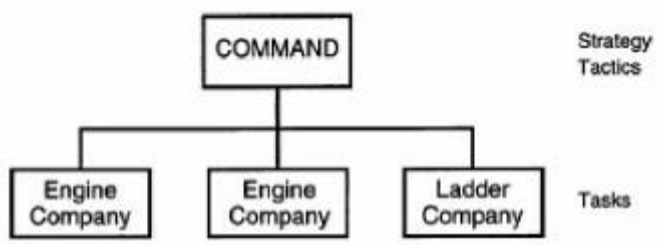
Sectors

Sectors can be based on either geographic or functional considerations. Sector is simply another term used by other incident management systems, to describe either a division or group.

Command Responsibilities

Regardless of the type or complexity of an incident, a command structure operates at three levels: the strategic level, responsible for overall incident command; the tactical level, representing grouped resources; and the task level, responsible for completing the objectives of individual companies or units. An example demonstrates how these levels are addressed at hazardous materials incidents. An incident, such as a dumpster fire, may start with only an engine company responding and the company officer filling the Incident Command function. Strategy, tactics, and tasks are formulated and carried out by this single unit.

Components are added as needed. For example, if the dumpster contains water-reactive materials and the application of water causes the fire to extend to a nearby building, the response may expand to involve two or three companies. The Incident Commander remains in charge, with those in charge of the responding companies answering directly to the IC.



Only in the smallest incidents can the Incident Commander continue to manage all of the major and strategic areas. If the incident escalates, he or she must delegate some responsibilities. If the fire in this example extends to several areas of the building, additional resources will be needed. These resources will be organized into Divisions/Groups or Sectors.

Response Objectives

There are a number of basic objectives that must be met by the first units and the commanding officer on arriving at the scene of a hazardous materials incident.

First, **establish command and secure the area.** Establish controlled access areas starting at an outside perimeter and work toward isolation of the contaminated area. After you secure the outer perimeter, establish warm and hot zones.

Activity

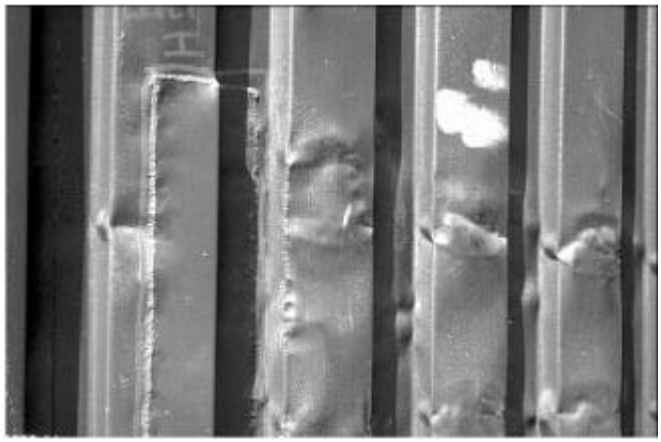
Conduct Activity 8-3 as you discuss response objectives.

Hazard area secured with fencing and signs

Survey the scene and size up the situation. Regardless of the hazard, the strategic priorities are the same: life safety (operating forces and civilians), incident stabilization, and property and environment conservation.

After initial sizeup and communication of incident status, **collect additional information.** Determine the identities, quantities, handling considerations, and locations of the involved hazardous materials; by what means the material is spreading; and the hazards likely to result from the spill or release.

Next, **evaluate container damage.** Use all available information to evaluate the stability of the hazardous material containers.



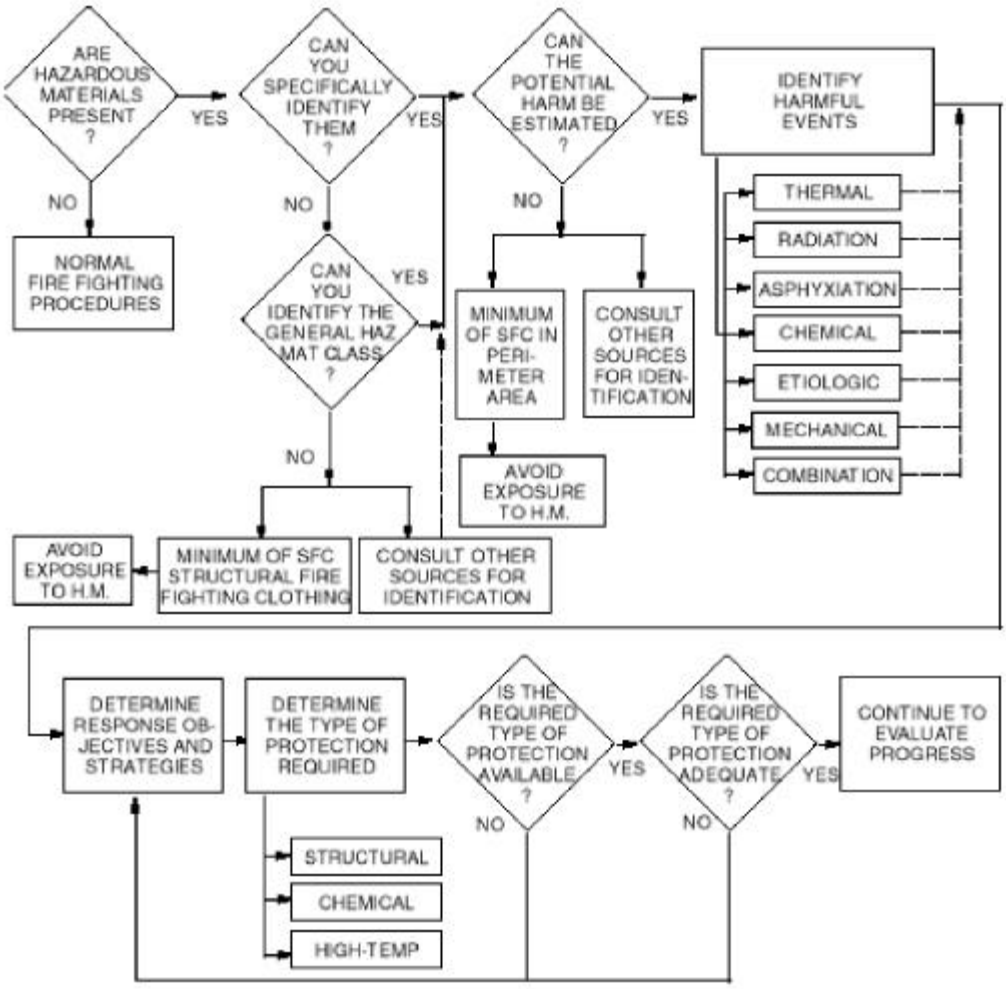
Damage to intermodal container containing radioactive materials

Assess vulnerable populations and evaluate the need for rescue and protective actions for groups of people. Rescue of endangered individuals at hazardous materials incidents should not be performed unless the safety of the rescuers can be assured.

Isolate the hazard. First Responder actions for isolating hazards are limited to defensive tactics only. While response recommendations found in references and advice from experts should influence the Incident Commander's decision regarding tactics, he or she must also weigh the risks and benefits of specific actions.

Continue to evaluate the situation and make decisions based on new information. Most experienced responders use a process for making decisions. A process ensures that decisions are arrived at in a logical, well thought-out way. An example of a decision-making process is shown on the following page.

A DECISION MATRIX



*SFC--- Structural Fire Fighting Clothing

ESTABLISHING A HAZARD AREA

As a First Responder, you may be involved in several different roles at hazardous materials incidents. One of your most important initial actions is isolating the hazard area by establishing zones.

Hot Zone

Activity

Conduct Activity 8-4 as you discuss hazard areas.

The hot zone (also referred to as the hazard zone, the restricted zone, or the exclusion zone) is the area in which the hazardous material is actually located. It is the area of maximum hazard and is restricted to essential personnel using appropriate protective clothing and equipment. Access to this area is tightly controlled at a single entry point, and no one is allowed to enter this zone for any reason without a “buddy.” Also, prior to entry, a backup team with the same number of members as the entry team must be standing by.

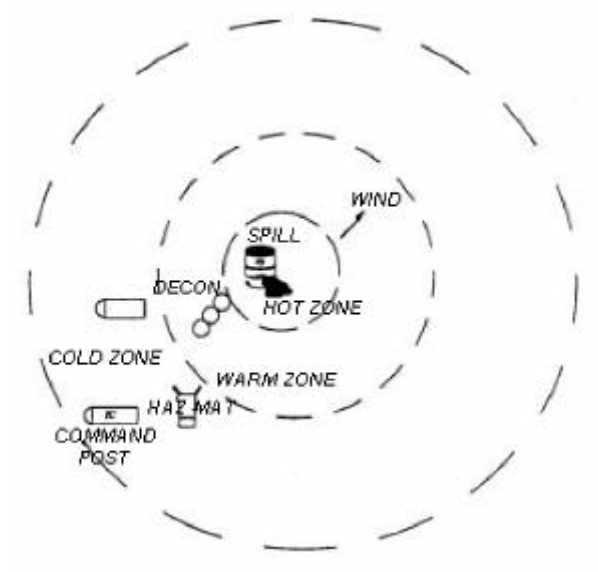
Time within the hot zone must be minimized through careful planning and monitoring. The entry team must have communication devices and alternate plans for communication if radios do not function. There must be an emergency recall system in case it becomes necessary to rapidly evacuate the area.

Warm Zone

The warm zone (also called the transition zone or the contamination reduction zone) is a transition area between the hot zone and the cold zone (clean area). This area, located away from the hazard, helps prevent contaminants from spreading to unaffected areas. Decontamination takes place in the warm zone, and personnel must use protective equipment appropriate to the level of hazard. The line that separates the hot zone from the warm zone is the hot line, and this may be marked with barrier tape.

Cold Zone

The cold zone is the area beyond the range of potential contamination. The public is excluded from this area to allow the fire department and other emergency response agencies to function. The command post, treatment area for decontaminated patients, and rehabilitation area for emergency response personnel are established in the cold zone.



Zone set-up at a hazardous materials incident

THE MEDIA

Activity

Conduct Activity 8-5 as you discuss how to deal with the media.

Whenever a hazardous material is involved in an incident, regardless of whether or not there is a release, the public is likely to assume it is a dangerous situation.

Although it is important that you know how to communicate with the media and the public in case you are acting as a public information officer, be aware that in most cases public information must come from a single authorized source.

Responding to Interview Questions

If you are to be interviewed, anticipate the questions the media will ask and prepare for them. In many cases, technical and hazard information can be supplied by the shipper or government agency. Avoid the pitfalls of an interview:

- Repeating the negatives
- Denial
- Attacking
- Responding to worst-case scenarios

Select three key points you want to address to the public, and formulate short, to-the-point responses that answer the question *and* focus on your key message.

When an interviewer poses a question, structure your response in the following way:

- Identify with interviewers by recognizing their concerns ("Yes, I used to think that, too..")
- Give information by describing what the hazardous material is, and what it does or does not do. Provide the facts.
- Explain the action the fire department and other responders are taking to control the situation.

Always keep in mind that the media may be more interested in building up the more sensational aspects of a story. Despite the precautions that may have been taken, the public perceives any hazardous materials as a serious threat, and the news media will focus on the danger angle.

TERMINATION

Key Points

Termination involves:

- **Transferring command**
- **Record-keeping**
- **Debriefing**
- **Post-incident analysis**

Termination of an incident should follow carefully developed procedures that include transferring command (if cleanup operations will continue beyond the emergency phase), record keeping, debriefing, and post-incident analysis. Though the environment surrounding a hazardous materials incident may have to be cleaned up, this is not the responsibility of fire fighters.

Records that should be collected may include logs from the Decontamination Officer/Leader, the Incident Safety Officer's report or log, and documents generated by the Incident Commander. Any written information about the materials involved, such as shipping documents or MSDSs, should be turned over to the Incident Commander.

Debriefing should occur as soon as possible after the incident has been stabilized. The debriefing process ensures that all participants have a basic understanding of what materials were involved and any relevant health risks. The Incident Commander should also take this opportunity to supplement reports with information from personnel operating at the scene.

Activity

Conduct Activity 8-6 as you discuss terminating an incident.

Post-Incident Evaluation

The post-incident evaluation is a key element in improving emergency response to hazardous materials incidents. The analysis may be used by the fire service only, or it may be shared with other agencies, industries, or private contractors that need the information for planning and prevention activities.

During the analysis, all aspects of the incident should be reviewed. The incident itself and relevant events leading up to the incident should be summarized, followed by a review of all procedures and responses by the fire department. These may include command and control, tactical operations, interagency cooperation, and resources and support services.

Health and safety issues related to the incident should be evaluated and follow-up extended to anyone exposed to the hazardous materials.

Information that is collected and reviewed as part of this process should be used to identify areas for improvement, standard operating procedures that should be revised, and implications for training. The information can also be used for pre-planning. In this way, review of the incident can have a very positive effect on your health and safety.

Conclusion

Briefly review the key points covered in this section.

UNIT 9:
PRE-INCIDENT PLANNING

LEARNING OBJECTIVES

By the end of this unit, participants will be able to:

- State the objectives of pre-incident planning
- Explain the process for developing a pre-incident plan
- List types of information needed to assess risks
- Explain how to assess community vulnerability
- List resources that may be considered when planning
- Describe environmental factors that should be considered when pre-incident planning

INSTRUCTOR NOTES

Purpose of Unit:

This unit reviews pre-incident planning for hazardous materials incidents. Pre-incident planning is a process that is similar to fire planning, with which students may already be familiar. The case studies discussed in Unit 8 are assessed here in terms of pre-incident planning.

Materials and Supplies:

Chalkboard or flip chart
Copies of a pre-incident plan for a local company
A blueprint for the building you are in (optional)
Slide projector and slides 100-111

Instructor Preparation:

Obtain a pre-incident plan for a local company well in advance of training. Make sure it covers most of the items addressed in this section. Obtain the blueprints for the building in which you are training, if possible. These will be useful when you have the students plan the building.

Contact your state Emergency Management Agency to obtain a copy of Annex D, the state Radiological Protection Plan required by SARA. This document establishes responsibilities and reporting structures within a radiological program.

INTRODUCTION

Introduction

Tell the students:

- **What they will learn in this section**
- **Approximately how long it will take**

Fire departments should begin planning and preparing for hazardous materials incidents long before they occur. Through pre-incident planning, hazards can be identified, resources appropriated, and personnel trained. First Responder responsibilities for pre-incident planning are determined by each jurisdiction.

The objectives of pre-incident planning are to prevent and prepare for incidents. Both are important and both save lives. Hazards can be identified and plans can be prepared before life threatening situations occur. Preparedness is not a new concept for fire fighters. For years, fire services have conducted pre-fire plans for buildings and used these plans during drills and actual fires. These same skills are used in pre-incident planning activities for hazardous materials incidents.

Activity

Show the students a copy of a pre-incident plan for a local company. Refer to this plan for examples as you discuss this topic.

HAZARD IDENTIFICATION

A good plan begins with identifying the types and locations of hazards within a community. It must also include a way to notify authorities of any change in status of a material, its quantity, or its location. The sample Pre-Incident Plan Form on the following pages lists the elements of a typical pre-incident plan.

Activity

If time permits,"pre-incident plan" the building you are in, using the form on the following pages. Allow the students to help complete the plan.

SAMPLE PRE-INCIDENT PLAN FORM

SECTION I - LOCATION INFORMATION

Location: _____

Building/Site Name: _____

Type of Business: _____

Building Size: Frontage: _____ x Depth: _____ = Area: _____

Owner: _____

Owner's Address: _____

Owner's Telephone: _____

Owner's Agent: _____

Agent's Address: _____

Agent's Telephone: _____

Emergency Contact: _____

Emergency Telephone: _____

Cleanup Contractor: _____

Prepared by: _____

SECTION II - BUILDING INFORMATION

Specific Property Use: _____

Number of Stories: _____

Age of Building: _____

Construction Type: 1st Type _____ _____% 2nd Type _____ _____%

1 = Fire Resistive
2 = Protective Non-Combustible
5 = Heavy Timber
6 = Unprotected

3 = Protected Ordinary
4 = Protected Wood Frame
7 = Unprotected Ordinary
8 = Unprotected Wood Frame

Relevant Features: _____

Type of Roof Construction: _____

Standpipes:
Exterior Connections: _____ Locations: _____

Interior Connections: Wet _____ Dry _____

Location	Type
_____	_____
_____	_____
_____	_____

Sprinkler Systems:

Exterior Connection Location:

% Coverage: Wet: _____ Dry: _____ Both: _____

Shutoff Location: _____

Valves: Open (Y/N) _____ Supervised (Y/N) _____ Zoned Areas (Y/N) _____

Other Extinguishing Systems (halon, CO 2 , dry powder, etc.):

Type: _____

Location: _____

Warning System:
Detection Type (heat, smoke, both): _____

Connection to Alarm (local, central, master, auxiliary):

Alarm Company: _____ Telephone: _____

Access and Entrances: _____

SECTION III - BUILDING HAZARDS

Common Hazards - List any common hazards (heating system, combustibles, transformers) in the building and their locations

Utilities - List type and location of utility shutoffs (natural gas, electrical)

Special Hazards - List any special hazards (acetylene, propane tanks, other chemicals) in the building and their locations, including types of containers and any containers (attach MSDS for each chemical)

SECTION IV - PROCEDURES TO BE USED IN THE EVENT OF A MAJOR SPILL/ RELEASE

(attach copies of both the facility plan and your department's plan)

SECTION V - HYDRANT LOCATIONS AND PLACEMENT OF APPARATUS

(attach a copy of the site plan with hydrants and preferred apparatus locations highlighted)

SECTION VI - TARGET HAZARDS IN THE AREA TO BE PROTECTED/ EVACUATED

(attach a copy of the site plan with specific hazards/vulnerable areas identified and highlighted)

SECTION VII - SITE PLAN

(attach a copy of a detailed site plan (8 ½" x 11" only)

Activity

Distribute copies of Annex D, the State Radiological Protection Plan and discuss responsibilities at a radiological incident.

Fixed Sites

If you are involved with developing pre-incident plans, you should visit all facilities that have been identified as housing hazardous materials. In addition to obtaining specific data on each hazardous material, you should review the facility's emergency plans. You can obtain specific data on hazardous substances from MSDSs. If, for some reason, MSDSs are not available or are incomplete, consult other references.

It is not always readily apparent that a site contains hazardous materials. The facility may be small and contain only very small quantities of hazardous materials (below the mandatory reporting levels), or the owners and operators may not be aware of the hazards presented by the materials they are using. At times, you must be a detective. You must look at what the facility is manufacturing, how supplies are stored, and what kind of equipment is being used. You also need to recognize clues that hazardous materials are present. Clues include obvious signs such as placards and labels or subtle signs such as specific processes and procedures.

Transportation Routes

Fixed-site industrial facilities are not the only locations of potential hazardous materials incidents. Transportation corridors, including waterways and highways, represent potential sites for incidents and must be planned. Hazardous materials incidents may also occur at landfills, construction sites, retail areas, underground storage tanks, utility right-of-ways, and rail yards.

The hazard identification phase of pre-incident planning primarily involves gathering information. Once you have begun gathering information, you should start developing a comprehensive plan of action.

HAZARD ANALYSIS AND RISK ASSESSMENT

Slides

Show slides 100-111 and ask the students the following questions:

- **What hazards would you expect to find if you planned these sites?**
- **What potential hazards would you look for?**
- **What are the vulnerable areas?**
- **What are the vulnerable populations?**

The next step is hazard analysis and risk assessment. This is the process during which you:

- Identify the potential for an incident that will cause damage to life, property, or the environment
- Analyze the risk or probability of an incident occurring
- Identify vulnerable areas

Identify the Potential

Use the information obtained from inspections and pre-incident planning visits, along with data received from facilities, reference textbooks, and other agencies, to determine the likelihood that an incident will occur. This will also help you estimate the risks an incident would present to fire service personnel, civilians, property, and the environment.

Analyze the Risk

To assess risks, you need information on:

- Transportation frequency and routes
- Specific risks to people and property in vulnerable areas
- Past experiences with the material and the facility
- Control and safeguard mechanisms currently in place

A thorough hazard identification and risk assessment identifies fixed facilities of most concern to a community. Site-specific pre-incident plans should be developed for those facilities. Before you conduct an actual inspection of the sites, review all available information on the facility, including:

- Previous inspection reports
- Drawings
- Permit applications
- History of fires or chemical incidents
- MSDSs or lists of chemicals

Identify Vulnerable Areas

For planning purposes, the population and facilities located within susceptible areas are considered vulnerable. Information about the vulnerable population can be the basis for planning activities that may be needed, such as evacuation.

After a site visit, estimate the residential population, as well as the number of persons who may be present at commercial, industrial, and recreational facilities. Note high volume roadways and water supply sources as well as facilities with high-density or dependent populations.

Community characteristics can be used to determine the relative degree of vulnerability. The level of vulnerability depends on the anticipated difficulty of protecting the population and on the number of persons that could be exposed if a hazardous materials incident were to occur.

ANALYSIS OF RESOURCES

Resources include everything needed to control an incident such as personnel, supplies, equipment, and funding. Resources also include knowledge, expertise, access to other agencies, and regulatory processes.

Required Resources vs. Available Resources

Activity

Ask students from various departments to briefly describe their resources in terms of:

- **Personnel and training**
- **Specialized equipment**
- **Specialized training**
- **Mutual assistance agreements**

After determining what resources will be needed to appropriately respond to an incident, make an inventory of actual resources. If there is a discrepancy between the two, a plan must be developed to work within limitations or to obtain the necessary resources. This could include measures to prevent an incident, reduce the risks, limit the consequences, or improve response capabilities.

Your available resources and training help dictate how you handle hazardous materials incidents. One fire department may have the resources and training to handle large scale hazardous materials incidents while another jurisdiction may need to develop a mutual support response from a neighboring department. For yet another, the best approach may be to identify the hazard and take steps to prevent the incident.

None of these approaches is wrong. The right response is working within limitations of resources and training. The wrong response is going beyond those limitations.

Activity

Conduct Activity 9-2 as you discuss resources.

Not all communities need every type of equipment on the market, nor do they all need the most detailed technical training available. Each community's needs depend, in part, on the number of incidents likely to occur and the availability of outside resources, such as a hazardous materials emergency response team in a nearby city, a readily available industry expert, and state or federal agencies that are available to assist with incident response.

Incidents that consume large amounts of resources do not occur frequently. Rather, it is the smaller incidents, such as a spilled five-gallon pail, a leaking gas tank on a car, or plastic burning in a building that represent the most frequently encountered hazardous materials incidents. Ironically, these are the incidents for which there is the least planning and the ones often over-looked as health and safety risks.

During the preparation phase, you must list and categorize all possible sources of assistance, as well as all available equipment
and supplies. Inventory the capabilities and limitations of your department or company. Decisions can then be made about who, or what agency, will be able to augment your resources.

Outside agencies that may be of assistance and with whom you should plan include:

- Other fire departments and hazardous materials response teams
- Public health agencies
- Chemists and industrial hygienists
- SERC
- LEPC
- State and local environmental agencies
- Industry response organizations
- The water authority
- Universities with chemists, toxicologists, and public health specialists
- Federal agencies (EPA, OSHA, and Coast Guard)
- Hazardous materials cleanup companies
- Utility companies

If these outside agencies and organizations are to be used, their limitations and capabilities must be understood and incorporated into the planning process. As an emergency response plan is developed, each resource must be consulted and included in the process.

Large numbers of resources are needed less frequently when pre-incident planning activities lead to prevention. As facilities are planned, there are many opportunities to initiate educational programs, increase civilian awareness to the potential for hazardous materials incidents, and initiate corrective actions to prevent incidents. Prevention may not be as exciting or as interesting as hazardous materials response, but it does save valuable resources, including lives and health.

Conclusion

Briefly review the key points covered in this section.

Activity

Conduct the Post-Test to the course. Allow about 30 minutes, then collect the students' answers.

UNIT 9
APPENDIX

REGULATIONS

This material was designed to provide emergency responders with background information on some of the regulations that have pioneered changes in the fire service. This information has been summarized to address fire service interests, and is not intended to be all inclusive or to provide legal interpretation.

A. Federal Regulations

1. RCRA

In 1976, Congress passed the Resource Conservation and Recovery Act (RCRA) which allowed the federal government to regulate the creators, transporters, and treatment and disposal operators of hazardous wastes. This was the federal government's first effort at managing hazardous wastes and their effect on public health and the environment. However, this act did not affect the many hazardous waste sites that had been created prior to the passage of RCRA—many of which were abandoned and contained unknown quantities of unknown wastes.

2. CERCLA

In order to address the cleanup of those sites not covered under RCRA, Congress enacted the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA). CERCLA quickly became known as Superfund, in part because of the funds that it created for the cleanup and proper reclamation of abandoned and inactive hazardous waste disposal sites. Specifically, this act created a five-year program that allowed the government to spend $1.6 billion to clean up hazardous waste sites. It further allowed the federal government to negotiate cleanups by responsible parties, to sue such parties for the cost of cleanup, or to sue for orders directing responsible parties to clean up the sites themselves.

In addition, Superfund provided for the creation of the *Agency for Toxic Substances and Disease Registry* (ATSDR). The ATSDR is charged with carrying out the health-related responsibilities of CERCLA and RCRA. For example, the agency collects, maintains, analyzes, and disseminates information related to human exposure to toxic or hazardous substances. It also assists the Environmental Protection Agency (EPA) in identifying hazardous waste substances that should be regulated, and performs numerous other activities. However, the bulk of responsibility for cleanup and management was delegated to EPA.

Superfund progress was very slow and expensive. Numerous lawsuits had to be brought against responsible parties; this used up a tremendous amount of Superfund money and delayed cleanup progress at many of the sites. In addition, CERCLA had neglected to include a statement of principles or goals and objectives. As a result, there seemed to be much confusion over exactly what outcomes were expected.

3. SARA

In an effort to overcome these obstacles, and after much discussion and many drafts, Congress passed the Superfund Amendments and Reauthorization Act of 1986 (SARA). The overriding purpose of SARA was to expand and accelerate the cleanup efforts originally established by CERCLA. In order to do this, SARA provided additional funding ($7.5 billion) and time (an additional 5 years) to the original Superfund program. SARA also made changes in the law to promote speedier action and a more definitive direction for the cleanup efforts.

a. SARA TITLE I
PROVISIONS RELATING PRIMARILY TO RESPONSE AND LIABILITY

SARA Title I establishes new worker protection standards which address hazardous materials issues such as, but not limited to: site analysis, training, medical surveillance, protective equipment, decontamination procedures, and emergency response. This section also addresses the establishment of certain grant programs, including the hazardous waste worker training grant that sponsored this training program.

b. SARA TITLE II
MISCELLANEOUS PROVISIONS

SARA Title II deals with various provisions such as financial liability, insurance, oversight and reporting requirements, and, more importantly, to response personnel and the transportation of hazardous materials.

c. SARA TITLE III
EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW

SARA Title III, often referred to as "The Emergency Planning and Community Right-to-Know Act of 1986," contains the SARA provisions most relevant to fire fighters. These provisions encourage communities and emergency responders to play active roles in pre-incident planning and prevention. Title III is made up of three subtitles that may be further broken down by section. Those sections most relevant to first responders are listed below:

Subtitle A: Emergency Planning and Notification

Section 301: *Establishment of state commissions, planning districts, and local committees*

Section 302: *Substances and facilities covered and notification procedures*

Section 303: *Comprehensive emergency response plans*

Section 304: *Emergency notification*

Section 305: *Emergency training and review of emergency systems*

Subtitle B: Reporting Requirements

Section 311: *Material Safety Data Sheets*

Section 312: *Emergency and hazardous chemical inventory forms*

Section 313: *Toxic chemical release forms*

Subtitle C: General Provisions

The emergency planning sections were designed to help state and local governments develop greater response and preparedness capabilities. They require that each state establish a *State Emergency Response Commission* (SERC), which in turn must designate local emergency planning districts and appoint *Local Emergency Planning Committees* (LEPCs).

The LEPCs' primary responsibility is the development of emergency response plans. These plans help prepare communities for potential hazardous materials emergencies.

In preparing their emergency response plans, LEPCs must:

- Identify facilities and transportation routes of potentially hazardous substances
- Establish emergency response procedures
- Designate a community coordinator and facility coordinators to implement the plan
- Devise methods for identifying potential releases and the area and population likely to be affected
- Identify available emergency equipment and facilities and those individuals responsible for them
- Develop evacuation plans
- Develop standards for an emergency response personnel training program
- Develop a plan for rehearsing emergency response plans

The emergency notification sections of Title III require that facilities immediately notify their LEPCs and SERCs of any hazardous materials releases meeting or exceeding reportable quantities. At a minimum, notification must include the chemical name, the quantity released, and possible health risks. Facilities must also prepare formal, written notices regarding these releases. The Community Right-to-Know reporting requirements state that facilities using, making, or storing certain chemicals in certain quantities must provide Material Safety Data Sheets (MSDSs) or a list of MSDS chemicals to the LEPC, the SERC, and the local fire department. Local fire departments, LEPCs, and SERCs cannot dictate how the reporting is to be done; SARA dictates reporting procedures.

Toxic chemical release reporting is intended to inform the public as well as government officials about toxic chemical releases. Facilities are responsible for submitting (to EPA and state officials) data on releases of specified chemicals that occurred during the previous calendar year.

d. SARA TITLE IV
RADON GAS AND INDOOR AIR QUALITY RESEARCH

Title IV of SARA addresses issues that are most directly related to non-emergency work.

4. OSHA 1910.120

OSHA 1910.120 (section q) addresses six main issues that have an impact on fire fighters and other emergency response personnel:

- **Medical surveillance programs**
  - Established by the employer
  - Required for members of hazardous materials response teams
  - Required for all personnel who become exposed to hazardous materials, especially those experiencing symptoms of exposure

- **Training programs**
  - *Minimum* training requirements include:
    - Eight hours of training for operations level first responders
    - An additional 24 hours of training for hazardous materials technicians, specialists, and incident commanders
  - Topics include, but are not limited to:
    - Care and use of chemical protective clothing
    - Techniques and procedures to stop or control leaks
    - Clothing and equipment decontamination
- **Emergency response planning**
  - Required for fire departments who respond to hazardous materials emergencies
  - Minimum planning components include:
    - Pre-incident planning
    - Personnel roles, lines of authority, training, and communications
    - Emergency recognition and prevention
    - Site security and control
    - Evacuation routes and procedures
    - Decontamination
    - Emergency medical treatment
    - Critique of response
    - Personal protective equipment
- **Incident management systems**
- **Decontamination procedures**
- **Chemical suit testing**

5. OSHA 1910.1200

OSHA's Hazard Communication Standard (1910.1200), commonly known as the "Worker Right-to-Know Rule," applies to all employers and, therefore, protects the interests of all workers. Specifically, this regulation is intended to provide all employees who work with or around hazardous materials easy access to hazard information about these materials. It requires that employers make MSDSs readily available to employees. It further requires that employers provide annual employee training to identify where MSDSs are stored and how MSDS information should be interpreted. OSHA 1910.1200 not only preempts state hazard communication laws in states without state OSHA plans, it also requires federal OSHA approval for state hazard communication laws in states that operate their own OSHA programs.

OSHA also develops and oversees numerous other regulations that are not necessarily related to hazardous materials, but pertain to the health and safety of workers in other ways.

6. Hazardous Materials Transportation Act

This act gives the Department of Transportation (DOT) regulatory authority to establish transportation regulations such as placarding and labeling of hazardous substances, container and vessel specifications, and limitations on the quantities and/or types of materials that may be transported under certain conditions. In addition, the DOT oversees inspection and compliance with these regulations. Detailed information on DOT regulations can be found in Title 49 of the Code of Federal Regulations.

As part of the DOT, the United States Coast Guard (USCG) is responsible for regulating transportation of hazardous materials on navigable waters. The USCG maintains the Chemical Hazards Response Information System (CHRIS), which provides health and safety information for responders to hazardous materials spills.

7. Environmental Protection Agency

The EPA is responsible for regulation, control, and management of air and water pollution, hazardous waste disposal, noise, radiation, toxic substances, and licensing pesticides, fungicides, and rodenticides. SARA has expanded EPA's responsibilities to include occupational health and safety standards (EPA's 40 CFR 311) identical to OSHA 1910.120 for state and local government workers not covered by OSHA.

B. State and Local Regulations

Many state and local governments are developing their own regulations pertaining to the manufacture, storage, and transportation of hazardous materials within their jurisdictions. While these regulations must at least meet the minimum federal requirements and must not be inconsistent with federal regulations, they may be somewhat different from federal regulations. This has the potential for creating an untold number of different regulations from state to state, and possibly from locality to locality. It could become a tremendous burden for anyone transporting hazardous materials through different localities and states to understand and comply with each of these regulations. The transportation industry is working with individual jurisdictions and the federal government to alleviate this problem.

As previously mentioned, Title III of SARA mandates that each state establish a SERC (State Emergency Response Commission), LEPCs (Local Emergency Planning Committees), and local emergency planning districts. The SERC designates the local emergency planning districts. LEPCs must include representatives from each of the following departments/interests: state and local government, police, fire, civil defense, public health, environment, medical treatment, transportation, affected facilities, community groups, and the media.

Each LEPC is responsible for developing a district-wide emergency response plan; establishing rules pertaining to the transportation, storage, and use of hazardous materials in their district; notifying the public about LEPC meetings and activities; establishing public inquiry procedures; and evaluating available resources. The emergency response plans are reviewed by the SERC, which also oversees other LEPC activities.