DOCUMENT RESUME

ED 213 863 CE 031 486

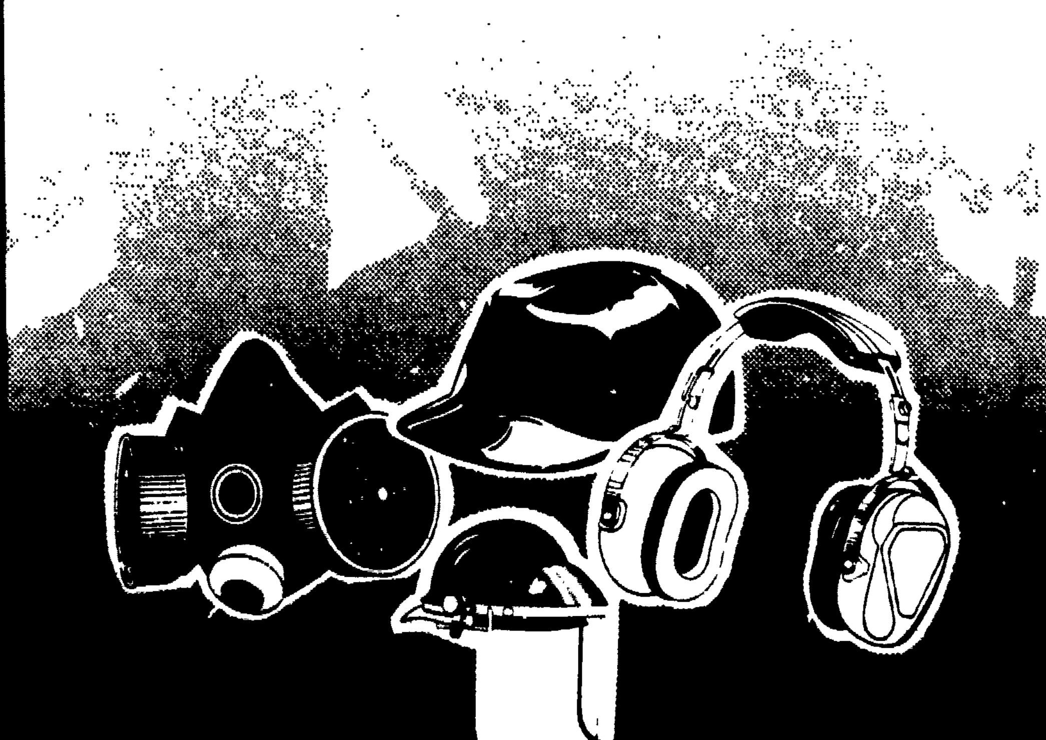
TITLE	Hazardous Materials Safety. Module SH-29. Safety and Health.
INSTITUTION	Center for Occupational Research and Development, Inc., Waco, Tex.
SPONS AGENCY	Office of Vocational and Adult Education (ED). Washington, DC. Div. of National Vocational Programs.
PUB DATE	81
CONTRACT	300-79-0709
NOTE	45p.; For related documents see CE 031 450-507.
AVAILABLE FROM	The Center for Occupational Research and Development, 601 Lake Air Dr., Suite C, Waco, TX 76710 (Instructor Guides, $9.75 each; Learning Modules, $3.00 each. Entire set of Learning Modules available as two subsets: SH-21, SH-41, SH-43, SH-45, and SH-48, $12.00; remaining 45 modules, $97.50).
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Behavioral Objectives; *Health Education; *Learning Activities; Learning Modules; Poisoning; Postsecondary Education; *Safety Education; Secondary Education; Special Health Problems; *Vocational Education
IDENTIFIERS	Compressed Gas Equipment; Explosives; *Hazardous Materials; *Occupational Safety and Health

ABSTRACT

This student module or hazardous materials safety is one of 50 modules concerned with job safety and health. This module provides information about the types of hazardous materials, the effects of each type, and general guidelines regarding the handling of these materials. Following the introduction, 15 objectives (each keyed to a page in the text) the student is expected to accomplish are listed (e.g., Define corrosive and name two principal hazards). Then each objective is taught in detail, sometimes accompanied by illustrations. Learning activities are included. A list of references and answers to learning activities complete the module. (CT)

SAFETY AND HEALTH

HAZARDOUS MATERIALS SAFETY



MODULE SH-29

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This work was developed under contract number 300790709 for the U. S. Department of Education, Office of Vocational and Adult Education.

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The Center for Occupational Research and Development
601 Lake Air Drive, Suite C
Waco, Texas 76710

INTRODUCTION

Modern manufacturing involves the use of a wide range of hazardous materials. Literally thousands of substances handled daily in America's workplaces have the potential to cause harm to the workers who encounter them. More and more employees are learning that they must exercise caution in dealing with the materials of their occupation.

Hazardous materials may cause cancer or birth defects, lead to death by asphyxiation, bring about damage to body systems, produce inflammation of the skin or eyes, burst into flame, or explode. Some hazardous materials may strike a sudden and deadly blow, as in these cases:

- Seventeen days after cutting cadminum-plated bolts with an oxygen propane torch in an underground vault, a 56-year old welder died as a result of cadmium exposure.
- In a Colorado industrial plant, a thermostat ruptured at 600°F. Dangerous concentrations of mercury vapor hospitalized six men.

Other hazardous materials may take a less obvious toll, working over a period of time to undermine the health and shorten the lives of workers, as in the following situations:

- Of 6,000 men who have been uranium miners, an estimated 600 to 1,100 will die during the next 20 years as a result of radiation exposure, principally from lung cancer.
- A New Mexico farmer fed grain that had been treated with methyl mercury to his hogs. One of the hogs was later slaughtered, and the family ate the meat. Three of the children later developed severe brain damage, and the pregnant mother gave birth to a severely retarded son. The tragic occurrences were traced to the methyl mercury in the hog feed.

Some hazardous materials are relatively new; others are found in the environment and have been on the earth at least as long as human beings have been. Whatever their origin, these materials are now part of modern life, and great benefits are derived from them. If hazardous materials are to be used without a sacrifice of life or health, however, workers must develop a respect for their hazard potential and a working knowledge of the precautions required for their safe use.

This module provides information about the types of hazardous materials, the effects of each type, and general guidelines regarding the handling of these materials. The Department of Transportation classification system is the basis for the discussion on hazardous materials.

OBJECTIVES

Upon completion of this module, the student should be able to:

1. List and describe nine categories of hazardous materials. (Page 3)
2. Identify three physiological effects from hazardous materials. (Page 6)
3. Define flammable liquids, using the terms flash point, auto-ignition temperature, and flammable range. (Page 9)
4. Explain the potential hazard of materials that carry the flammable solid label. (Page 14)
5. List 15 of 20 precautionary measures for handling or working around flammable materials. (Page 16)
6. Identify three conditions to which commercial explosives are sensitive, the types of explosive materials used commercially, and a general rule for persons not trained in the use of explosives. (Page 21)
7. List five precautions for handling and storing explosives. (Page 23)
8. Explain five procedures for safe handling of compressed-gas cylinders. (Page 25)
9. State the hazard associated with oxidizing materials. (Page 28)
10. Identify the three ways that poisonous materials enter the body and four factors that determine how the body reacts to exposure. (Page 29)
11. Define TLV and explain the three categories of TLV. (Page 31)
12. Identify four ways in which worker contact with a harmful substance may be prevented or minimized. (Page 33)
13. Identify the principal hazards and types of protection associated with radiation exposure. (Page 34)
14. Define corrosive and name two principal hazards. (Page 36)
15. Define the etiologic classification of hazardous materials and identify where etiologic hazards may exist. (Page 38)

OBJECTIVE 1: List and describe nine categories of hazardous materials.

A precise definition of hazardous materials is not easy to construct. After all, to a nonswimmer, even ten feet of water may be considered a hazardous material. Household bleach is used in millions of homes with no harmful effects, but if it is mixed with ammonia, the resulting fumes can be fatal. Flour seems a benevolent substance, but finely suspended flour dust filling a closed room has the explosive potential of dynamite. Clearly, the potential hazard of a substance depends to some extent on how and where that material is used. Any substance that can cause harm or injury unless dealt with carefully can be considered a hazardous material.

The U.S. Department of Transportation (DOT), which issues regulations regarding transportation of hazardous materials, uses a system of nine classes of hazardous materials. These classes are listed below and described in the following text:

- Flammable liquids.
- Flammable solids.
- Explosives.
- Compressed gases.
- Oxidizing materials.
- Poisons.
- Radioactive materials.
- Corrosives.
- Etiologic (disease-producing) agents.

Flammable liquids are those that release enough vapor to form burnable mixtures with air at temperatures below 100°F. Vapors from flammable liquids can catch fire when they reach a certain concentration in air. Some frequently used flammable liquids are carbon disulfide, acetone, benzene, gasoline, and turpentine.

Flammable solids are materials that can ignite easily due to friction, chemical changes, heated surfaces, or absorption of moisture. Flammable solids include agricultural dusts, metal filings, textile fibers, and other particulate matter.

An explosive is any chemical compound, mixture or device that has as its primary function the instantaneous release of large amounts of gas or heat. Examples of explosives are lead azide, black powder, photographic flash powder, flares, and small arms ammunition. Some materials that are not classified as explosives may have explosive potential under certain circumstances.

A compressed gas is any material that is compressed in its gaseous state at an absolute pressure higher than 40 pounds per square inch (psi) at 70°F. Compressed gases are usually stored in cylinders or tanks that must be properly constructed and handled with care to prevent hazards associated with pressure. A number of compressed gases are highly flammable. Some examples of compressed gases are acetylene, carbon dioxide, methane, and oxygen.

Oxidizing materials are those that support the combustion of other materials. The primary oxidant is oxygen found in air.

Poisons, or toxic materials, have an adverse effect on human beings. They range from extremely dangerous materials, which, if inhaled in small amounts, are enough to kill a person, to materials that are hazardous only if they are ingested or contact the skin. Examples of poisons are beryllium, phosgene, arsine, and carbon tetrachloride. Certain other materials such as tear gas are classified as irritating; these materials give off intensely irritating fumes that may cause inflammation of breathing passages.

Radioactive materials, such as those that emit alpha, beta, gamma, and X-rays, are hazardous because of their ability to damage living cells and to affect genetic patterns.

Corrosives are a broad category of hazardous materials. Some corrosives are liquids; others are solids; many are capable of causing visible destruction or permanent changes in human tissue at the point of contact. Some corrosives are also extremely poisonous; others are flammable. Corrosives are also known to "eat" into metals, causing them to disintegrate.

Etiologic agents are biological materials such as viruses or bacteria that cause human disease.

These nine DOT classifications are used for labeling and transportation purposes. Workers need to understand what the DOT classifications mean and what kind of precautions to take with each type of hazardous material.

ACTIVITY 1:*

Match the term on the left with its description or examples on the right. Use each example only once.

___	1.	Etiologic.	a.	Cause destruction or damage in human skin tissue and other materials.
___	2.	Compressed gases.	b.	Disease-causing agents.
___	3.	Flammable solids.	c.	Can affect genetic patterns.
___	4.	Poisons.	d.	May kill or have adverse effects on humans.
___	5.	Explosives.	e.	Stored in cylinders or tanks.
___	6.	Corrosives.	f.	Support combustion.
___	7.	Radioactive materials.	g.	Will burn readily.
___	8.	Oxidizing materials.	h.	Produce ignitable vapors at a temperature of 80°F or below.
___	9.	Flammable liquids.	i.	Lead azide, black powder, photographic flash powder.

*Answers to Activities appear on page 39.

OBJECTIVE 2: Identify three physiological effects from hazardous materials.

All of the types of hazardous materials discussed in Objective 1 have the capacity to injure a person's body or affect physical health; that is, they have basic physiological effects. In general, a hazardous substance will cause any one, or a combination of, these three physiological reactions:

- Injury to surface tissue (skin).
- Local problems (harm to tissues at the point of contact).
- Systemic problems (whole body systems are affected).

Many materials, whether chemical, physical, or biological, may cause injury when they come in contact with the surface of the skin. One of the most serious and common forms of surface tissue injury is burns. Although fire is the usual cause of burning, it is not the only cause. Corrosives can also lead to burning and serious injury. The rate and severity at which a person will burn is dependent on how corrosive the material is, the permeability of the skin, and the length of exposure. Skin burns are classified into three degrees of severity:

1. First-Degree Burns. First-degree burns involve only a redness of the skin; the most common first-degree burn is sunburn. First-degree burns from fires may result from a very short exposure time. Contacts between the skin and a hot surface such as an iron may produce similar burns depending on the temperature of the surface contacted and the duration of contact. Table 1 shows the effects on skin of contact with surfaces at different temperatures. Freezing of skin and body tissues are given also, as these may produce effects similar to those of heat burns.

2. Second-Degree Burns. Second-degree burns are much more serious than first degree. Second-degree burns are more painful even than third-degree burns, since nerve endings are deadened with third-degree burns. Broken blisters resulting from second-degree burns expose the body to infection.

TABLE 1. EFFECTS ON SKIN OF CONTACT WITH SURFACES OF DIFFERENT TEMPERATURES.

Temperature (°F)	Sensation or Effect
212 (boiling)	Second-degree burn on 15-second contact
180	Second-degree burn on 30-second contact
160	Second-degree burn on 60-second contact
140	Pain; tissue damage (burns)
120	Pain
90	Warm (neutral)
54	Cool
32	Pain
30 & below	Pain; tissue damage (freezing)

3. Third-Degree Burns. In third-degree burns, the skin, red blood cells, capillaries, and sometimes even the muscles are destroyed. Burns may be white, light gray, brown, or even charred black. The areas around a third-degree burn may be burned to a lesser degree. Third-degree burns are much more serious than other types because of tissue destruction, loss of plasma from the body, and disruption of the body's chemical balance. In turn, all of these conditions cause shock. Facial burns often result in injury to the upper respiratory passages usually with swelling which can cause obstructions to breathing. Although the damage is more serious, the destruction of the nerve endings in third-degree burns may cause less initial pain than lesser burns which leave them exposed.

Cryogenic burns, caused by skin contact with an extremely cold surface, will also cause third-degree burns, destroying skin and underlying tissue, and possibly resulting in gangrene. The extreme coldness of a cryogenic substance can also cause a local arrest in blood circulation. During subsequent thawing, the likelihood of blood clot formation is quite high.

Burns are not the only cause of injuries to surface tissue. Dermatitis is a skin inflammation caused by contact with an irritating or sensitizing substance. Exposure to solvents often causes the removal of the oils that keep the skin soft and pliable, making it dry, scaly, and with a tendency to crack easily. Some redness may result from the irritating effects created by the absence of body fat tissue. Skin that has been exposed to sensitizing substances often has poor resistance to bacterial infection and heals slowly when injured. Replacement of oils with creams and lotions to control the condition is only partly effective. The only hope of recovery generally is removal from further contact with the damaging substance.

A second type of physiological effect which may result from hazardous materials is local problems or harm to tissues at the point of contact. The sites of contact are often areas of the skin or the mucous membranes of the eyes, nose, mouth, throat, and lungs. There are many different agents which will result in "local" problems at many different locations of the body. Irritants, for example, are substances which injure the body by inflaming the tissues at the point of contact. This reaction may take the form of heat, redness, swelling and/or pain. Strong irritants may produce blisters. Usually an irritant will show its effects in the respiratory tract.

An irritant may be a gas, liquid, solid, or dust. Ammonia, for example, can cause injury to the upper respiratory tract (larynx, pharynx. and nose). Chlorine causes damage along the entire tract. Nitrogen tetroxide and nitric acid injure the lower portion of the respiratory tract. However, the harmful effects of all these do not usually spread to other areas of the body.

The third type of physiological effect that can result from contact with hazardous substances is systemic problems. With systemic problems, harmful effects occur not only at the point or area of the body with which a hazardous substance comes in contact, but also in other areas of the body. (For systemic problems to develop, absorption into the bloodstream must take place.) Systemic injuries will occur most rapidly by the route that permits easiest access of the substance to the bloodstream. Routes by which this may occur are through the respiratory system, the skin, or the gastrointestinal tract. Of these, the route through the respiratory system is the most common and the most dangerous, since the least amount of self-protection is afforded the body in this system. Direct injection into the tissue and bloodstream is the most rapid route by which systemic injuries can occur but injection is not common in industrial accidents. Absorption through a cut or wound in the skin is far more ordinary.

Substances that damage the internal systems often affect the kidneys, liver, spleen, and nervous system. Such substances can cause suffocation, paralysis, and death. Common industrial substances that produce systemic reactions include carbon tetrachloride, benzene, formaldehyde, methyl alcohol, lead, and mercury.

ACTIVITY 2:

Name three general physiologial effects from contact with hazardous materials.

1. ______________________
2. ______________________
3. ______________________

OBJECTIVE 3: Define flammable liquids, using the terms flash point, auto-ignition temperature, and flammable range.

FLAMMABLE LIQUIDS

Several concepts are helpful in understanding the nature of flammable liquids. The first of these concepts is that of fire itself.

For a fire to occur, four ingredients or conditions must be present. These four fundamentals are referred to as the fire pyramid (Figure 1). There must be fuel, oxygen (in the air), heat, and a chain reaction. Fuel may be provided by liquids that will burn as well as by oily rags, sawdust, paper, scrap, and other materials. Oxygen is usually in plentiful supply from the air itself. Heat may be provided by electrical sparks, open flames, hot particles, and embers, as well as many other sources. The fourth side of the fire pyramid is a chain reaction between fuel and oxygen.

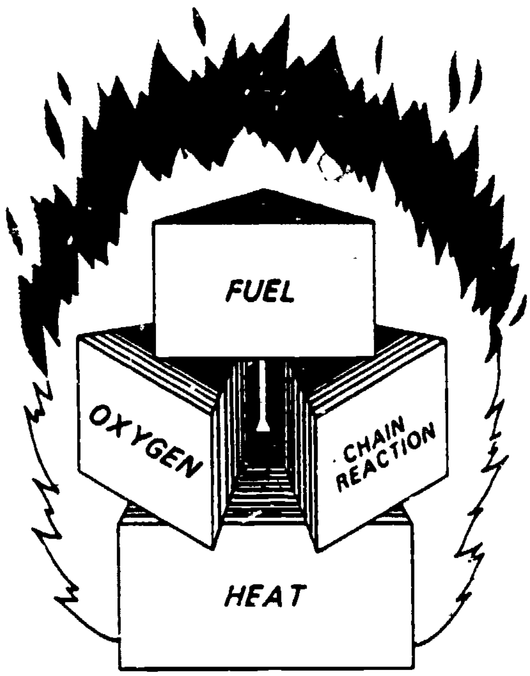

Figure 1. The fire pyramid.

FLASH POINT, FLAMMABLE AND COMBUSTIBLE LIQUIDS

Many of the liquids that are commonly used in industry today will catch fire and burn; that is, they will ignite. Ignitable liquids burn easily and rapidly. Fires fueled by ignitable liquids are harder to extinguish than some other kinds of fires. In addition, vapors from ignitable liquids are likely to explode.

An ignitable liquid tends to evaporate and become a vapor as the temperature goes up or the pressure goes down. Just as water vapor escapes from a pond or a pool of water, vapor escapes from other liquids. When an ignitable liquid burns, it is the vapor that provides the fuel for the fire.

The lowest temperature at which a liquid releases enough vapor to support burning is called the flash point. The flash point is used to classify the relative fire hazards of liquids. Liquids classified as flammable have flash points below 100°F. These liquids will release enough vapor to form burnable mixtures with air at temperatures below 100°F. Liquids classified as combustible have flash points above 100°F. These liquids must be heated to temperatures greater than 100°F before they will release enough vapor to form burnable mixtures.

At normal room temperatures, flammable liquids are a much greater fire hazard than combustible liquids. Therefore, combustible liquids - wherever they will do the job - should be used instead of flammable liquids.

Some examples of flammable liquids and combustible liquids that are used in industry are listed in Table 2.

TABLE 2. FLAMMABLE LIQUIDS AND COMBUSTIBLE LIQUIDS COMMONLY USED IN INDUSTRY.

Flammable Liquids	Combustible Liquids
Carbon disulfide	Fuel oils
Ether	Kerosene
Acetone	Ethylene glycol
Benzene (Benzol)	Cresote oil
Gasoline	Formaldehyde (37% solution)
Petroleum ether (Petroleum naptha or benzene)	Mineral oil
Laequer thinner	Mineral spirits
Alcohol (undiluted)	Phenol
MEK (Methy ethyl ketone)	Hydraulic fluid
Toluene	Transformer oil
VM + P naptha	Quenching oil
Turpentine	Linseed oil
Xylene	
Isopropyl alcohol	

AUTO-IGNITION TEMPERATURE

Auto-ignition temperature is the lowest temperature at which flammable gas or vapor-oil mixture will ignite from its heat source or from contact with a heated surface without the necessity of a spark or flame. Vapors and gases will ignite spontaneously at a lower temperature in pure oxygen than in air. The majority of vapors and gases will not self-ignite in air until they reach temperatures of about 500°F to 900°F. Therefore, the greatest danger of fire in using and handling combustible and flammable liquids comes not from auto-ignition but from common ignition sources such as sparks, flames, and static electricity.

FLAMMABLE RANGE

When a liquid is warmer than its flash point, enough vapor is escaping to create a mixture that will burn. The mixture of vapor and air in concentrations that will burn and spread flame is said to be in the FLAMMABLE RANGE or EXPLOSIVE RANGE.

When a vapor reaches the minimum concentration in air at which the mixture of vapor and air will burn, the lower flammable limit, or LFL, has been reached. Below the lower flammable limit, the vapor and air mixture is too lean to burn.

There is a point at which the concentration of vapor in air becomes too great for the mixture to burn. That point is known as the upper flammable limit, or UFL. Above the upper flammable limit, the mixture is too rich to burn (as occurs when an automobile engine is flooded).

Flammable range is the difference between lower and upper flammable limits. The difference is expressed as the percentage of vapor in air by volume. Each liquid has its own characteristic flammable or explosive range. For gasoline, the range is 1.4 to 7.6 percent.

The flammable range of a liquid is affected very little by normal variations in atmospheric pressure, temperature, or humidity; but at very high temperatures, the UFL is raised and the LFL is lowered, thereby increasing the flammable range. If a liquid is used in or around processes involving high temperatures, the limits given for room temperatures are no longer applicable. Heating a liquid increases the hazard tremendously.

Another important thing to know about flammable and combustible liquids is that vapors of these liquids are heavier than air. Flammable and combustible liquid vapors tend to settle on the floor or flow downhill unless carried up by rising air currents. A trail of vapors can travel far from the source of ignition and settle and collect in lower areas. If this vapor trail contacts a source of ignition, the resulting fire may flashback to the source of the vapors and cause a larger fire or an explosion. Cases have been recorded in which vapor trails extending 200 yards from the source have ignited and caused the source to explode.

The intensity of a flammable liquid vapor explosion should not be underestimated. The explosion of vapors from a gallon of gasoline can have the force of one to forty sticks of TNT! And the dangerous combination of vapor and air meeting an ignition source takes place all the time. Fire experts estimate that around 65,000 fires a year are caused by flammable and combustible liquids. Fires and explosions of these liquids can be prevented by a:

- Keeping the liquid vapors confined so they can't mix with air, or by ventilating the area with fresh air. When liquids are sprayed indoors, such as in spray painting, ventilated booths or rooms must be used.
- Removing all possible ignition sources.
- Removing the air (oxygen) necessary for the fire to burn. These precautions will be discussed in greater detail in Objective 5.

ACTIVITY 3:

1. Define:
   a. Flash point ______________________
   ____
   b. Flammable liquid ______________________
   ____
2. Choose the best answer:
   Flammable range refers to -
   a. The difference between lower and upper flammable limits.
   b. The range of mixtures of vapor and air in concentrations that will burn.
   c. The range of mixtures of vapor and air that are too rich to burn.
   d. a and b.
   e. b and c.
3. Mark the statements True or False.
   ___ a. Flammable range is the same for all liquids that will burn.
   ___ b. Vapors can flow for long distances, leaving a trail back to their source.

OBJECTIVE 4: Explain the potential hazard of materials that carry the flammable solid label.

Flammable solids are materials that can ignite easily due to friction, chemical changes, heated surfaces, or absorption of moisture. The utmost care must be taken in the handling and storage of flammable solids.

The concepts of flash point and flammability limits apply to solids as well as to liquids and gases. (Gases are always above the flash point, as it has been defined.) When heated to its melting point, a solid becomes a liquid, which in turn, may vaporize and reach the lower flammable limit. Some solids, when heated, yield enough vapor to reach the lower flammable limit before they actually melt. Other solids break down into their various constituents when heated, and these constituents may include gases. Flammable solids may be organic or synthetic, metallic or nonmetallic.

Many metals have hazardous properties, and all metals except platinum and gold will burn. Some metals, such as magnesium, ignite easily, especially when in fine particles or thin sections. The same metals in large masses such as blocks, sheets, or bars may be comparatively difficult to ignite. Other metals that are not normally thought of as combustible, such as steel and aluminum, will ignite when in a finely divided form. Therefore, the size, shape, and quantity of the material, and the degree and intensity of the ignition source are important factors when evaluating metal and other solid flammable hazards.

A special problem arises out of the use of solid dusts. Metals have been milled so fine that they will ignite on exposure to air. These extra-fine particles of metals or solids may burn with explosive force. Metal fires also burn much hotter than ordinary fires and are extremely difficult to extinguish. Water and dry chemicals are ineffective extinguishing agents for these fires; halon will actually explode if applied. Dry powder is the proper extinguishing agent, but metal fires present particular difficulties.

Each metal has distinctive burning characteristics that must be known before the fire can be fought effectively.

Metal fires can be prevented through frequent collection of combustible metal chips and shavings and preventing the presence of oil or grease near or in finely divided particles of combustible metals. Clean, dry steel containers should be used for metal particles that are to be saved. These containers should be stored in an isolated storage yard or at a safe distance from all buildings.

Some materials that carry the flammable solid label are road flares, some charcoal briquettes, boxed matches, coal dust, barium peroxide, nitrate of soda, burnt cotton, calcium phosphide, white phosphorus, red phosphorus, aluminum dross, magnesium dross, movie film that has a nitro-cellulose base, and many others.

Containers that carry the flammable solid label should be kept away from all ignition sources, handled with caution so as not to create undue friction or impact, kept clean and dry, and prevented from overheating or contact with heated surfaces. Workers who notice flammable solid containers that are ruptured, leaking, or damaged should isolate these containers and report them to the supervisor immediately.

Containers that appear to be building up heat, that feel hotter to the touch than other similar containers, should be reported, also. Cartons, bags, or barrels that are emptied of flammable solid contents may present a significant fire hazard merely from the residue of flammable materials. These should be handled with the same care as they were when filled. At all times, workers should remember that flammable solid hazards are not the same as wood, paper, and other combustible materials; they are far more hazardous.

ACTIVITY 4:

1. List four general conditions that can cause flammable solids to ignite.

   a. ____________________

   b. ____________________

c. ______________________

d. ______________________

2. List four conditions of flammable solid containers that should be reported to a supervisor.

a. ______________________

b. ______________________

c. ______________________

d. ______________________

OBJECTIVE 5: List 15 of 20 precautionary measures for handling or working around flammable materials.

Since there are so many types of flammable materials, there cannot be a single set of guidlines on how to prevent injuries and damages from industrial applications. There are, however, general rules that are basic to any effective safety program. For the sake of brevity, they are listed below:

1. Whenever possible, avoid the use of a highly flammable material, a nonflammable or less flammable liquid should be used instead.
2. Limit the supply of flammable materials in the work area to the amount necessary for one work shift.
3. Provide adequate ventilation (which may include exhaust hoods, vacuums, and fans) for all operations involving the use or storage of flammable materials.
4. All flammable materials (especially liquids) should be kept in closed containers, safety cans, or fire-resistant containers, except during actual use.
5. Connections on all drums and pipes containing flammable and combustible liquids must be vapor- and liquid-tight.
6. Provide for bonding and grounding of equipment as well as for grounding of all electrical equipment involved in a process where flammable gases or liquids are used, stored, or transferred from one container to another (Figure 2).

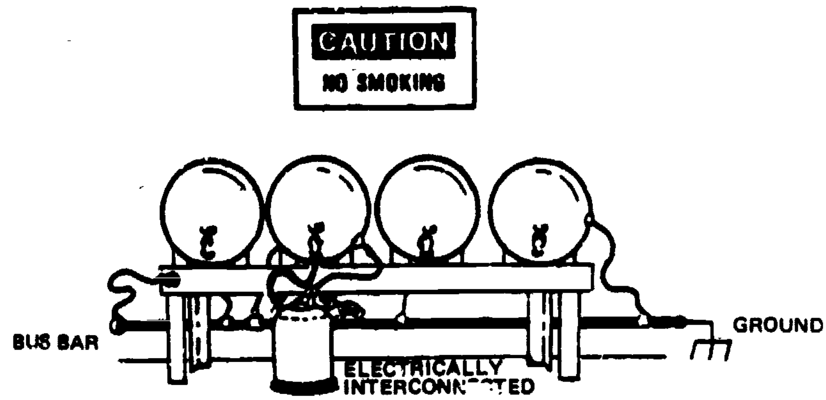

Figure 2. Drums grounded and bonded to receiving container.

7. Use only approved electrical equipment installed in conformity with code requirements of an agency having legal jurisdiction (often according to the National Electrical Code).

8. Provide adequate grounding for all situations and surfaces from which accumulations of static electricity might discharge to ignite flammable substances. (Figure 3.)

9. Insulate and protect hot surfaces, which might be sources of ignition, against spillage or leakage of fuels, etc.

10. Accidental mixtures of flammable liquids should be prevented.

11. All containers and valves containing flammables should be labeled, tagged, and identified.

12. Smoking, open flames, and spark-producing devices or equipment should not be permitted in a building or area where flammable materials are stored, handled, or used. Suitable "NO SMOKING" signs should be posted in areas where smoking is prohibited.

13. Place all flammable material containers so there is little chance they may be ruptured or damaged by impact of vehicles, equipment, etc.

14. Provide adequate fire extinguishing equipment in all hazardous areas. (See Figure 4.)

15. Provide for safe disposal of all flammable material wastes.

16. Use sand or other noncombustible substances for cleaning up spills of flammables. All spills should be cleaned up promptly.

17. Combustible waste materials, such as oily shop rags or paint rags, must be stored in covered metal containers and disposed of daily. Good "housekeeping" practices should always be practiced.

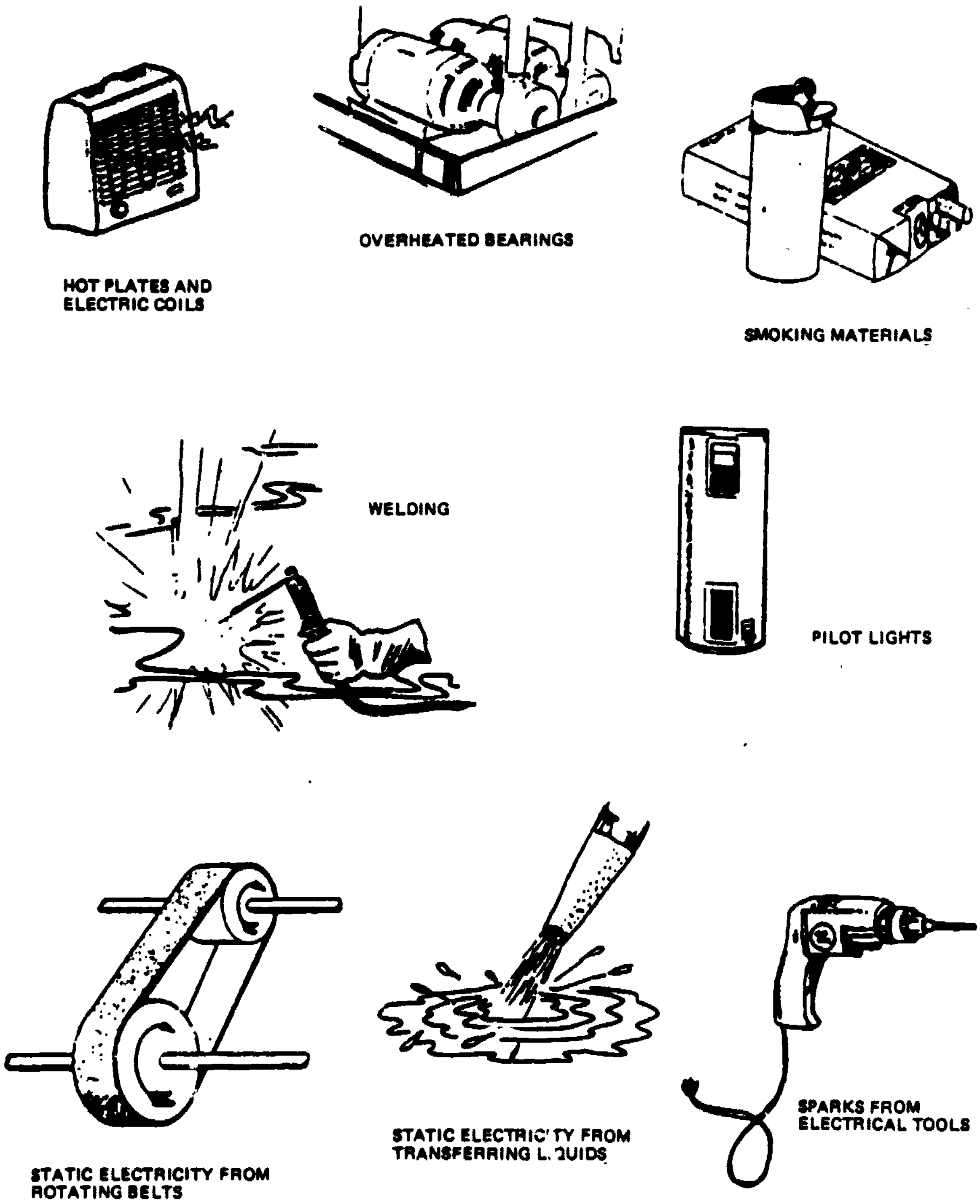

Figure 3. Common sources of ignition.

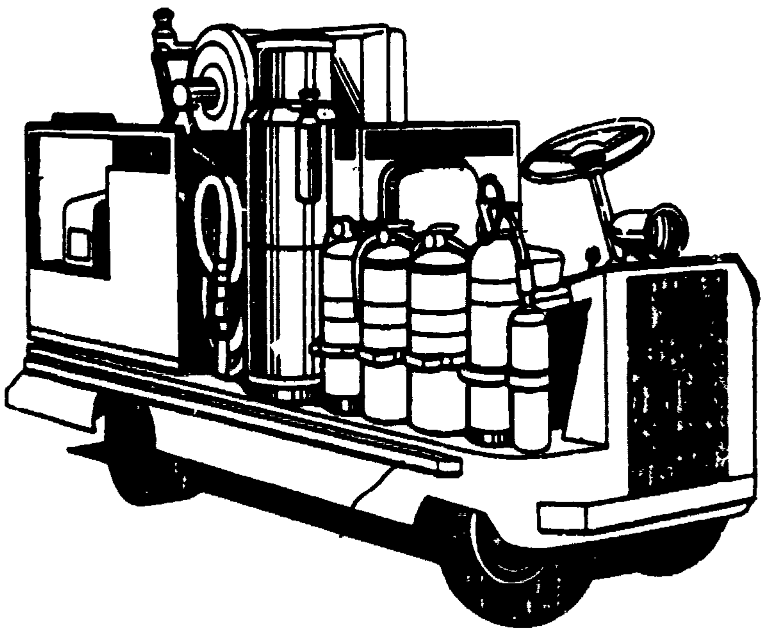

Figure 4. Cart holding typical fire extinguishing materials and equipment is kept handy in case of emergency.

18. Ensure that exits and passageways, in case of a fire or disaster, are known to all personnel.

19. Make sure that all personnel involved in handling or use of flammables are aware of their characteristics and hazards.

20. Storage cabinets must be distinctly marked "FLAMMABLE - KEEP FIRE AWAY." (Figure 5.) Storage cabinets must meet National Fire Protec-

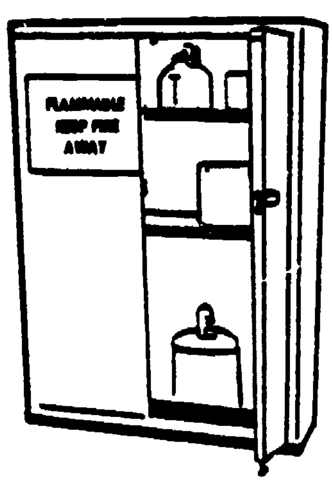

Figure 5. Storage cabinet.

tion Association test requirements. Cabinets constructed in the following manner will meet these requirements.

a. Metal cabinets must be constructed of at least No. 18 gage sneet iron, double-walled with tight joints and one and one-half inches air-space between. Doors must have three-point locks with a liquid tight sill raised at least two inches above the cabinet floor.

b. Wooden cabinets must be constructed of at least one-inch plywood (of a specified type) with rabbeted joints fastened in two directions with flathead screws.

ACTIVITY 5:

List 15 precautionary measures when working with flammable materials.

1. ______
2. ______
3. ______
4. ______
5. ______
6. ______
7. ______
8. ______
9. ______
10. ______
11. ______
12. ______
13. ______
14. ______
15. ______

OBJECTIVE 6: Identify three conditions to which commercial explosives are sensitive, the types of explosive materials used commercially, and a general rule for persons not trained in the use of explosives.

Explosive materials are a highly useful tool in our modern society; they are instrumental in clearing land, building roads, and mining fuels, to name a few of the numerous applications. If accorded due respect, explosives can be transported, stored, and handled without accidents, but it must be remembered at all times that explosives are made to explode. Commercial explosives such as black blasting powder, blasting caps, and detonating cord are sensitive to impact, fire and heat, and friction. If they are not handled with the proper caution and knowledge, unplanned explosions may occur. Storage requirements are strict and transportation regulations must be followed at all times.

A competent, authorized person should always be in charge of explosives. For everyone other than authorized persons, the general rule should be simply "don't touch" without the proper guidance. Loading, unloading, and transportation should be carried out under the direction of a qualified supervisor.

An explosive is a chemical compound or mixture of compounds that suddenly undergoes a very rapid chemical change, with the production of large quantities of heat and gases. The "explosion" is usually accompanied by a vigorous shock and loud noise. Explosives can be categorized in one of two classes based on how fast they detonate: high explosives react extremely quickly - on the order of thousandths of a second - while low explosives react somewhat more slowly. A high explosive is said to explode or "detonate." Dentonation is the creation and rapid release of the gas generated by the explosion. On the other hand, a low explosive burns a little slower; this is termed as "deflagration." Both types are dangerous (don't mistake the word "low" to mean unhazardous).

High explosives decompose or explode almost instantaneously on being initiated or set off by a detonating action such as that of a detonator (blasting cap, electric blasting cap), detonating cord or a special primer of some sort. Dynamite is the most common type of high explosive. Others include nitroglycerin, picric acid, and TNT.

Black blasting powder is a so-called deflagrating or burning explosive and explodes much more slowly than dynamite. However, it is quite sensitive to spark, flame, and friction. Partly because of this, and partly because it is relatively expensive, black powder has been almost entirely replaced by safer and more economical explosives and blasting agents. Some other initiating explosives are lead azide and mercury fulminate.

Detonating devices are used to set off the main explosive charge without injury to operating personnel. Blasting caps (ordinary blasting caps) are short capsules closed at one end and containing a small quantity of one or more very sensitive, powerful high explosives. These caps, when ignited by means of a length of safety fuse, are used for initiating other explosives, such as dynamite.

Electric blasting caps and delay electric blasting caps are completely closed shells with two wires protruding from one end. The opposite end contains one or more small powerful charges of high explosive. Like the ordinary caps described above, these caps are also used for initiating other explosives, but are made to function by the application of electric current.

All blasting caps, both ordinary and electric, have the warning, "Blasting Cap - Explosive - Dangerous" printed on the shell.

Blasting caps and electric blasting caps may explode prematurely when exposed to spark, heat, shock or friction; therefore, they should not be handled roughly, probed, connected to electric sources, or used as a toy by anyone. Every care should be taken to ensure that all types of caps (and other explosive products) do not get into the hands of children. Blasting caps should be employed for blasting only by or under the direction of fully experienced personnel.

Safety fuse is a flexible cord containing an internal burning medium by which fire or flame is conveyed at a continuous and uniform rate from the point of ignition to the point of use, usually a blasting cap.

Detonating cord is a flexible cord containing a center core of high explosives used to detonate other explosives with which it comes in contact. Different types of detonating cord have different size cores and various combinations of coverings, which may include textiles, water-proofing compounds, and plastic, designed to protect the core from damage in handling and use, and from water penetration.

All of the explosives and detonating devices listed above require extreme care in handling.

ACTIVITY 6:

1. Name three conditions to which commercial explosives are sensitive.

   a. ____________________

   b. ____________________

   c. ____________________

2. State the general rule regarding explosives for everyone other than authorized persons or those working directly under the supervision of authorized persons. ____________________

   ____

3. Mark each statement True or False.

   ___ a. Low explosives have only a slight hazard potential.

   ___ b. Detonating cord contains a center core of high explosives.

   ___ c. Blasting caps will not explode unless exposed to heat or shock.

OBJECTIVE 7: List five precautions for handling and storing explosives.

Explosive materials must be kept in proper storage facilities, known as magazines, when they are not being used. Magazines should be separated from one another and from inhabited buildings, highways, and passenger railways. Recommended distances from such populated areas are set forth in a publication of the Institute of Makers of Explosives Safety Library "American Table of Distances."

Magazines should be clean, dry, well ventilated, reasonably cool, properly located, sturdy in construction, securely locked, weather-resistant, fire-resistant, and theft-resistant. "EXPLOSIVES - KEEP OFF" signs should be posted near magazines to warn persons of the contents of these storage facilities.

When explosives are being moved from a railroad car or truck to magazines, they should be unloaded promptly according to DOT regulations and the instructions tacked on the inside of cars. Railroad cars or trucks should not be left unattended between loading trips unless locked. Workers loading or unloading must NEVER be smoking or carrying matches, or lighters. There should be no dry grass or debris within 25 feet of the vehicle and no ignition sources nearby. Any runways, chutes, or conveyors used for unloading should have no exposed sparking metal parts. Explosives should not be exposed to excessive heat from sources such as lighters, lanterns, impact, friction, or electricity.

Any damaged or leaking explosives should be separated from the other explosives, placed in supplementary tight containers, set aside in a magazine and reported to the manufacturer.

ACTIVITY 7:

1. Check the statements below which are true regarding safe storage of explosives.

   ___ a. Magazines should be located 25 feet from inhabited buildings.

   ___ b. Magazines should be resistant to fire, weather, and theft.

   ___ c. Signs declaring the content of magazines should not be posted since they might invite vandalism.

2. Check the statements below which are true regarding safe handling of explosives.

___ a. Explosives should not be exposed to sparks, flames, impact, or friction.

___ b. Damaged or leaking explosives should be placed in tight containers and buried.

___ c. Railroad cars or trucks should not be left unattended during unloading unless locked.

OBJECTIVE 8: Explain five procedures for safe handling of compressed-gas cylinders.

Whether gases are carried by rail, water, air, or highway, the two common methods of shipment are in the gaseous state at an absolute pressure higher than 40 pounds per square inch (psi) at 70°F, or in the liquid state in cryogenic containers (containers of very low temperature).

Gases exert pressure. Gases actually consist of a large number of extremely small particles, called molecules, that continually fly about in the space they occupy. Any container of gas will be bombarded by these flying molecules striking the insides of the container walls; thus, the gas occupies the space of enclosure. Enough space exists between the molecules in a gas that more gas can be added into a given space and will fit, but at the same time more and more molecules will be hitting the sides of the container. The energy of these bombarding molecules creates pressure. The greater the number of molecules of gas that are present in the container and the faster they move, the higher the pressure. Compressed gases have to be contained in specially built cylinders that are designed to accommodate the pressure of a lot of gas compressed into a relatively small volume.

Because of the tremendous pressure contained within, compressed-gas cylinders must be stored and handled with care. A ruptured cylinder will have tremendous speed and destructive power as it leaks gas. Ruptured cylinders have been known to break through concrete walls. In addition to the hazard of the cylinder itself, the leaking gas may be flammable, corrosive, oxidizing, or poisonous.

To prevent accidents with compressed gases, cylinders must be handled with caution according to the general guidelines listed below:

1. Only cylinders meeting DOT regulations should be used.
2. Filling or charging of cylinders should be done only by qualified personnel.
3. Gas should never be transferred from one cylinder to another.
4. The gas should always be referred to by its technical name.
5. Cylinder labels should not be mutilated, changed, or removed.
6. When not in use, each cylinder must have its protective cap secured over the cylinder valve.
7. All cylinders should be stored and transported in an upright position.
8. All cylinders must be secured in storage and transport.
9. All cylinders must be secured during transportation - use a suitable hand truck.
10. Cylinders should never be used as rollers, supports, or for any purpose other than to contain the contents as received.
11. Cylinders should not be placed where they might become part of an electric circuit.
12. Cylinders must not be lifted with an electromagnetic crane or by slings, ropes, or chains. Lifting by crane should be done only when a suitable cradle or platform is provided.
13. Cylinder valves should always be kept closed.
14. Cylinders should be protected from damage by fire and other conditions that might cause overheating.
15. Cylinders should be stored in dry, cool areas.

Workers should be aware of any signs of cylinder damage, such as dents, cuts, gouges, digs, pits, bulges, or any evidence of fire damage. Any of these conditions should be reported to the supervisor.

Overheating of cylinders or tanks that contain compressed-gases can be extremely dangerous. If a gas enclosed in a cylinder is heated so that its temperature rises, the pressure of the gas will also increase. As long as the temperature of the gas does not rise above 125°F, the gas is assumed to be safe. If the gas does exceed this temperature (and even the sun's rays can produce enough heat to do this), the cylinder is likely to burst, usually near its valve, and both the traveling cylinder and the gas itself can create a dangerous situation.

Some gases having very low boiling points are stored as liquids in insulated vacuum-jacketed containers known as dewars, or in insulated pressurized cylinders. Contact with these liquids causes "burns" due to the freezing of the skin tissue by the rapidly evaporating liquid. Also, the liquid produces a large volume of gas when it vaporizes. In inadequately ventilated areas, this large volume of gas may decrease the oxygen content of the air below the level necessary to sustain life. Adequate ventilation, monitoring of the oxygen content of confined areas and the use of protective clothing minimize the hazards of cryogenic gases. Examples of materials stored as liquids and classified as "cryogenic" are liquid nitrogen and liquid oxygen.

ACTIVITY 8:

1. Name five signs of cylinder damage that should be reported to a supervisor.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

   e. ______________________________

2. Check the statements below that are true about the overheating of compressed gas cylinders.

   ___ a. The pressure of the gas within an overheated cylinder will decrease.

   ___ b. An overheated cylinder may rupture.

   ___ c. A cylinder is assumed to be okay if the temperature of the gas remains below 125°F.

3. Which one of the following rules is not a safe handling procedure for compressed-gas cylinders?

___ a. Protective caps should be over the valve when the cylinder is not in use.

___ b. Cylinders should be stored on their sides in a suitable cradle.

___ c. Cylinders should be secured in storage and transport.

OBJECTIVE 9: State the hazard associated with oxidizing materials.

The Department of Transportation defines an oxidizing substance as one that gives off oxygen easily and thereby stimulates combustion. Such reactions can be explosive.

Although oxygen supports combustion, it does not burn. Oxygen is considered a hazardous element because flammable materials burn much faster in oxygen, and oxygen can quickly combine with other elements and compounds to produce spontaneous ignition. When oxygen comes into contact with oil, grease, or fuel oils, the result can be a sudden and violent fire. Employees who encounter materials bearing the OXIDIZER label should be aware of the extreme fire hazard associated with oxygen.

ACTIVITY 9:

What is the hazard associated with oxidizers? ________

____

OBJECTIVE 10: Identify the three ways that poisonous materials enter the body and four factors that determine how the body reacts to toxic exposure.

A material may be considered toxic, or poisonous, when a small quantity will cause injurious effects in the average, normal adult person.

Various cleaners, paints, lubricants, and solvents used in the home are toxic. Many products used on lawns and gardens, including fungicides, insecticides, and herbicides, are often toxic. In industry, the potential for hazards is even greater because of the great number and much larger quantities of chemicals used. Certain safeguards must be maintained to avoid or minimize harmful exposures to workers in industrial plants and to the general public. Workers need to understand the physiological process by which the human body can "handle" a toxic material, the effects on the body that can be produced, and the precautionary measures that must be observed to prevent injury.

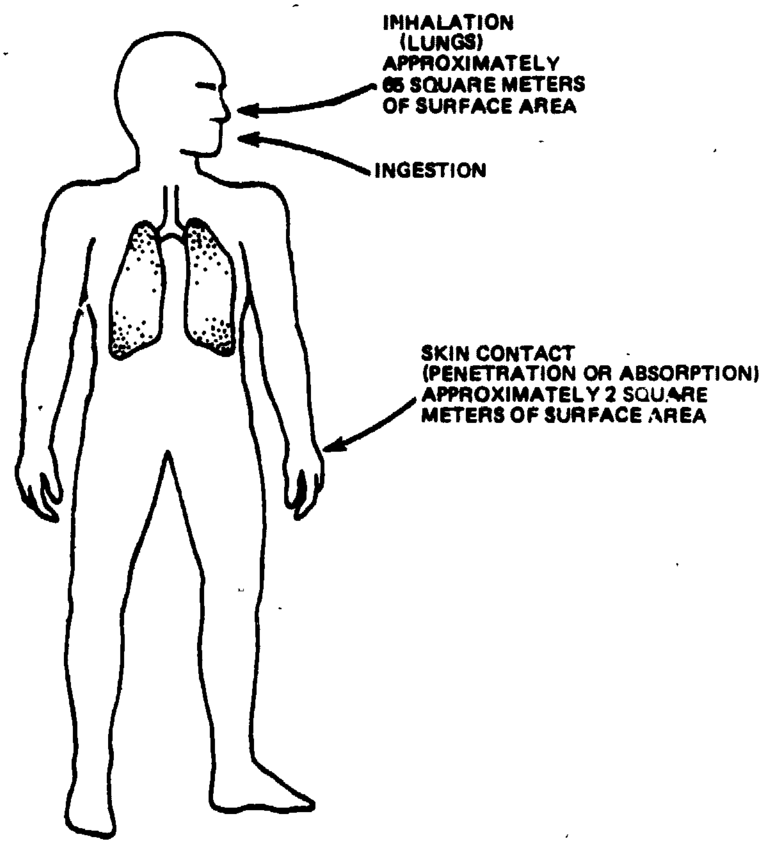

Figure 6. Mechanisms of entry of toxic materials.

The three most common ways by which toxic materials enter the body are (1) inhalation (breathing), (2) ingestion (swallowing), and (3) absorption through the skin. Of these three illustrated in Figure 6, the most common is absorption. However, the entry method causing the highest percentage of deaths in inhalation.

Ingestion is sometimes encountered in industry where workers eat or even smoke without first washing; or where foods, candy, gum, or cigarettes are stored where toxic materials are used. Some cases of lead and mercury poisoning have been traced to this route of entry into the body.

Skin absorption is a more difficult route of entry to protect against because it is not always noticeable and because there is so much handling of products and equipment in industrial activities.

Inhalation is the most potentially hazardous route by which toxic substances can enter the body. The internal surface of the lungs is rich in blood vessels that readily absorb inhaled gases. Airborne gases, vapors, dusts, and mists travel freely with air currents in the work area, and the worker is often unaware of any harmful exposure.

Gases may be hazardous as asphyxiants, irritants, or anesthetics. Asphyxiants are substances that can stop respiration by damaging red blood cells or by reducing their oxygen-carrying potential. Irritants produce inflammation of tissue such as eyes, skin, nasal passages, or other respiratory membranes. Anesthetics cause a loss of muscle control and/or consciousness. Accidental exposure to anesthetic gases is sometimes a factor in worker injury; as the narcotic effect of an anesthetic takes place, the worker's reflexes and attention are reduced to a hazardous level.

No matter how poison enters the body, reactions may develop which will change the way the body normally functions. Exactly how a human body will react is determined by many factors, the most important of which include the following:

1. The amount of toxic material in the bloodstream, or in a specific organ (the concentration).
2. Exactly how much an individual can take of a particular substance before it causes harm (the body's tolerance).
3. How fast the body can eliminate the toxic substance or change it into something harmless - perhaps by giving prompt medical attention (the rate of recovery).
4. The physical condition of the individual.

Toxic action may have acute or chronic effects. Acute poisoning involves a single dose of a heavily concentrated substance over a short period of time. Carbon monoxide poisoning is a good example. Chronic poisoning involves many doses of a substance in smaller concentrations over a much longer period of time. The level of toxicity slowly builds up within the victim's body, and the symptoms are often difficult to detect.

ACTIVITY 10:

1. List three ways that poisons enter the body.
   a. ______________________________
   b. ______________________________
   c. ______________________________
2. List four factors that determine how the human body will react to toxic exposure.
   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________

OBJECTIVE 11: Define TLV and explain the three categories of TLV.

As miraculous as our bodies are in their ability to recover from injury and fight disease, they are actually complex and delicately balanced systems. Each tiny cell is the site of constant chemical action as it takes in nutrients, reproduces, produces needed materials for life, and resists attack by biological agents. Poisons react with the constituents of the cell in such a way that the cell is damaged or destroyed and is unable to do its work in keeping the human organism healthy.

The study of poisons and their effect on living systems, known as toxicology, is an ongoing effort, particularly as new substances are introduced by industry. The American Conference of Governmental Industrial Hygienists publishes exposure limits for toxic substances that are reviewed and updated each year. The Threshold Limit Values (TLV) represent an exposure level to airborne concentrations of substances under which most people can work, day after day, without experiencing ill effects upon their health. There are three categories of Threshold Limit Values:

- Time-Weighted Average (TLV-TWA) is the average concentration considered safe for a normal eight-hour day or 40-hour week.
- Short-Term Exposure Limit (TLV-STEL) is the maximal concentration to which a person can be exposed continuously for a period of up to 15 minutes, without suffering irritation or chronic (long-term) or irreversible change in body tissues. Any dizziness, stupor, or tendency to lose consciousness that would increase the probability of accident or reduce work efficiency would also be cause for setting a Short-Term Exposure Limit.
- Ceiling (TLV-C) is the concentration that should not be exceeded even for an instant.

Threshold limit values are not absolute. Concentrations of chemicals rarely remain constant in the workplace throughout the day. Further, most work environments contain mixtures of chemicals rather than a single compound. Finally, all individuals are not going to react to the same substance in the same way.

ACTIVITY 11:

(Choose the correct answer.)

1. The concentration of toxic substance that should not be exceeded even for one instant is -
   a. TLV-STEL.
   b. TLV-C.
   c. TLV-TWA.
2. A possible cause for setting a TLV-STEL might be which of the following effects:
   a. Dizziness, stupor.
   b. Irreversible tissue damage.
   c. Death.

OBJECTIVE 12: Identify four ways in which worker contact with a harmful substance may be prevented or minimized.

The type of toxic material and the manner in which a poison enters the body often determine the method of control. The goal of preventing or minimizing worker contact with harmful substances may be accomplished in a number of ways:

1. Substitution of a less harmful material for one which is dangerous to health.
2. Change or alteration of a process to minimize worker contact.
3. Isolation or enclosure of a process or work operation to reduce the number of persons exposed.
4. Wet methods to reduce generation of dust in operations.
5. General or dilution ventilation with clean air to provide a safe atmosphere.
6. Local exhaust at the point of generation or local dispersion of contaminants.
7. Personal protective devices.
8. Good housekeeping, including cleanliness of the workplace, waste disposal, adequate washing, toilet, and eating facilities.
9. Training and education.

It has been said "an ounce of prevention is worth a pound of cure." In no situation is this more true than in the area of toxic materials. Each operation should begin with a careful analysis of possible dangers by trained personnel. When control measures are selected and implemented, workers should be trained in safe handling procedures, use of personal protective equipment, or whatever method of control has been established. Regardless of the safety measures that are built into the system, workers should not lose the respect for the hazardous materials they encounter or use each day.

ACTIVITY 12:

Name four ways that worker contact with harmful substances may be prevented or minimized.

1. ______

2. ______

3. ______

4. ______

OBJECTIVE 13: Identify the principal hazards and types of protection associated with radiation exposure.

Radiation is energy that is transmitted in wave or energetic particle form. Certain forms of radiation are capable of exciting the atoms of matter and changing them into electrically charged particles or ions, so these forms of radiation are called ionizing. When ionizing radiation is absorbed by human tissue, harmful effects may be produced. The three fundamental types of ionizing radiation that might be encountered through shipping or handling of radioactive materials are alpha, beta, and gamma.

Alpha particles are able to penetrate the human body or shielding material only slightly and travel only very short distances, so relatively thin protective shielding (about as thick as this paper) is adequate to protect the human body from them. However, alpha particles ionize the tissue they do contact, and so are very destructive when taken into the body by inhalation or ingestion. Sources of alpha particles include uranium, man-made plutonium, and radium.

Beta radiation has much greater penetrating power than alpha radiation but shielding is still relatively easy to provide. Sources of beta radiation include radium, tritium, and radon gas. Beta radiation is a hazard mainly when it localizes in a single area of tissue, such as when radioactive iodine concentrates in the thyroid gland and there may induce thyroid cancer.

Gamma rays pose a serious threat to health because they can pass through the body, ionizing the various molecules they contact. Sources of gamma rays include cobalt-60, cesium-137, and iridium-192.

While the principal hazard associated with radioactive material is its ability to kill or damage cells, the effects of radiation vary greatly with the amount and duration of exposure. Both short-term and long-term effects may result from radiation exposure. Nausea, fatigue, vomiting, diarrhea, and shock are some of the symptoms which may appear within two weeks of a severe whole body exposure, and death may be the eventual result of such an exposure. Less severe but still serious effects of exposures (other than severe whole body exposure) are changes in the density of blood vessels, the formation of eye cataracts, and the graying of hair.

Skin cancer, bone cancer, thyroid cancer, leukemia, and other cancers are associated with radiation exposure. Genetic changes have also been noted in exposed persons.

Three basic principles form the basis of protection against radiation: shielding, time, and distance. As mentioned above, shielding against alpha particles requires a material only as thick as paper. A one-inch sheet of metal provides an adequate barrier against beta radiation. With its penetrating power, gamma radiation requires two to four inches of lead or one to two feet of concrete.

The time of exposure to radiation is another factor in its effect. The shorter the exposure time, the less effect radiation can have on tissue. The best protection is afforded by distance. The intensity of the radiation decreases as it moves away from the source. Expressed arithmetically, doubling the distance from the source reduces the exposure to one-fourth the original amount.

Radiaton cannot be felt as it penetrates the body. There is no warning signal to alert persons to its presence by odor, sensation, or appearance. Therefore, proper labeling and proper attention to the labeling of radioactive materials is absolutely essential for safe handling.

ACTIVITY 13:

(Fill in the blanks.)

1. The principal hazard associated with radioactive material is its ability to kill or damage _______.
2. __________ radiation can pass through the human body.
3. Three principles govern radiation protection: ______________, ______________ and ___________.
4. Since radiation gives no warning signal when it penetrates the body, proper attention to _________ on containers of radioactive material is essential.

OBJECTIVE 14: Define corrosive and name two principal hazards.

Corrosives include materials that destroy or permanently damage human tissue at the point of contact. Corrosives may also eat into metals and other materials.

Tons of corrosive materials are shipped across the country annually to be used by industries and schools. Incidents that involve their spillage frequently cause severe personal injuries and economic losses. Several corrosive materials cause the ignition of any organic matter with which they come in contact. Others emit toxic gases. The common acids and bases, as well as bromine, chloride trifluoride, and hydrogen peroxide are examples of corrosive materials.

Even though both acids and bases are classified as corrosives, they are completely opposite in character. In fact, acids and bases are so different that they can be used to neutralize each other. An example would be the combination of hydrochloric acid (HCl) mixed with a very caustic base sodium hydroxide (NaOH) that produces harmless salt water (NaCl and H_2O).

Acids are grouped into two broad classifications: inorganic (or mineral) acids and organic acids. Inorganics are totally nonflammable, whereas organic acids can burn. Fortunately, the ignition temperature of most organic acids is very high as compared to room temperature.

The properties of acids and bases are dependent on the amount of material dissolved in water. "Concentrated" solutions are more hazardous as corrosive materials than are "diluted" forms of the same material. In fact, if highly diluted, the material may cease to be corrosive. However, when water is added to an acid, the resulting heat may produce spattering of the acid.

In addition to injuring the skin and the underlying tissue, a corrosive can create a wound that provides a point of entry for the toxic corrosive to reach the bloodstream, producing an effect worse than skin damage. Also, damage and injury can occur from breathing corrosive vapors. If a corrosive chemical is swallowed, it may give warning by intense pain in the mouth, throat, and stomach. This will usually be followed by difficulty in swallowing and breathing and then vomiting. Some corrosives will not cause symptoms immediately, but emergency action is no less important in these cases than in the obvious or painful ones.

In general, the basic precautions used to protect oneself with toxic materials should be exercised when dealing with corrosives. However, it is very important to remember to wash away any corrosives that may come in contact with a worker's skin. If corrosives have come in contact with clothing, the contaminated clothing should be removed immediately.

Proper exhaust ventilation must be provided for all processes in which corrosives are used. The vapors must be drawn off as they are generated to prevent exposure. Eye-wash and emergency showers should be located in the immediate area where a corrosive is used.

The use of personal protective equipment is very important when working around corrosives. This includes rubber gloves, sleeves, aprons, boots, and chemical splash goggles and face shields, where there is a danger of splashing. Respirators should be used for short-term exposure, such as during dispensing or mixing. The protective equipment chosen should have specific capabilities to protect against chemical(s) in use. As in all work environments, good personal hygiene and housekeeping are essential ingredients of the safety program where corrosive materials are in use.

ACTIVITY 14:

Define corrosive and name two principal hazards.

1. ______________________

____

2. a. ______________________

   b. ______________________

> **OBJECTIVE 15:** Define the etiologic classification of hazardous materials and identify where etiologic hazards may exist.

Etiologic agents are those biological materials such as viruses or bacteria that cause human disease. Certain bacteria, fungi, parasites, other microorganisms are known to cause illness, extreme discomfort and, in some circumstances, even death. Biological agents can be a hazard to persons handling hides and skins, to butchers, and others working with animals or animal products, and to employees of sewage treatment facilities and waste areas. Shipping and handling of biological agents is often the concern of scientific and medical center laboratories. Strict laboratory procedures and precautions are essential where biological agents are being handled.

ACTIVITY 15:

Identify four areas or types of work in which etiologic agents may be a problem.

1. ______________________
2. ______________________
3. ______________________
4. ______________________

REFERENCES

Meyer, Eugene. Chemistry of Hazardous Materials. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1977.

NIOSH, Occupational Diseases. Washington, DC: DHEW (NIOSH) Publication No. 77-181.

NIOSH, Safety and Health for Industrial/Vocational Education. Washington, DC: 1981.

Schieler, Leroy and Pauze, Davis. Hazardous Materials. New York: Van Nostrand Reinhold Company, 1976.

ANSWERS TO ACTIVITIES

ACTIVITY 1

1. b.
2. e.
3. g.
4. d.
5. i.
6. a.
7. c.
8. f.
9. h.

ACTIVITY 2

1. Surface tissue injury.
2. Local problems.
3. Systemic problems.

ACTIVITY 3

1. a. The lowest point at which a liquid releases enough vapor to support burning.
   b. A liquid having a flash point below 100°F.
2. d.

2. d.

3. a. False.

   b. True.

ACTIVITY 4

1. (Any four.)

   a. Friction.

   b. Heat.

   c. Moisture.

   d. Exposure to air.

   e. Impact.

2. a. Ruptured.

   b. Leaking.

   c. Damaged.

   d. Hot.

ACTIVITY 5

Any 15 of the 20 on pages 16, 17, and 20.

ACTIVI

1 Impact.

   b. Fire or heat.

   c. Friction.

2. Don't touch.

3. a. False.

   b. True.

   c. False.

ACTIVITY 7

1. ✓ b.

2. ✓ a.

   ✓ c.

ACTIVITY 8

1. (Any five.)

   a. Dents.

   b. Cuts.

   c. Gouges.

   d. Digs.

43

e. Pits.

f. Bulges.

2. ✓ b.

✓ c.

3. ✓ b.

ACTIVITY 9

Fire.

ACTIVITY 10

1. a. Ingestion (eating).
   b. Inhalation (breathing).
   c. Absorption (through the skin).
2. a. Concentration in bloodstream or organ.
   b. Tolerance.
   c. Rate of recovery.
   d. Physical condition of the individual.

ACTIVITY 11

1. b.
2. a.

ACTIVITY 12

Any four of the nine listed on page 33.

ACTIVITY 13

1. Cells.
2. Gamma.
3. Shielding, time, and distance.
4. Labels.

ACTIVITY 14

1. Corrosive materials are those that damage or destroy living tissue at the point of contact.
2. a. Injury to skin and underlying tissue.
   b. Provides point of entry for toxic materials to enter bloodstream.

ACTIVITY 15

1. Persons handling hides and skins.
2. Butchers and animal workers.

3. Sewage treatment plant workers.
4. Laboratory workers.