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40 HOUR HAZARDOUS WASTE & EMERGENCY RESPONSE TRAINING

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1 LEGISLATION AND STANDARDS

In 1970, Congress established the Occupational Safety and Health Administration (OSHA). As defined in its enabling legislation, the Occupational Safety and Health Act of 1970, OSHA's mission is to “Assure so far as possible every working man and woman in the Nation safe and healthful working conditions”. This mandate involves the application of a set of tools by OSHA (e.g., standards development, enforcement, compliance assistance), which enable employers to maintain safe and healthful workplaces.

1.1 What Is Hazwoper?

HAZWOPER is a somewhat new acronym having absolutely nothing to do with a large malt-o-ball or a Big Mac Burger left out on the counter too long. It does have everything to do with the safety of employees and property, of the employer and surrounding communities, whether industrial, commercial or residential.

Over 70,000 chemicals are used by industry. Some 15,000 chemicals are made in industrial laboratories on a large scale today and between 500 and 1,000 new chemicals are introduced each year. These simple statistics provide the basis for increased awareness, training and responsibility when working with any type of chemicals.

As the environment becomes more fragile and our responsibilities in protecting the environment and people increase, training becomes absolutely critical in meeting these responsibilities. No matter how technologically advanced we become with improved machines, equipment and processes; there's always the threat of an unplanned emergency. In emergencies, human factors and, specifically, the training of those persons working in and around hazardous materials must be of the highest caliber and intensity. The more you know, the better you'll be able to react to emergencies. Your training can be the difference between successful containment or prevention of the emergency.

HAZWOPER actually means Hazardous Waste Operations and Emergency Response. Today, we'll discuss what this means and explain your responsibilities in meeting the requirements of these laws, rules and procedures. The objective of HAZWOPER training is to provide the information necessary to help each and every person involved with hazardous materials, to be able to respond effectively to any emergency. Now you may say, “I'm not involved with hazardous waste, I only work with petroleum products or toluene.” Different government agencies regard these materials as hazardous waste if they are spilled, so everyone's involved. The protection of people, environment, and property are the primary goals of HAZWOPER training.

OK lets begin with the Federal requirements as identified in 29 Code of Federal Regulations 1910.120. The Regulation is divided into three parts: (1) clean-up operations at uncontrolled hazardous waste disposal sites, identified for clean up;
(2) routine operations at hazardous waste treatment, storage and disposal facilities;
(3) emergency response operations at sites where hazardous substances have been or may be released.

1.2 What types of occupations are exposed to HAZMAT?

Ground Water/Soil Sampling
General Labor
Site Investigation
Equipment Operation
Plant Operation
Transferring Waste
Waste Treatment/Recycling
Surveying
Lab Analysis
Monitoring Air/Water/Soil
Removing Soils
Excavation
Emergency Response
Maintenance
Construction
Drum Removal
Pumping Tanks
Solvent Recovery
Firefighting
Drilling

NFPA 472 Standard for Professional Competence of Responders to Hazardous Materials Incidents

This standard identifies the levels of competence required of responders to hazardous materials incidents. It specifically covers the competencies for first responders at the awareness level, first responders at the operational level, hazardous materials technicians, incident commanders, hazardous materials branch, officers, hazardous materials branch safety officers, and other specialist employees.

The purpose of this standard is to specify minimum competencies for those who will respond to hazardous materials incidents. It is not the intent of this standard to restrict any jurisdiction from exceeding these minimum requirements.

One purpose of the competencies contained herein is to reduce the numbers of accidents, injuries, and illness during response to hazardous materials incidents, and to help prevent exposure to hazardous materials to reduce the possibility of fatalities, illness, and disabilities affecting emergency response personnel.

The combination of both OSHA and the NFPA 472 Standard will provide you with an effective and comprehensive training program for **YOU** the HAZMAT response personnel.

2 TOXICOLOGY AND CHEMISTRY

2.1 Objectives

At the conclusion of this module you should be able to do the following:

Use a Material safety data sheet (MSDS) and NOISH Pocket Guide to Chemical Hazards to identify the following hazards.

- Physical and chemical characteristics.
- Physical hazards of the material.
- Health hazards of the material.
- Signs and systems of exposure.
- Routes of entry.

Describe the following toxicological terms and explain the risks associated with them.

- Parts per million (ppm).
- Parts per billion (ppb).
- Lethal dose (LD_{50}).
- Lethal concentrations (LC_{50}).
- Permissible exposure limit (PEL).
- Threshold limit value time-weightier average (TLV-TWA).
- Threshold limit value short-term exposure limit (TLV STEL).
- Threshold limit value ceiling (TLV-C).
- Immediately dangerous to life and health (IDLH).

It is important to understand the fundamentals of toxicology and to recognize potential health hazards to on site personnel and the surrounding community.

2.2 Terms and Definitions

Toxicology is the study of toxic or poisonous substances. It relates to the physiological effect, source, symptoms and remedial measures for the materials.

A Toxin is any substance, which upon contact with a living organism can cause injury or interference with the life processes of that organism without acting mechanically.

Toxicity is the amount of a toxin or poison under specified conditions that will result in detrimental biological changes. Toxins cause injury in relatively small amounts compared to other substances, but materials classified as toxic may differ by a factor of ten billion in their potencies. The margin of safety is determined by the dosage and the toxicity of the material encountered.

Dose is the quantity of a substance that enters into the biological system. Dose is not synonymous with concentration.

Concentration is the quantity of a substance in which a biological system is externally exposed.

Units of Dose and concentration can be expressed in terms of the quantity administered:

a) Per unit weight, usually expressed as milligrams of substance per kilogram of body mass (mg/kg).

b) Per area of skin surface, expressed as mg/cm.

c) Per unit volume of air inhaled, usually expressed as parts of vapor or gas per million parts (ppm) of air by volume.

d) Solids would be expressed as milligrams of material per cubic metre, ppm (part per million) 1/1,000,000 - 1 inch 15.5.

Acute Toxicity is the toxicity resulting from exposure to a relatively high concentration of a toxic material over a short period of time (i.e., seconds, minutes, and hours). The relationship of exposure and toxic effect is usually quite clear since the effect is relatively immediate.

Chronic Toxicity is the toxicity resulting from exposure to a relatively low concentration of a toxic material over a relatively long period of time (i.e., months, and years). The relationship between exposure and toxic effect is not always apparent, and in some cases cannot be established with certainty.

2.3 Modifying Factors

Some factors, which may modify the toxic effects of a substance, are:

a) The route of exposure or entry.

b) The physical state of the substance.

c) External temperature.

d) Physiological condition of the subject.

e) Possible synergistic effects, as with smoking when in a lead or asbestos environment.

f) Dosage.

2.4 Dose Response Relationship

a) Toxicity - potential of a substance to cause harm.

b) Hazard - probability that a substance will cause harm.

c) Route of exposure.

d) Dose.

e) Duration.

f) Reaction and interaction.

g) Individual factors (age, nutrition, susceptibility).

2.5 Routes of Exposure

Inhalation

a) Efficient route.

b) Most important.

c) Local effects.

d) System effects (body wide).

Dermal

a) Passing through unbroken skin (osmosis).

b) Cuts and scrapes.

c) Absorption through mucous membranes (nose).

d) Local effects most common.

e) Systemic effects can occur.

Ingestion

a) Lesser concern.

b) Factors leading to exposure.

c) Toxic effects - local or systemic.

Injection

a) Lesser concern.

b) Puncture from sharp object, e.g., nails, glass and needle stick.

c) Toxic effects - local or systemic.

2.6 Practical Considerations

Most toxic effects are reversible and do not cause permanent damage, although complete recovery may take a long time. With regard to emergency response personnel, potential acute exposures must be prevented.

Acute exposures do not persist for long periods of time. Acute skin exposures may occur when workers must work close to substances in order to control a release or contain and treat the spilled material. Once the immediate site problems have been alleviated, exposures tend to become more chronic in nature as cleanup progresses.

Chronic exposures usually are associated more with hazardous waste site investigations where contaminated soil, debris and water or containment systems may hold diluted chemicals. Abandoned waste sites represent potential chronic exposure problems. However, during initial activities at emergency, response personnel engaged in sampling, handling containers, or bulking compatible liquids face an increased risk of acute exposures to splashes, mists, gases or particulates.

2.7 Dose Response

2.7.1 Acute Exposure

One time, high-level exposure, short time period.

Symptoms and effects usually immediately apparent.

Effects can be reversible or irreversible.

Range of Effects:

1. Temporary, but reversible.
2. Permanent but irreversible.

2.7.2 Chronic Exposure

Repetitive or continuous, low level exposure, long time periods.

Symptoms and effects usually delayed.

Range of Effects:

1. Irritant.
2. Nuisance, but temporary.

3. Permanent, but reversible.

4. Permanent, but irreversible.

5. Chronic, but debilitating.

6. Death.

2.8 Toxicity Measurements

2.8.1 Threshold Limit Values (TLV)

The first organization to suggest occupational guidelines for exposure to chemical hazards was the American Conference of Governmental Industrial Hygienists (ACGIH). In 1941, ACGIH suggested Maximum Allowable Concentrations (MACs) for use. A list of MACs was put together in 1946. In the early 1960s, ACGIH revised the MAC recommendations and renamed them Threshold Limit Values (TLVs).

TLVs were developed based on the body's ability to withstand various insults and continue to recover until a level is reached where recovery will no longer occur, or occur at decreased rates. This is referred to as the Threshold Concept. In other words, there is a sufficiently small amount of exposure to toxic substances that does nothing injurious. This concept implies that a threshold of effect, or a “no-effect” level exists. This no-effect level will vary from chemical to chemical. The development of Threshold Limit Values is based on these important concepts. There are many professionals who believe the threshold concept does not apply to carcinogens and that no exposure should be tolerated since it is believed that even low-level exposure to carcinogens could potentially result in cancer.

TLVs refer to airborne concentrations of substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, without adverse effect. Some susceptible individuals may be affected at levels below the TLVs.

TLVs are based on the best available information from industrial experience, experimental human and animal studies and, when possible, from a combination of the three. TLVs vary widely for the various substances. TLVs are revised yearly.

TLVs were formulated for the normal industrial workplace, which waste sites and spills are not. Thus, they can be used in decision-making at sites or spills only with great discretion. Before using the TLVs, the substance or substances of concern must be identified, which requires sound analytical techniques. TLVs can only provide a segment of the information needed to confidentially evaluate the situation.

2.8.2 Measures of Threshold Limit Values

Time Weighted Average

This is the average concentration most workers can be repeatedly exposed to during an 8-hour day, 40-hour week without developing adverse acute or chronic affects.

TLV with "Skin" Notation

A TLV may include a special "skin" notation. This indicates that direct skin contact should be avoided due to the chemical's skin absorption properties.

TLV-C: Ceiling

A TLV-C is a ceiling value. It's the concentration that cannot be exceeded even instantaneously because of serious health effects.

TLV – STEL: Short Time Exposure Limit

This is the allowable exposure concentration for a short time period. A 15-minute average exposure period, repeated no more than four times a day, with at least one hour between successive exposures, provided the 8-hour TWA is not exceeded. The STEL supplements the TWA where acute affects from high short time exposures are recognized.

2.9 Other Exposure Measurement Values

2.9.1 Immediately Dangerous To Life and Health (IDLH)

The "immediately dangerous to life and health" level was developed by NIOSH/OSHA for respirator selection and usage. IDLH means conditions that pose an immediate threat to life, health, or threat of severe exposure to contaminants. Exposure to IDLH environments is likely to cause irreversible damage or death. They can be found in the "NIOSH/OSHA Pocket Guide to Chemical Hazards".

2.9.2 Permissible Exposure Levels (PELS)

OSHA legally mandated values, found in 29 CFR, 1910.1000.

HOW MUCH IS A PART PER MILLION? BILLION? TRILLION?

Twenty years ago, science could measure only in parts per million (ppm). Impurities below that range could not be found. Now we can often detect impurities in parts per billion (ppb) or trillion (ppt). The result is that we are finding impurities more often in our food, water, and other products. These toxic substances can sometimes cause health problems to levels a person cannot detect with his or her own senses. The question is, are these numbers so small that we can safely ignore them? Is 11 ppm of a toxic chemical in drinking water or air really a threat? How about one ppm? Or one ppb?

The chemical industry might say we can ignore these numbers. Eleven parts per million is equal to an eleven-ounce needle in a ton of hay or to eleven minutes in two years. These levels sound harmless. Also, some say that any dangers of toxic chemicals at such levels are outweighed by their potential or actual benefits, especially if used as recommended.

But let's look at this in another way. One part per million of a substance means there is one milligram of that chemical for every kilogram of water, soil, or body weight. For example, in an adult weighing 130 pounds, a dose of one ppm equals 59 milligrams.

Consider this in terms of a common aspirin tablet. The average aspirin tablet has 325 milligrams of active ingredient. Two tablets equal 650 milligrams, about 11 ppm in a 130-pound person. This dose of aspirin seems small. Yet it can stop pain and reduce fever. While 11 ppm may seem small, it can mean a lot of change in our bodies.

2.9.3 Comparison of Parts Per Million, Billion and Trillion

One part per million (ppm) is equal to:

– One bottle of soda in a row of bottles over 40 miles long.

– One muffin in a stack of muffins 4 miles high.

– One car in a line of traffic 2650 miles long.

One part per billion (ppb) is equal to:

– One burger in a chain of burgers; circling the earth 2½ times.

– One step taken during a trip to the moon and back.

– One quarter in a stack of quarters nearly 1500 miles high.

One part per trillion (ppt) is equal to:

– One minute of time in the past 1,920,000 years.

– One postage stamp in an area the size of Chicago.

2.9.4 Relative Toxicity

Relative toxicities of material are compared in various ways, but care should be taken not to interpret these values as absolute in all cases. Harmful amounts of toxic substances are usually listed in one or more of the following ways:

– LD_{50} - Lethal dose, 50% kill amount of material when administered to laboratory animals kills half of them. Expressed as mg substance/kg animal. Lethal dose for average persons is LD_{50} x weight of person in kilograms.

– LC_{50} - Lethal concentration, 50% kill concentration of material, usually expressed in pm by volume which when administered to laboratory animals kills half of them in some time period of exposure.

– TLV - Threshold limit value upper limit of a toxicant concentration to which an average healthy person may be repeatedly exposed on an all day every day basis.

2.9.5 Physiological Action of Toxins

A good way to describe the various toxicants is by their physiological actions on living organisms. The following physiological categories of toxins will be discussed:

- Irritants
- Asphyxiate
- Nerve poisons
- Systemic poisons

Irritants are those substances, which have a corrosive, inflammatory action on moist mucous membranes. A term commonly associated with irritating material is **pulmonary edema** a buildup of fluid in the lungs. This condition may occur when a high concentration of an irritating material reaches the lungs. In an attempt to dilute the irritating substance, the lungs pour out fluid. This fluid may collect in the lungs and actually drown the respiratory system. Irritants may be divided into three classes:

- **Upper Respiratory Irritants** are highly water-soluble and are removed in the upper respiratory tract, i.e., the nose and throat.

  Examples: aldehydes, ammonia, mineral acids, halogen acids, sulphur oxides.

- **Lower Respiratory Irritants** are only slightly water-soluble and may be carried throughout the lungs.

  Examples: chloropicrin, nitrogen oxides, phosgene, arsenic trichloride.

- **Whole Respiratory Irritants** are moderately water-soluble but are only partially removed in the upper respiratory tract. Their effects are severe throughout the respiratory tract.

  Examples: chlorine, toluene, dimethyl, sulfate, ozone.

Asphyxiant are those substances, which interfere with the oxidation process of the body. Closely associated with asphyxiant, is the term anoxia, which is a deficiency of oxygen in the body tissue. A person may not be aware that his body is not receiving sufficient oxygen unless he is able to recognize the subtle effects of acute anoxia.

Some symptoms of acute anoxia are as follows:

- Mild euphoria, possible increased heartbeat and breathing rate.
- Headache and great fatigue after mild exertion.
- Altered breathing, nausea.
- Conscious or unconscious collapse.
- Convulsions, gasping, breathing stops, heart stops.
- Brain damage - 5 minutes, death - 8 minutes.

Simple Asphyxiation may result from a decrease or dilution of atmospheric oxygen.

Examples of simple asphyxiant: carbon dioxide, hydrogen, nitrogen, and methane.

Why does a man capable of holding his breath for one minute, collapse unconscious after a few breaths in an oxygen atmosphere?

Normally the atmosphere contains about 21% oxygen. When a person inhales only a 5% concentration of oxygen, then venous blood returning to the lungs gives up additional oxygen to the lungs rather than receiving oxygen as it would in a normal situation.

Super unoxygenated blood is then distributed throughout the body. When super unoxygenated blood reaches the brain, the brain shuts down. It may be only a few seconds between the first breath and collapse.

Chemical Asphyxiant causes suffocation even though adequate oxygen may be available.

Examples: carbon monoxide, hydrogen sulfide, aniline, hydrogen cyanide, acrylonitrile, sulfur dioxide, and mercaptan.

Carbon Monoxide binds to the blood hemoglobin 220 times tighter than oxygen. The more carbon monoxide that binds to blood, the less oxygen can be carried.

Nitrites and Aromatic Amines such as aniline cause oxygen not to release from the blood. A characteristic of this type of poisoning is a bluish coloration of the lips and fingernails. Effects are about one-half as severe as those for carbon monoxide.

Hydrogen Sulfide (H_2S) is the only common material that can halt respiration. It is a colorless, flammable gas with an offensive odor. However, H_2S can deaden the sense of smell at low concentrations. Hydrogen sulfide is 5 to 6 times more toxic than carbon monoxide.

Hydrogen Cyanide blocks oxygen uptake by the cells. It is an odorless, non-irritating gas that is highly toxic. A concentration of 250-300 ppm is usually rapidly fatal. Cyanide salts are also dangerous because they react with acids to form hydrogen cyanide.

Nerve Poisons are particularly hazardous because most physical and mental processes in the human body are controlled by the nervous system. There are two categories of nerve poisons based on their mechanism of action: depressants and convulsants.

Depressants interfere with the transmission of nerve impulses causing a narcotic effect, which can lead to unconsciousness and coma.

Examples: lead and lead compounds, isopropyl alcohol, acetone, carbon disulfide, cyclohexane, ethyl ether, dichloride, and methyl chloride.

Convulsants act at the spaces between nerve cells causing a continuous stimulation. These materials are extremely hazardous because their action is at a very critical site in the body. The major group of common materials, which fall into this category, are the organ phosphorus pesticides.

Examples: Diazonon, Malathion and Parathion.

Systemic Poisons injure or destroy internal organs of the body such as the liver, kidneys, and heart.

Liver Poisons

The liver is involved in purification and detoxification of the bloodstream. When heavy metals are removed from the bloodstream, however, there is no mechanism for eliminating these heavy metal compounds from the liver. The heavy metals tend to accumulate and damage the liver as they build up. Another major class of liver poisons contains organic chlorinated compounds and fat solvents. Fat-soluble compounds are concentrated and stored in the liver damaging liver tissues.

Examples: Lead, mercury, arsenic, beryllium, carbon tetrachloride, chloroform, vinyl chloride, chlordane, DDT.

Persons exposed in a fire situation will encounter gaseous combustion and decomposition products, which are generally toxic. The most common fire gases are carbon dioxide, carbon monoxide, sulfur dioxide, nitric oxide, nitrogen dioxide, ammonia, hydrogen sulfide, and hydrogen cyanide. Plastics are becoming notorious because of the toxic gases produced during fires.

Examples: Polyvinyl Chloride (PVC) hydrogen Chloride. Phosgene, Polyurethane Foam, Orion, Plexiglas, Nylon, hydrogen Cyanide, Ammonia, Nitrogen Dioxide, Nitric Oxide.

Procedures for handling victims whom have inhaled toxic substances:

– Rescuer must wear full protective clothing and breathing apparatus.
– Use “buddy system” for any rescue attempt and a lifeline.
– Carry patient to fresh air immediately.
– Institute general first aid measures that apply.

Procedures for handling victims whom have swallowed toxic substances:

– **DO NOT induce vomiting in patient** unless authorized.

Procedures for handling exposure of the skin to toxic or corrosive substances:

– Immediately remove contaminated clothing, jewelry.
– Drench skin with large amounts of running water.
– Rapid washing with soap and water reduces extent of poison absorption and injury. Include ear canal, nose and under nails.
– Initiate general first aid measures that apply.
– Cover injured area with loosely applied clean cloth.
– Avoid application of ointments, greases, powder or drugs to injured area. Do not administer drugs unless directed by a physician.
– For local pain, apply ice.

NOTE: These treatments may be administered until trained medical personnel arrive.

Summary

Toxic compounds may injure the human body in many ways and require only very small amounts to produce these injuries. Usually there are definite symptoms which provide clues that poisoning has occurred. Many potentially hazardous incidents may be avoided by being aware that toxic substances are present and taking proper safety precautions.

2.10 Chemicals Handling - General Guideline

Chemicals present different problems in storage, handling and use. While chemicals are safe when handled and stored properly, improper storage or handling could be hazardous. All employees should be aware that some chemicals may ignite when heated, react with water, heat spontaneously, decompose into hazardous substance, or cause ignition on contact with combustible materials. It is essential that the properties of each chemical be understood.

Remember to refer to the Material Safety Data Sheet when working with any chemical.

2.10.1 Definitions of Hazardous Chemicals

Compatibility:
Capable of forming a chemically or biochemically stable system.

Incompatibility:
Capable of forming a chemically or biochemically unstable system.

Corrosive:
Capable of dissolving or eating away gradually, especially by chemical action.

Reactive:
Normally unstable and readily undergoes violent change without detonating.

Volatile:
Evaporating readily at normal pressures and temperatures.

Flammable:
Easily ignited and burns so vigorously and persistently that it creates a hazard.

Explosive:
Any chemical compound, mixture substantially instantaneous release of gas and heat.

Toxic:
Of, relating to, or caused by a poison.

Inert:
Deficient in active properties.

Radioactive:
Any material, which spontaneously emits radiation.

Heavy metals:
Having high specific gravity. (Examples: Arsenic, copper, lead mercury).

Organics:
(Aliphatic and halogenated aromatic) of, relating to, or containing carbon compounds.

Cyanides:
Compound of cyanogen PCBs that are poisonous and environmental pollutants.

Pesticides:
Agents used to destroy pests.

2.10.2 Material Safety Data Sheets

Material Safety Data Sheets must contain the following information:

1. The manufacturer's name, address, and telephone number, date of preparation as well as date of last revision.

2. The name and chemical identity of all hazardous components (including common names).

3. The threshold limit value (TLV) and the OSHA Permissible Exposure Limit (PEL).

4. Chemical and physical properties such as vapor pressure, vapor density, boiling point, odor and appearance.

5. Pertinent fire and explosion data including flashpoint.

6. Reactivity information.

7. Health hazard data such as routes of entry, carcinogenicity, acute and chronic exposure information, sign and symptoms of exposure, pre-existing medical conditions that could be complicated by exposure, and emergency first aid procedures.

8. Personnel health and safety measure such as respiratory protection, eye protection, protective clothing, ventilation and other equipment.

9. Safe handling procedures including precautions for spill and leak clean up, waste disposal methods and handling and storage data.

The American National Standards Institute (ANSI) has developed a voluntary format, which consists of 16 sections each MSDS sheet being the same.

EXAMPLE ANSI MSDS:

<u>MATERIAL SAFETY SHEET</u>

MATERIAL SAFETY SH
NUMBER 0001
ISSUE DATE: September 9, 1997

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

   Yarn Lubricant 289 - Code 707,T120

   PETEX
   2700 W.W. Thorne Drive
   Houston, TX 77073

1-800-687-7052

2. COMPOSITION INFORMATION ON INGREDIENTS

Chemical Name	Percentage	CAS Number
Component A	12%	Trade Secret

3. HAZARDS IDENTIFICATION

Emergency Overview

Clear oil-like liquid with slight, sweet odor. Contact with eyes may cause numbness.

Potential Health Effects

Eyes: May cause numbness (anaesthesia) to eyes.

Skin: Will not irritate the skin and is not likely to cause allergic skin reaction.

Ingestion: Swallowing large amounts of Compound A can cause diarrhoea.

4. FIRST AID MEASURES

Eyes: Flush eyes with water for 15 minutes if liquid contact occurs and contact medical personal to check your eyes.

Skin: Wash with soap and water and check with medical personnel.

5. FIRE FIGHTING MEASURES

Fire and Explosion

Yarn Lubricant 289 is not considered flammable or combustible, but will burn if involved in a fire.

6. ACCIDENTAL RELEASE MEASURES

Contain spilled liquid with sand and dirt and place absorbed spill in a chemical waste container.

This material forms smooth slippery surface on floors that pose an accident risk.

7. HANDLING AND STORAGE

Ensure that containers are properly secured before moving.

Store in diked area and KEEP AWAY FROM OXIDIZING MATERIALS.

8. EXPOSURE CONTROL/PERSONAL PROTECTION

Appropriate engineering controls should be designed and installed to prevent mist levels from exceeding the recommenced exposure guidelines.

If there is a potential of eye and skin contact it is recommended that personal wear safety glasses and neoprene gloves.

Full-face NOISH air purifying respirators are recommended for mist levels exceeding the exposure guidelines.

<u>Exposure Guidelines</u>

Yarn Lubricant 289

OSHA		AGGIH		PETEX	
TWA	STEL	TWA	STEL	TWA	STEL
n/e	n/e	5.0 mg/m^3	n/e	5.0 mg/m^3	n/e

n/e- none established

9. PHYSICAL AND CHEMICAL PROPERTIES

<u>Appearance</u>: Clear, oil-like liquid
<u>Odor</u>: Slight sweet odor
<u>Odor Threshold Level</u>: Unknown
<u>Physical State</u>: Liquid
<u>pH</u>: 6 to 8
<u>Vapor Pressure</u>: Very low
<u>Melting Point</u>: Not determined
<u>Solubility in Water</u>: Miscible
<u>Specific Gravity</u>: Less than water (water = 1)
<u>Evaporation rate</u>: Very low
<u>Viscosity</u>: Oil-like
<u>Percent Volatile</u>: Less than 1%
<u>Molecular Weight</u>: 96.8

10. STABILITY AND ACTIVITY

Yarn Lubricant 289 is considered a stable material under normal storage and handling conditions. It is considered incompatible with strong oxidizers.

11. TOXICOLOGICAL INFORMATION

<u>Acute Oral Effects</u>: Expected to be low.

<u>Acute Dermal Toxicity</u>: Expected to be low.

<u>Inhalation Toxicity</u>: Study on rats was conducted at 50 mg/m^3 with no adverse effects.

Eye Irritation: An eye irritation study produced mild conjunctival irritation that cleared by day four. There was no corneal irritation.

Skin Irritation: No skin irritation was noted in the two-week rat dermal study.

Sensitization: No sensitization was noted in a 10 dose repeated insult patch test in humans.

Mutagenesis: Negative in the Ames test.

12. ECOLOGICAL INFORMATION

No data available on adverse effects of the material on the environment.

13. DISPOSAL CONSIDERATIONS

Yarn Lubricant 289 is not a considered a hazardous waste under the Federal Hazardous Waste Regulations 40 CFR 261. State and local regulations may be more restrictive, consult them regarding the proper disposal of this material.

14. TRANSPORT INFORMATION

Yarn Lubricant 289 is not a Hazardous Material.

15. REGULATORY INFORMATION

According to OSHA Hazard Communication Standard, Yarn Lubricant 289 is a hazardous chemical.

Yarn Lubricant 289 complies with all TACA Inventory requirements.

Yarn Lubricant 289 is not a CERCLA Reportable Quantity (RQ); however, release into a waterway may require reporting to the National Response Centre if a sheen or emulsion is observed.

Yarn Lubricant 289 contains no priority pollutant as regulated under the Clean Water Act.

16. OTHER INFORMATION

All containers of Yarn Lubricant 289 must be labelled “Yarn Lubricant 289”.

The following Hazard Ratings are recommended for containers of Yarn Lubricant 289.

NAPA	HMIS
Health - 1	Health - 1
Fire - 1	Fire - 1
Reactivity - 0	Reactivity - 0

Specific Hazard - None Personal Protection Index

3 SURVEYING THE INCIDENT

3.1 Objectives

At the conclusion of this module you should be able to do the following:

1. Identify the five categories of hazardous materials.
2. Explain the difference between the physical properties of gases, liquids and solids.
3. Explain the National Fire Protection Association (NFPA) 704 System.
4. Know how to use the 2000 Emergency Response Guide Book in an emergency.
5. Understand the possible hazards associated with explosives, gases, flammables, flammable solids, oxidizers and organic peroxides, poisons/toxic, etiologic agents, radioactive materials and corrosives.
6. Understand the handling of drums and other containers.

3.2 Definition of Hazardous Materials

A hazardous material is a naturally occurring or man made material that because of its physical or chemical properties can cause the deterioration of other materials or can be injurious to living things.

3.3 Classification of Hazardous Materials

Materials can be hazardous in five ways:

1. Flammable, ignitable or explosive.
2. Corrosive.
3. Reactive.
4. Toxic or poisonous.
5. Radioactive.

3.4 Physical Properties of Hazardous Materials

Physical Condition

The condition of a material (gas, liquid or solid) strongly influences the potential danger posed by that material. A material that is dangerous in one form may be relatively harmless in another.

1. Gases are more hazardous than liquids or solids, as a general rule.
    a) Flammable gases ignite easily.
    b) Toxic gases can easily enter the body through inhalation.
    c) Gases in the environment are more difficult to contain and control than liquids or solids, but they are more easily dispersed.
    d) Gases sometimes are tasteless and odorless.
    e) Gases can be heavier or lighter than air, which can present a problem, if atmospheric testing, as in confined spaces, is not properly conducted.
2. Liquids are more hazardous than solids.
    a) Liquids generally have a higher vapor pressure than solids and flammable liquids ignite easily only when vaporized.
    b) Vapors from toxic liquids can be inhaled.
    c) Liquids have the greatest potential for skin absorption compared to gases or solids. Toxic liquids can be absorbed by the skin if spilled or splashed.

d) Hot or cold liquids have a greater risk of thermal injury than gases or solids. Liquids can be very hot, such as liquid sulfur (246°F) or very cold, such as liquid nitrogen (-230°F).

e) Liquids can sink, float or dissolve in water. In the environment they can be collected, contained or absorbed if insoluble; they can be dispersed or diluted if soluble.

3. Solids are generally less hazardous than gases or liquids unless finely divided, such as a powder.

a) Ignitable solids will burn when the ignition temperature is reached.

b) Toxic solids have the most difficulty gaining access to the body.

c) Solids in the environment can be easily collected and contained.

3.5 Hazardous Material/Hazardous Waste Characteristics

Four particular characteristics are associated with hazardous wastes: ignitability, corrosivity, reactivity and toxicity. Some wastes may have more than one of these characteristics. **Ignitable** wastes can catch fire easily. **Corrosive** wastes can burn the eyes on contact or corrode standard containers. **Reactive** wastes can catch fire, explode or give off dangerous fumes when exposed to water or air. **Toxic** wastes are poisonous.

3.6 Hazard Classification Systems

Hazardous materials are stored and transported in large quantities. Frequently, some are released that present a potential hazard to the public and environment. Such an incident can be managed better when the hazardous material is identified. Unfortunately the contents of storage tanks or drums may not always be properly identified; records or shipping papers may be inaccessible. Even with such information, an experienced person is needed to define the hazards and their seriousness.

Because of the immediate need for information concerning a hazardous material, two systems for hazard identification were developed and have become widely used. Both systems help responders to deal with an incident quickly and safely, and were devised for persons untrained in chemistry. The first system is the National Fire Protection Association (NFPA), 704 M System, which is used mostly on storage tanks and smaller containers. The second system is used exclusively on containers and tanks that are being transported.

NFPA - NATIONAL FIRE PROTECTION ASSOCIATION

NFPA Standard applies to facilities, which manufacture, store or use hazardous materials. The system identifies the “health”, “flammability” and “reactivity” hazards of a material. Blue for “health” hazard, red for “flammability”, and yellow for “reactivity” such as dangerous gas.

3.6.1 Health Hazard

Definition: The likelihood of a material to cause, either directly or indirectly, temporary or permanent injury or incapacitation due to an acute exposure by contact, inhalation, or ingestion.

Degrees of Hazard: The degrees of health hazard shall be ranked according to the probable severity of the effects of exposure to personnel as follows:

4 Materials that, on very short exposure, could cause death or major residual injury, including those that are too dangerous to be approached without specialized protective equipment. This degree usually includes:

- Materials that, under normal conditions or under fire conditions, are extremely hazardous (i.e., toxic or corrosive) through inhalation or through contact with or absorption by the skin.
- Materials whose LD_{50} for acute oral toxicity is less than or equal to 5 milligrams per kilogram (mg/kg).
- Materials whose LD_{50} for acute dermal toxicity is less than or equal to 40 milligrams per kilogram (mg/kg).
- Dusts and mists whose LC_{50} for acute inhalation toxicity is less than or equal to 0.5 milligrams per liter (mg/L).
- Any liquid whose saturated vapor concentration at 20°C is equal to or greater than ten times its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 1,000 parts per million (ppm).
- Gases whose LC_{50} for acute inhalation toxicity is less than or equal to 1,000 parts per million (ppm).

3 Materials that, on short exposure, could cause serious temporary or residual injury, including those requiring protection from all bodily contact. This degree usually includes:

- Materials that give off highly toxic combustion products.
- Materials whose LD_{50} for acute oral toxicity is greater than 5 milligrams per kilogram (mg/kg), but less than or equal to 50 milligrams per kilogram (mg/kg).
- Materials whose LD_{50} for acute dermal toxicity is greater than 40 milligrams per kilogram (mg/kg), but less than or equal to 200 milligrams per kilogram (mg/kg).
- Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 0.5 milligrams per liter (mg/L), but less than or equal to 2 milligrams per liter (mg/L).
- Any liquid whose saturated vapor concentration at 20°C is equal to or greater than its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 3,000 parts per million (ppm) and that does not meet the criteria for degree of hazard 4.
- Gases whose LC_{50} for acute inhalation toxicity is greater than 1,000 parts per million (ppm), but less than or equal to 3,000 parts per million (ppm).
- Materials that either is severely corrosive to skin on single, short exposure or cause irreversible eye damage.

2 Materials that, on intense or short exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of respiratory protective equipment that has an independent air supply. This degree usually includes:

- Materials that give off toxic or highly irritating combustion products.
- Materials that, under normal conditions or fire conditions, give off toxic vapors that lack warning properties.
- Materials whose LD_{50} for acute oral toxicity is greater than 50 milligrams per kilogram, but less than or equal to 500 milligrams per kilogram (mg/kg).
- Materials whose LD_{50} for acute dermal toxicity is greater than 200 milligrams per kilogram (mg/kg), but less than or equal to 1,000 milligrams per kilogram (mg/kg).
- Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 2 milligrams per liter (mg/L), but less than or equal to 10 milligrams per liter (mg/L).
- Any liquid whose saturated vapor concentration at 20°C is equal to or greater than one-fifth (1/5) its LC_{50} for acute inhalation toxicity, if its LC_{50} is less than or equal to 5000 parts per million (ppm), and that does not meet the criteria for either degree of hazard 3 or degree of hazard 4.
- Gases whose LC_{50} for acute inhalation toxicity is greater than 3000 parts per million (ppm), but less than or equal to 5,000 parts per million (ppm).
- Materials that cause severe but reversible respiratory, skin or eye irritation.

1 Materials that, on shore exposure, could cause irritation, but only minor residual injury, including those requiring the use of an approved air-purifying respirator. This degree usually includes:

- Materials that, under fire conditions, gives off irritating combustion products.
- Materials that, under fire conditions, cause skin irritation, but not destruction of tissue.
- Materials whose LD_{50} for acute oral toxicity is greater than 500 milligrams per kilogram (mg/kg), but less than or equal to 2,000 milligrams per kilogram (mg/kg).
- Materials whose LD_{50} for acute dermal toxicity is greater than 1000 milligrams per kilogram (mg/kg), but less than or equal to 2,000 milligrams per kilogram (mg/kg).
- Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 10 milligrams per liter (mg/L), but less than or equal to 200 milligrams per liter (mg/L).
- Gases and vapors whose LC_{50} for acute inhalation toxicity is greater than 5000 parts per million (ppm), but less than or equal to 10,000 parts per million (ppm).
- Materials that are moderate respiratory irritants or that cause slight to moderate eye irritation.

0 Materials that on short exposure under fire conditions would offer no hazard beyond that of ordinary combustible materials. This degree usually includes:

- Materials whose LD_{50} for acute oral toxicity is greater than 2,000 milligrams per kilogram (mg/kg).
- Materials whose LD_{50} for acute dermal toxicity is greater than 2,000 milligrams per kilogram (mg/kg).
- Dusts and mists whose LC_{50} for acute inhalation toxicity is greater than 200 milligrams per liter (mg/L).
- Gases and vapors whose LC_{50} for acute inhalation toxicity is greater than 10,000 parts per million (ppm).

3.6.2 Flammability Hazards

Degrees of Hazard: The degrees of hazard shall be ranked according to the susceptibility of materials to burning as follows:

4 Materials that will rapidly or completely vaporize at atmospheric pressure and normal ambient temperature or that are readily dispersed in air, and which will burn readily. This degree usually includes:

- Flammable gases.
- Flammable cryogenic materials.
- Any liquid or gaseous material that is liquid while under pressure and has a flash point below 73°F (22.8°C) and a boiling point below 100°F (37.8°C) (i.e., Class IA flammable liquids).
- Materials that ignite spontaneously when exposed to air.

3 Liquids and solids that can be ignited under almost all ambient temperature conditions. Materials in this degree produce hazardous atmospheres with air under almost all ambient temperatures or, though unaffected by ambient temperatures, are readily ignited under almost all conditions. This degree usually includes:

- Liquids having a flash point below 73°F (22.8°C) and having a boiling point at or above 100°F (37.8°C) and those liquids having a flash point at or above 73°F (22.8°C) and below 100°F (37.8°C) (i.e., Class IB and Class IC flammable liquids).
- Materials that on account of their physical form or environmental conditions can form explosive mixtures with air and that are readily dispersed in air, such as dusts of combustible solids and mists of flammable or combustible liquid droplets.
- Materials that burn with extreme rapidity, usually by reason of self-contained oxygen, (e.g., dry nitrocellulose *and many organic peroxides).*

2 Materials that must be moderately heated or exposed to relatively high ambient temperatures before ignition can occur. Materials in this degree would not under normal conditions form hazardous atmospheres with air, but under high ambient temperatures or under moderate heating, may release vapor in sufficient quantities to produce hazardous atmospheres with air. This degree usually includes:

- Liquids having a flash point above 100°F (37.8°C), but not exceeding 200°F (93.4°C) (i.e., Class II and Class IIIA combustible liquids).
- Solid materials in the form of coarse dusts that may burn rapidly but that generally do not form explosive atmospheres with air.

– Solid materials in a fibrous or shredded form that may burn rapidly and create flash fire hazards, such as cotton, sisal, and hemp solids and semisolids that readily give off flammable vapors.

1 Materials that must be preheated before ignition can occur. Materials in this degree require considerable preheating, under all ambient temperature conditions, before ignition and combustion can occur. This degree usually includes:

– Materials that will burn in air when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes or less.

– Liquids, solids and semisolids having a flash point above 200°F (93.4°C) (i.e., Class IIIB combustible liquids).

– Most ordinary combustible materials.

0 Materials that will not burn. This degree usually includes any material that will not burn in air when exposed to a temperature of 1500°F (815.5°C) for a period of 5 minutes.

3.6.3 Reactivity (Instability) Hazards

Degrees of Hazard: The degrees of hazard shall be ranked according to ease, rate and quantity of energy release as follows:

4 Materials that in themselves are readily capable of detonation or explosive decomposition or explosive reaction at normal temperatures and pressures. This degree usually includes materials that are sensitive to localized thermal or mechanical shock at normal temperatures and pressures.

3 Materials that in themselves are capable of detonation or explosive decomposition or explosive reaction, but that require a strong initiating source that must be heated under confinement before initiation. This degree usually includes:

– Materials that are sensitive to thermal or mechanical shock at elevated temperatures and pressures.

– Materials that react expolosively with water without requiring heat or confinement.

2 Materials that readily undergo violent chemical change at elevated temperatures and pressures. This degree usually includes:

– Materials that exhibit an exotherm at temperatures less than or equal to 150°C when tested by differential scanning calorimetry.

– Materials that may react violently with water or form potentially explosive mixtures with water.

1 Materials that in themselves are normally stable, but that can become unstable at elevated temperatures and pressure. This degree usually includes:

– Materials that change or decompose on exposure to air, light or moisture.

– Materials that exhibit an exotherm at temperatures greater than 150°C, but less than equal to 300°C, when tested by differential scanning calorimetry.

0 Materials that in themselves are normally stable, even under fire conditions. This degree usually includes:

– Materials that do not react with water.

- Materials that exhibit an exotherm at temperatures greater than 300°C but less than or equal to 500°C when tested by differential scanning calorimetry.
- Materials that do not exhibit an exotherm at temperatures less than or equal to 500°C when tested by differential scanning calorimetry.

3.6.4 Special Hazards

Symbols: Materials that demonstrate unusual reactivity with water shall be identified with the letter **W** with a horizontal line through the center (**W**). Materials that posses oxidizing properties shall be identified by the letters **OX**.

3.7 UN Hazard Identification System

Transportation Canada regulates over 16,000 dangerous goods. The regulations require labels on small containers, and placards on tanks and trailers. These placards and labels indicate the nature of the hazard presented by the cargo. The classification used for the placards and labels is based on the **United Nations Hazard Classes**. The UN hazard class number is found in the bottom corner of a DOT placard or label.

UN HAZARD CLASS SYSTEM

UN Hazard

Class Number	Description
1	Explosives
2	Nonflammable and flammable compressed gases
3	Flammable liquids
4	Flammable solids, spontaneously combustible substances and water-reactive substances
5	Oxidizing materials, including organic peroxides
6	Toxics, irritants and etiologic (disease-causing materials)
7	Radioactive materials
8	Corrosive materials (acids, alkaline liquids and certain corrosive solids)
9	Miscellaneous hazardous materials not covered by any of the other classes

To facilitate handling a hazardous material incident some placards are altered to accept a four-digit identification number and must be written on the shipping papers or manifest. In the event of an incident, the ID number on the placard will be much easier to obtain than the shipping papers. Once the number is obtained, The 2000 Emergency Response Guide Book can be consulted. This book describes the proper methods and precautions for responding to a release of each hazardous material with an ID number. The Guidebook is a tool that will convert the clues provided by labels, placards and four-digit ID numbers into more useful information. The Guide pages provide field information in health hazards, stability, and protective clothing and respiratory protection. They also recommend procedures for fire fighting, spill and leak control and emergency care.

The book is organized into four principal sections, including the white, yellow and blue indices in the front, the orange-topped Guide pages in the middle, and green in back.

Using both systems when responding to hazardous material incidents will help to properly identify and characterize the hazards involved.

3.8 Classification of Hazardous Materials

An explosive is any chemical compound, mixture, or device whose primary purpose is to function by explosion, with or without an ignition source (flame or spark) intentionally/unintentionally generated with substantial releases of heat and gas.

Division 1.1 – Explosives present a maximum hazard through mass detonation.

<u>Examples are dynamite, TNT, black powder, military ammunition</u>.

Divisions 1.2, 1.3, 1.4 – Explosives are those material or devices which function by deflagration and present a flammable hazard.

<u>Examples are display fireworks, rocket motor, military ammunition</u>.

Divisions 1.5, 1.6 – Explosives are those materials or devices that contain insensitive explosives.

<u>Examples are common fireworks, detonating fuses, small arms ammunition</u>.

Possible hazards from explosives:

1. Blast over-pressure and shock waves

2. Fragment scattering

3. Fire proliferation

A compressed gas is any material having an absolute pressure in the container exceeding 40 psi at 21°C or having an absolute pressure exceeding 104 psi at 54°C.

A flammable gas is any as capable of forming ignitable mixtures with air.

<u>Examples are hydrogen, acetylene, propane, and butane</u>.

A nonflammable gas will not burn but may support combustion.

<u>Examples are carbon dioxide, oxygen, sulfur dioxide, and chlorine</u>.

NOTE: Some nonflammable gases do not support combustion.

<u>Examples are argon, and helium</u>.

A liquefied gas is a gas that is partially in a liquid state at a temperature of 21°C.

<u>Examples are propane, butane, chlorine, anhydrous ammonia, vinyl chloride, and carbon dioxide</u>.

A nonliquified gas is entirely gaseous at a temperature of 21°C.

Examples are hydrogen, nitrogen, and oxygen.

A gas in solution is a non-liquified gas that is dissolved at high pressure in a solvent.

Example is acetylene in acetone.

A cryogen is a gas that must be cooled to a very low temperature to maintain it in a liquid form.

Examples are nitrogen, oxygen, and hydrogen.

Possible hazards associated with compressed gases:

1. Container rupture
2. Combustion, explosion
3. Asphyxiation
4. Toxicity or corrosiveness
5. Frostbite
6. Reactivity

A **flammable liquid** is any liquid with a flash point below 37°C.

Examples are gasoline, ethylene oxide, ethyl alcohol, toluene, and benzene.

A combustible liquid is any liquid that has a flash point at or above 37°C but below 93°C.

Examples are fuel oil, diesel, solvent, and thinners.

A **pyrophoric liquid** is any liquid that ignites spontaneously in dry or moist air at or below 54°C.

Examples are aluminum alkalies, alkyl borane.

Possible hazards associated with flammable and combustible liquids:

1. Fire
2. Container rupture
3. Combustion explosion
4. Toxicity or corrosiveness
5. Aquatic contamination

A **flammable solid** is any solid material which is liable to cause fire through friction or retained heat from manufacturing or processing or that can be ignited readily, and when ignited burns so vigorously and persistently as to create a serious transportation hazard.

Air-reactive (pyrophoric) solids will ignite at normal temperatures when exposed to air.

Example is white phosphorous.

Water-reactive solids will react in varying degrees when mixed with water or in contact with humid air.

Examples are metallic sodium, and calcium carbide.

Spontaneously combustible solids can decompose in the presence or absence of air.

Examples are oily cotton waste, and burnt fibers.

Possible hazards associated with flammable solids:

1. Fire
2. Explosion
3. Toxicity and corrosiveness

An **oxidizer** is a substance that yields oxygen readily to stimulate combustion.

Examples are sodium nitrate, calcium hypochlorite, and potassium permanganate.

Possible hazards associated with oxidizers:

1. Increase fire intensity
2. Sensitive to heat, shock, friction
3. React spontaneously with organic matter

An organic peroxide is an unstable organic derivative of the inorganic compound hdrogen peroxide.

Examples are benzovl peroxide, peracetic acid, and methyl ethyl ketone peroxide.

Possible hazards associated with organic peroxides:

1. Fire
2. Explosion-sensitive to heat, shock, friction
3. Toxic combustion by products
4. Exposure to fire may evaporate inhibitor and increase

Poison is any substance of such a nature that a very small amount is dangerous to life.

Examples are hydrogen cyanide, phosgene, nitrogen tetroxide, and aniline.

Irritating materials are liquids or solids, which, upon contact with fire or exposure to air, give off dangerous or irritating fumes.

Example is tear gas grenades.

Possible hazards associated with poisons:

1. Inhalation, skin absorption, or ingestion can be harmful
2. Container rupture
3. Fire
4. Aquatic contamination

Etiologic agents are living micro-organisms that may cause human disease.

Examples are biological and viral specimens.

A **radioactive material** is any material that spontaneously emits ionizing radiation.

Examples are plutonium, enriched uranium, radioactive iodine and radon

Possible hazards associated with radioactive material:

1. Lethal or sub-lethal effects from exposure.
2. Smoke, steam, or run-off water may be contaminant sources.

A **corrosive** is any liquid or solid that can destroy human skin tissue or any liquid that has a severe corrosion rate of steel.

Acids

Examples are sulfuric, nitric, and hydrochloric acids, ferric chloride solution.

Bases

Examples are sodium Hydroxide, potassium Hydroxide, and alkaline corrosive battery fluid.

Possible hazards associated with corrosives:

1. Severe health hazard
2. Violent reactions with some materials
3. Container rupture
4. Some may act as an oxidizer (example: nitric acid)
5. Heat of reaction may be sufficient to ignite combustible matter

6. Flammable reaction products may be produced

7. Aquatic contamination

3.9 Handling Drums and Other Containers

Accidents may occur during handling of drums and other hazardous waste containers. Hazards include detonations, fires, explosions, vapor generation, and physical injury resulting from moving heavy containers by hand and working around stacked drums, heavy equipment, and deteriorated drums. While these hazards are always present, proper work practices - such as minimizing handling and using equipment and procedures that isolate workers from hazardous substances - can minimize the risks to site personnel.

3.9.1 Inspection

The appropriate procedures for handling drums depend on the drum contents. Thus, prior to any handling, drums should be visually inspected to gain as much information as possible about their contents. The inspection crew should look for:

– Symbols, words or other marks on the drum indicating that its contents are hazardous, e.g., radioactive, explosive, corrosive, toxic, and flammable.

– Symbols, words, or other marks on a drum indicating that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume individual containers.

– Signs of deterioration such as corrosion, rust, and leaks.

– Signs that the drum is under pressure such as swelling and bulging.

– Drum type.

– Configuration of the drumhead.

Conditions in the immediate vicinity of the drums may provide information about drum contents and their associated hazards. Monitoring should be conducted around the drums using instruments such as a gamma radiation survey instrument, organic vapor monitors, and a combustible gas meter.

The results of this survey can be used to classify the drums into preliminary hazard categories, for example:

0. Radioactive.
1. Leaking/deteriorated.
2. Bulging.
3. Explosive/shock-sensitive.
4. Contains small-volume individual containers of laboratory wastes or other dangerous materials.

As a precautionary measure, personnel should assume that unlabeled drums contain hazardous materials until their contents are characterized. Also, they should bear in mind that drums are frequently mislabeled - particularly drums that are reused. Thus, a drum's label may not accurately describe its contents.

If buried drums are suspected, ground-penetrating systems, such as electromagnetic wave, electrical resistivity, ground-penetrating radar, magnetometer, and metal detection, can be used to estimate the location and depth of the drums.

Special Drum Types and Their Associated Hazards

Polyethylene PVC-Lined Drums - often contain strong acids or bases. If the lining is punctured, the substance usually quickly corrodes the steel, resulting in a significant leak or spill.

Exotic Metal Drums - Very expensive drums that usually contain an extremely dangerous material
(e.g., alumi-material, nun, nickel, stainless, steel, or other unusual metal).

Single-Walled Drums Used as a Pressure Vessel - These drums have fittings for both product filling and placement of an inert gas, such as nitrogen. May contain reactive, flammable, explosive or substances.

Laboratory Packs - used for disposal of expired chemicals and process samples from university laboratories, hospitals, and similar institutions. Individual containers within the lab pack are often not packed in absorbent material. They may contain incompatible materials, radioisotoshock-sensitive, highly volatile, highly corrosive, or very toxic exotic chemicals. Laboratory packs can be an ignition source for fires.

Information Provided by Drumhead Configuration

CONFIGURATION INFORMATION
Whole lid removable. Designed to contain solid material.
Has a bung. Designed to contain a liquid.
Contains a liner. May contain a highly corrosive or otherwise hazardous material.

3.9.2 Bulging Drums

- Pressurized drums are extremely hazardous. Wherever possible, do not move drums that may be under internal pressure, as evidenced by bulging or swelling.

- If a pressurized drum has to be moved, whenever possible handle the drum with a grappler unit constructed for explosive containment. Either move the bulged drum only as far as necessary to allow seating on firm ground, or carefully over pack the drum. Exercise extreme caution when working with or adjacent to potentially pressurized drums.

3.9.3 Leaking, Open, and Deteriorated Drum

- If a drum containing a liquid cannot be moved without rupture, immediately transfer its contents to a sound drum using a pump designed for transferring that liquid.

- Using a drum grappler, place immediately in over pack containers:

3.9.4 Opening

Drums are usually opened and sampled in place however; remedial and emergency operations may require a separate drum opening area. Procedures for opening drums to enhance the efficiency and safety of drum-opening personnel, the following procedures should be instituted.

- If a supplied-air respiratory protection system is used, place a bank of air cylinders outside the work area and supply air to the operators via airlines and escape SCBAs. This enables workers to operate in relative comfort for extended periods of time.

- Protect personnel by keeping them at a safe distance from the drums being opened. If personnel must be located near the drums, place explosion-resistant plastic shields between them and the drums to protect them in case of detonation. Locate controls for drum opening equipment, monitoring equipment, and fire suppression equipment behind the explosion-resistant plastic shield.

- If possible, monitor continuously during opening. Place sensors of monitoring equipment, such as colorimetric tubes, dosimeters, radiation survey instruments, explosion meters, organic vapor analyzers, and oxygen meters, as close as possible to the source of contaminants, i.e., at the drum opening.

- Use the following remote-controlled devices for opening drums:

  - Pneumatically operated impact wrench to remove drum bungs.

  - Hydraulically or pneumatically operated drum piercers.

  - Backhoes equipped with bronze spikes for penetrating drum tops in large-scale operations.

- Do not use picks or chisels to open drums.

- If the drum shows signs of swelling or bulging, perform all steps slowly. Relieve excess pressure prior to opening and, if possible, from a remote location using such devices as a pneumatic impact wrench or hydraulic penetration device. If pressure must be relieved manually, place a barrier such as explosion-resistant plastic sheeting between the worker and bung to deflect any gas, liquid, or solids which may be expelled as the bung is loosened.

- Open exotic metal drums and polyethylene or polyvinyl chloride-lined (PVC-lined) drums through the bung by removal or drilling. Exercise extreme caution when handling these containers.

- Reseal open bungs and drill openings as soon as possible with new bungs or plugs to avoid explosions and/or vapor generation. If an open drum cannot be resealed, place the drum into an over-pack. Plug any openings in pressurized drums with pressure-venting caps set to a 5-psi (pounds per square inch) release to allow venting of vapor pressure.

3.10 Sampling

Drum sampling can be one of the most hazardous activities to worker safety and health because it often involves direct contact with the hazardous material. When manually sampling from a drum, use the following techniques:

- Keep sampling personnel at a safe distance while drums are being opened. Sample only after opening operations are complete.

- Do not lean over other drums to reach the drum being sampled, unless absolutely necessary.

- Cover drum tops with plastic sheeting or other suitable non-contaminated materials to avoid excessive contact with the drum tops.

- Never stand on drums. This is extremely dangerous. Use mobile steps or another platform to achieve the height necessary to safely sample from the drums.

- Obtain samples with either glass rods or vacuum pumps. Do not use contaminated items such as discarded rags to sample. The contaminants may contaminate the sample and may not be compatible with the waste in the drum. Glass rods should be removed prior to pumping to minimize damage to pumps.

3.11 Compressed Gas Cylinders

- Obtain expert assistance in moving and disposing of compressed gas cylinders.

- Handle compressed gas cylinders with extreme caution. The rupture of a cylinder may result in an explosion, and the cylinder may become a dangerous projectile.

- Record the identification numbers on the cylinders to aid in characterizing their contents.

3.12 Ponds and Lagoons

Drowning is a very real danger for personnel suited in protective equipment because the weight of protective equipment increases an individual's overall density and severely impairs their swimming ability. Where there is danger of drowning, provide necessary safety gear such as lifeboats, tag lines, railings, nets, safety harnesses, and flotation gear.

– Wherever possible, stay on shore. Avoid going out over the water.

– Be aware that some solid wastes may float and give the appearance of solid cracked mud. Caution should be exercised when working along shorelines.

4 SAFETY AT HAZMAT INCIDENTS

4.1 Objectives

At the conclusion of this module you should be able to do the following:

Describe the known hazards and evaluate the risks associated with the incident in each activity conducted.

List all the required information that must be included in an Emergency Response Plan.

Understand the effects of hazardous material exposure.

Understand the physical hazards associated with an emergency incident.

4.2 Site Safety Plans

The purpose of the site safety plan is to establish requirements for protecting the health and safety of responders during all activities conducted at an incident. It contains safety information, instructions and procedures.

A site safety plan must be prepared and reviewed by qualified personnel for each hazardous substance response. Before operations at an incident commence, safety requirements must be written, conspicuously posted or distributed to all response personnel, and discussed with them. The safety plan must be periodically reviewed to keep it current and technically correct.

In non-emergency situations, such as long-term remedial action at abandoned hazardous waste sites, safety plans are developed simultaneously with the general work plan. Workers can become familiar with the plan before site activities begin. Emergency response generally requires verbal safety instructions and reliance on existing standard operating procedures until, when time permits, a plan can be written.

The plan must contain safety requirements for routine (but hazardous) response activities and also for unexpected site emergencies. The major distinction between routine and emergency site safety planning is predictability. Routine activities are predictable and may be monitored and evaluated. A site emergency is unpredictable and may occur anytime.

4.3 General Requirenents

A site-specific health and safety plan becomes part of the company's written health and safety program. The site safety and health plan, which must be kept on site, shall address the safety and health hazards of each phase of site operations. The health and safety plan should:

- Describe the known hazards and evaluate the risks associated with the incident and with each activity conducted.
- List key personnel and alternates responsible for site safety, response operations and for protection of the public.
- Describe personal protective equipment and clothing to be worn by personnel.
- Designate work areas.
- Establish procedures to control site access.
- Describe procedures to control site access.
- Establish site emergency procedures.
- Address emergency medical care for injuries and toxicological problems.
- Describe requirements for an environmental surveillance program.
- Specify any routine and special training required for responders.

- Establish procedures for protecting workers from weather-related problems.

4.4 Site Safety Plan Scope and Detail

The plan's scope, detail and length is based on:

- Information available about the incident.
- Time available to prepare a site-specific plan.
- Reason for responding.

Three general categories of response exist - **emergencies, incident characterizations and remedial actions**. Considerations for personnel safety are generic and independent of the response category. However in scope, detail, and length, safety requirements and plans vary considerably. These variations are determined by the reason for responding (or category of response), information avail-able, and the severity of the incident with consideration for dangers to the responder.

4.4.1 Emergency Situations

Emergencies generally require prompt action to prevent or reduce undesired affects. Immediate hazards of fire, explosion, and release of toxic vapors or gases are of prime concern. Emergencies vary greatly in respect to types and quantities of material, numbers of responders, type of work required population affected, and other factors. Emergencies last from a few hours to a few days.

- Information Available: Varies from none too much. Usually information about the chemicals involved and their associated hazards is quickly obtained in transportation-related incidents, or incidents involving fixed facilities. Determining the substances involved is some incidents, such as mysterious spills, requires considerable time and effort.
- Time Available: Little time generally requires prompt action to bring the incident under control.
- Reason for Response: To implement prompt and immediate actions to control dangerous or potentially dangerous situations.

Effects on Plan

In emergencies, time is not available to write lengthy and detailed safety plans. Decisions for responder safety are based on a continual evaluation of changing conditions. Responding organizations must rely on their existing written standard operating safety procedures or a generic plan, and verbal safety instructions adapted to meet site-specific conditions. Since heavy reliance is placed on verbal safety instructions an effective system to keep all responders informed must be established. Whenever possible, these incident-specific instructions should be written.

4.4.2 Incident Characterization Situation

In non-emergency responses, such as preliminary inspections at abandoned waste sites or more comprehensive waste site investigations, the objective is to determine and characterize the chemicals and hazards involved, the extent of contamination, and risks to people and the environment. In general, initial inspections, detailed investigations, and extent of contamination surveys are limited in the activities that are required and number of people involved. Initial or preliminary inspections generally require 1 to 2 days. Complete investigations may last over a longer time period.

- **Information Available**: Much background information. Generally limited on-site data for initial inspection. On-site information more fully developed through additional site visits and investigations.

- **Time Available**: In most cases, adequate time is available to develop written site-specific safety plan.

- **Reason for Response**: To gather data to verify or refute existing information, to gather information to determine scope of subsequent investigations, or to collect data for planning remedial action.

Effects on Plan

Sufficient time is available to write safety plans. In scope and detail, plans tend to be brief containing safety requirements for specific on-site work relevant to collecting data. As information is developed through additional investigations, the safety plan is modified and, if necessary, more detailed and specific requirements added.

4.4.3 Remedial Actions Situation

Remedial actions are cleanups, which last over a long period of time. They commence after more immediate problems at an emergency have been controlled, or they involve the mitigation of hazards and restoration of abandoned hazardous waste sites. Numerous activities are required involving many people, a logistics and support base, extensive equipment and more involved work activities. Remedial actions may require months to years to completely accomplish.

- **Information Available**: Much known about on-site hazards.

- **Time Available**: Ample time for work planning.

- **Reason for Response**: Systematic and complete control, cleanup and restoration.

Effects on Plan

Since ample time is available before work commences, the site safety plan tends to be comprehensive and detailed. From prior investigations, much detail may be known about the materials or hazards at the site and the extent of the contamination.

4.5 Site Safety Plan Creation

To construct the plan, as much information as possible should be gathered about the anticipated incident. This would include, but not be limited to:

- Incident location and name
- Site description
- Site control procedures
- Chemicals and quantities involved
- Hazards associated with each chemical
- Behavior and dispersion of material involved
- Types of containers, storage or transportation methods
- Physical hazards
- Prevailing weather condition and forecast
- Surrounding populations and land use
- Ecologically sensitive areas
- Facility records
- Preliminary Assessment Reports
- Off-site surveys
- Topographic and Hydrologic information

This information provides a basis for developing a site-specific safety plan. Information is needed about the chemicals and hazards involved, movement of material on and off the site, and potential contact with responders or the public. This type of information is then used along with the reason for responding and the work plan to develop the safety plan. The plan is tailored to the conditions imposed by the incident and to its environmental setting. As additional information becomes available, the safety plan is modified to protect against the hazards discerned and to provide for site emergencies that may occur.

4.6 Site Control Issues

A site control program for protecting workers which is part of the site safety and health program should be developed during the planning stages of a hazardous waste operation. The program should be modified as necessary as new information becomes available.

In general, the purpose of a site control program is to:

1. Minimize potential contamination of workers.
2. Protect the public from the site's hazards.
3. Protect the environment from the spread of contamination.

4.7 Routine Operations

Routine operations are those activities required when responding to either an emergency or a remedial action at a hazardous waste site. These activities may involve a high degree of risk, but must be performed at all incident responses.

Safety practices for routine operations are very similar to generally accepted industrial hygiene and industrial safety practices. Whenever a hazardous incident progresses to the point where operations become more routine, the associated site safety plan becomes a more refined document.

ALL THE FOLLOWING INFORMATION MUST BE IN THE PLAN

4.7.1 Describe the Known Hazards and Risks

This must include all known or suspected physical, biological, radiological or chemical hazards. It is important that all health-related information be kept up-to-date. As air, water, soil or hazardous substance monitoring and sampling data becomes available, it must be evaluated, significant risk or exposures to workers noted, potential impact on the public assessed, and appropriate changes made to the plan. These evaluations must be repeated frequently since much of the plan is based on this information.

4.7.2 List Key Personnel and Alternates

The plan must identify key personnel (and alternates) responsible for site safety. It should also identify key personnel assigned to various site operations. Telephone numbers, addresses and organizations of these people must be listed in the plan and posted in a conspicuous place.

4.7.3 Designate Levels of Protection to be Worn

The type of personal protective equipment workers should wear must be designated by worksite location and job function. This includes the specific types of respirators and clothing to be worn for each level. No one shall be permitted in areas requiring personal protective equipment unless they have been trained in its use and are wearing it.

4.7.4 Delineate Work Areas

Work areas such as an exclusion zone, contamination reduction zone and support zone must be designated on the site map and the map posted. The size of zones, zone boundaries and access control points into each zone must be marked and made known to all site workers.

4.7.5 List Control Procedures

Control procedures must be implemented to prevent unauthorized access. Site security measures such as fences, signs, security patrols and check-in protocol must be set up. Procedures must also be established to control personnel entry into work zones where personal protection is required.

4.7.6 Establish Decontamination Procedures

Decontamination procedures for personnel and equipment must be established. Arrangements must also be made for the proper disposal of contaminated material, solutions and equipment.

4.7.7 Address Requirements for an Environmental Surveillance Program

A program to monitor site hazards must be implemented. This would include air monitoring and sampling. Other kinds of media sampling should also be done at or around the site that would indicate the presence of certain chemicals, their hazards, possible migration of hazards and associated safety requirements.

4.7.8 Specify Any Routine and Special Training Required

Personnel must be trained, not only in general safety procedures and use of safety equipment, but in any specialized work they may be expected to do.

4.7.9 Establish Procedures for Weather

Weather conditions can affect site work. Temperature extremes, high winds, rain, and other conditions have an impact on personnel safety. Work practices must be established to protect workers from the effects of weather. Shelters should be provided when necessary. Temperature extremes, especially heat and its effect on people wearing protective clothing, must be considered and procedures established to monitor for and minimize heat stress.

4.8 On-Site Emergencies

The plan must address site emergencies. Site emergencies are occurrences that require immediate action to prevent additional problems or harm to responders, the public, property or the environment. In general, all responses present a degree of risk to the workers. During routine operations risk is minimized by establishing good work practices and using personal protective equipment. Unpredictable events such as fire, chemical exposure or physical injury may occur and must be anticipated. The plan must contain contingencies for managing them.

4.9 Site Emergency Plan

Site emergency procedures must be written and include the following elements:

- List the names and emergency function of on-site personnel responsible for emergency actions along with the special training they have.
- Post the location of the nearest telephone.
- Provide alternative means for emergency communications.
- Provide a list of emergency services organizations that may be needed. Names, telephone numbers and locations must be posted. Arrangements for using emergency organizations should be made beforehand. Organizations that might be needed are:

  Fire
  Police
  Health
  Explosive experts
  Local Hazardous Materials Response units
  Civil Defense
  Rescue

- Address and define procedures for the rapid evacuation of workers. Clear, audible-warning signals should be established. Well-marked emergency exits should be located throughout the site. Internal and external communications plans should also be developed.
- A complete list of emergency equipment should be attached to the safety plan. This list should include emergency equipment available on-site, as well as all available medical, rescue, transport, fire-fighting and mitigate equipment.
- A process to debrief emergency responders and other involved personnel, critique the emergency response and follow-up with a written report and recommendations.

4.9.1 Address Emergency Medical Care

Determine the location of the nearest medical or emergency care facility. Find out if they are equipped to handle chemical exposure cases.

- Make arrangements to transport, admit and treat injured or exposed workers.
- Post the name of the medical or emergency care facility along with its phone number, location, travel time and directions.
- Determine the local physician's office location, travel directions, availability and phone number. Post the physician's phone number if other medical care is not available.
- Determine the nearest ambulance service and post the telephone number.

- List responding organizations' physicians, safety officers or toxicologists' names and telephone numbers. Also include the nearest poison control center phone number.

- Maintain accurate records on any exposure or potential exposure of site workers during routine operations and emergencies.

4.9.2 Duties

Advise workers of their duties during an emergency. In particular, it is imperative that the site safety officers, standby rescue personnel, decontamination workers and emergency medical technicians practice emergency procedures.

4.9.3 Decontamination

Incorporate into the plan procedures for the decontamination of injured workers and for the transport vehicles, transport personnel and medical care facilities. Contamination of medical personnel may occur and should be addressed in the plan. Whenever feasible, these procedures should be discussed with appropriate medical personnel in advance of operations.

4.9.4 Evacuation

Establish procedures in cooperation with local and state officials for evacuating residents who live near the site.

4.10 Implementation of the Site Safety Plan

The site safety plan must be written to avoid misinterpretation, ambiguity and the mistakes that verbal orders sometimes cause. The plan must be reviewed and approved by qualified personnel. Once the safety plan is implemented, it should be periodically examined and modified to reflect any changes in site work and conditions.

All agencies and organizations, which have an active role at the incident, must be familiar with the plan. The plan should be written in coordination with the organizations involved. Lead personnel from these organizations should sign the plan to signify they agree with it and will follow its provisions.

All personnel involved at the site must be familiar with the safety plan, or the parts that pertain to their specific activities. Frequent safety meetings should be held to keep everyone informed about site hazards, changes in operating plans, modifications of safety requirements and for exchanges of information. It is the responsibility of personnel involved at the site as workers or visitors to comply with the requirements of the plan.

Frequent audits by the incident commander or the safety designee should be made to determine compliance with the plan's requirements. Any deviations should be brought to the attention of the incident commander. Modifications in the plan should be reviewed and approved by appropriate personnel.

4.11 Medical Program

Workers during hazardous material emergency can experience high levels of stress. Their tasks may expose them to toxic chemicals, safety hazards, biologic hazards and radiation. They may develop heat stress while wearing protective equipment or working under temperature extremes, or face life-threatening emergencies such as explosions and fires. Therefore, a medical program is essential to assess and monitor workers' health and fitness both prior to employment and during the course of work. The program should provide emergency and other treatment as needed and keep accurate records. Information from a site medical program may also be used to conduct future epidemiological studies, adjudicate claims, provide evidence in litigation, and report worker's medical conditions to federal, state and local agencies as required by law. The recommendations assume that workers will have adequate protection from exposures through administrative and engineering controls, and appropriate personal protective equipment and decontamination procedures, as described elsewhere in this manual. Medical surveillance should be used to complement other control.

4.12 Hazards and How Chemicals Enter Our Bodies

Hazardous waste sites pose a multitude of health and safety concerns, any one of which could result in serious injury or death. These hazards are a function of the nature of the site as well as a consequence of the work being performed. They include:

- Chemical exposure
- Fire and explosion
- Oxygen deficiency
- Ionizing radiation
- Magnetic flux fields
- Biologic hazards
- Safety hazards
- Electrical hazards
- Heat stress
- Cold exposure
- Noise

Several factors distinguish the hazardous waste site environment from other occupational situations involving hazardous substances. One important factor is the uncontrolled condition of the site. Even extremely hazardous substances do not endanger human health or safety if they are properly handled. However, improper control of these substances can result in a severe threat to site workers and to the general public.

Another factor is the large variety and number of substances that may be present at a site. Any individual location may contain hundreds or even thousands of chemicals. Frequently, an accurate assessment of all chemical hazards is impossible due to the large number of substances and the potential interactions among the substances.

In addition, the identity of the substances on site is frequently unknown, particularly in the initial stages of an investigation. The Project Team Leader will often be forced to select protective measures based on little or no information. Finally, workers are subject not only to the hazards of direct exposure, but also to dangers posed by the disorderly physical environment of hazardous waste sites and the stress of working in protective clothing.

The combination of all these conditions results in a working environment that is characterized by numerous and varied hazards which:

- May pose an immediate danger to life or health (IDLH).
- May not be immediately obvious or identifiable.
- May vary according to the location on site and the task being performed.
- May change as site activities progress.

General categories of hazards that may be present at a site are described in this module. In approaching a site, it is prudent to assume that all these hazards are present until site characterization has shown otherwise. A site health and safety program, as described in Module 4.2 of this manual, must provide comprehensive protection against individual known hazards. It should be continuously updated to new information and changing site conditions.

4.13 Chemical Exposure

Preventing exposure to toxic chemicals is a primary concern at hazardous waste sites. Most sites contain a variety of chemical substances in gaseous, liquid, or solid form. These substances can enter the unprotected body by inhalation, skin absorption, ingestion, or through a puncture wound (injection). A contaminant can cause damage at the point of contact or can act systematically, causing a toxic effect at a part of the body distant from the point of initial contact.

Chemical exposures are generally divided into two categories - acute and chronic. Symptoms resulting from acute exposures usually occur during or shortly after exposure to a sufficiently high concentration of a contaminant. The concentration required to produce such effects varies widely from chemical to chemical. The term “chronic exposure” generally refers to exposures to “low” concentrations of a contaminant over a long period of time.

The “low” concentrations required to produce symptoms of chronic exposure depend upon the chemical, the duration of each exposure, and the number of exposures. For a given contaminant, the symptoms of an acute exposure may be completely different from those resulting from chronic exposure.

For either **chronic** or **acute** exposure, the toxic effect may be temporary and reversible, or may be permanent (disability or death). Some chemicals can cause obvious symptoms such as burning, coughing, nausea, tearing eyes, or rashes. Other chemicals may cause health damage without any such warning signs. This is a particular concern for chronic exposures to low concentrations. Health conditions, such as cancer or respiratory disease, may not become manifest for several years. In addition, some toxic chemicals may be colorless and/or odorless, may dull the sense of smell, or may not produce any immediate or obvious physiological sensations. Thus, a worker’s senses or feelings cannot be relied upon in all cases to warn of potential toxic exposure.

The effects of exposure not only depend on the chemical, its concentration, route of entry, and duration of exposure, but may also be influenced by personal factors such as the individual’s smoking habits, alcohol consumption, medication use, nutrition, age and sex.

An important exposure route of concern at a hazardous waste site is inhalation. The lungs are extremely vulnerable to chemical agents. Even substances that do not directly affect the lungs may pass through lung tissue into the bloodstream, where they are transported to other vulnerable areas of the body. Some toxic chemicals present in the atmosphere may not be detected by human senses, i.e., they may be colorless, odorless, and their toxic effects may not produce any immediate symptoms. Respiratory protection is therefore extremely important if there is a possibility that the worksite atmosphere may contain such hazardous substances. Chemicals can also enter the respiratory tract through punctured eardrums. Those individuals should be medically evaluated to determine if such a condition would place them at risk and preclude their working at the task in question.

Direct contact of the skin and eyes by hazardous substances is another important route of exposure. Some chemicals directly injure the skin. Some pass through the skin into the blood stream where they are transported to vulnerable organs. Skin absorption is enhanced by abrasions, cuts, heat, and moisture.

The eye is particularly vulnerable because airborne chemicals can dissolve in its moist surface and be carried to the rest of the body through the bloodstream (capillaries are very close to the surface of the eye). Wearing protective equipment, not using contact lenses in contaminated atmospheres (since they may trap chemicals against the eye surface), keeping hands away from the face, and minimizing contact with liquid and solid chemicals can help protect against skin and eye contact.

Although ingestion should be the least significant route of exposure at a site, it is important to be aware of how this type of exposure can occur. Deliberate ingestion of chemicals is unlikely, however, personal habits such as chewing gum or tobacco, drinking, eating, smoking cigarettes, and applying cosmetics on site may provide a route of entry for chemicals.

The last primary route of chemical exposure is injection, whereby chemicals are introduced into the body through puncture wounds i.e., by stepping or tripping and failing onto contaminated sharp objects. Wearing safety shoes, avoiding physical hazards, and taking common sense precautions are important protective measures against injection

4.14 Precautions Against Hazardous Material Exposure

Read container labels and Material Safety Data Sheets (MSDSs). They will list safe handling procedures such as “wait for corrosive or solvent to dry completely before welding or cutting metal”.

Always add acids to water (not water to acids) to prevent boiling over and splashing

Never sniff a chemical to identify its type or location.

Use appropriate personal protective equipment (PPE) when working with chemicals. These may include chemical splash goggles, full-face respirators, safety gloves, barrier creams, splash aprons, corrosive-resistant boots or any combination of the above.

Make sure that PPE fits properly and that you know how to use it.

When using respirators, match your canister or cartridge to the correct respirator and the particular chemical and replace when necessary.

Don't wear contact lenses. These can absorb chemicals or trap them against your eyes.

Know the location of eyewash stations and safety showers and how to use them. In most cases, if you are exposed to a chemical splash they will be your first emergency treatment.

Slowly mix corrosives or solvents or dip parts into them.

Never put your hands into corrosives or solvents even if you are wearing gloves.

Always wash your hands well before eating, smoking, and before and after every shift.

Use engineering controls, including fans, exhaust hoods, and other ventilation systems installed for your protection.

Know emergency first aid procedures.

If you are unclear about your company's safety procedures for handling chemical substances, speak to your supervisor. Make sure you understand everything you need to know about protecting yourself from chemical hazards.

The last primary route of chemical exposure is injection, whereby chemicals are introduced into the body through puncture wounds for example, by stepping or tripping and falling onto contaminated sharp objects. Wearing safety shoes, avoiding physical hazards, and taking common sense precautions are important protective measures against injection.

4.15 What Are Some Effects Of Hazardous Material Exposure?

Scientists are constantly testing various chemicals to determine if they are toxic and to see what the long-term effects continuous exposure may have.

Toxic chemicals are defined as those gases, liquids, or solids, which, through their chemical properties, can produce injurious or lethal effects upon contact with the body.

The toxicity of a chemical is not synonymous with its quality for being a health hazard. Toxicity is the capacity of a material to produce injury or harm. Hazard is the possibility that exposure to a material will cause injury when a specific quantity is used under certain conditions.

Toxic chemicals can enter the body from being swallowed, such as handling food after being in direct contact with a toxic material, or inhaled (poor ventilation, or the lack of proper respiratory protection) or absorbed through the skin (lack of proper personal protective equipment such as, eye protection, gloves, aprons, etc.).

The effects of toxic chemical exposure to a substance are dependent on dose, rate, physical state of the substance, temperature, site absorption, diet, and general state of health of the individual. Some of the immediate symptoms may include:

- Eye Irritation.
- Mucus Membrane Irritation.
- Dermatitis
- Nausea.
- Headache.
- Choking or Coughing.
- Dizziness, etc.

The cumulative effects of many toxic chemicals may not be known for years to come. We do know that many serious diseases and cancer are directly related to toxic exposure.

It is obvious that the scientists do not know all of the effects of toxic chemicals; however, we do know enough to realize their potential hazard.

4.16 Explosion and Fire

There are many potential causes of explosions and fires at hazardous waste sites:

- Chemical reactions that produce explosion, fire, or heat.

- Ignition of explosive or flammable chemicals.

- Ignition of materials due to oxygen enrichment.
- Agitation of shock or friction-sensitive compounds.
- Sudden release of materials under pressure.

Explosions and fires may arise spontaneously. However, more commonly, they result from site activities, such as moving drums, accidentally mixing incompatible chemicals, or introducing an ignition source, such as a spark from equipment, into an explosive or flammable environment. At hazardous waste sites, explosions and fires not only pose the obvious hazards of intense heat, open flame, smoke inhalation, and flying objects, but may also cause the release of toxic chemicals into the environment. Such releases can threaten both personnel on site and members of the general public living or working nearby. To protect against the hazard, have qualified personnel field monitor for explosive atmospheres and flammable vapors, keep all potential ignition sources away from an explosive or flammable environment, use non-sparking, explosion-proof equipment, and, follow safe practices when performing any task that might result in the agitation or release of chemicals.

4.17 Oxygen Deficiency

The oxygen content of normal air at sea level is approximately 21 percent. Physiological effects of oxygen deficiency in humans are readily apparent when the oxygen concentration is decreased, causing increased breathing and heart rate. Oxygen concentrations lower than 16 percent can result in nausea and vomiting, brain damage, unconsciousness and death. To take into account individual physiological responses and errors in measurement, concentrations of 19.5 percent oxygen by volume or lower are considered to be indicative of oxygen deficiency.

Oxygen deficiency may result from the displacement of oxygen by another gas or the consumption of oxygen by a chemical reaction. Confined spaces or low-lying areas are particularly vulnerable to oxygen deficiency and should always be monitored prior to entry. Qualified field personnel should always monitor oxygen levels and use atmosphere supplying respiratory equipment when oxygen concentrations drop below 19.5 percent by volume.

4.18 Ionizing Radiation

Radioactive materials emit one or more of three types of harmful radiation - alpha, beta, and gamma. Alpha radiation has limited penetration ability and is usually stopped by clothing and the outer layers of the skin. Alpha radiation poses little threat outside the body, but can be hazardous if materials that emit alpha radiation are inhaled or ingested.

Beta radiation can cause harmful effects and is hazardous if materials that emit beta radiation are inhaled or ingested. Use of protective clothing, coupled with scrupulous personal hygiene and decontamination, affords good protection against alpha and beta radiation.

Gamma radiation easily passes through clothing and human tissue and can also cause serious permanent damage to the body. Chemical-protective clothing affords no protection against gamma radiation itself; however, use of respiratory and other protective equipment can help keep radiation-emitting materials from entering the body by inhalation, ingestion, injection, or skin absorption.

If levels of radiation above natural background are discovered, consult a health physicist.

4.19 Biological Hazards

Wastes from hospitals and research facilities may contain disease-causing organisms that could infect site personnel. Like chemical hazards etiologic agents may be dispersed in the environment via water and wind. Other biologic hazards that may be present at a hazardous waste site include poisonous plants, insects, animals, and indigenous pathogens. Protective clothing and respiratory equipment can help reduce the chances of exposure.

4.20 Safety Hazards

Hazardous waste sites may contain numerous safety hazards such as:

- Holes or ditches.
- Precariously positioned objects, such as drums or boards that may fall.
- Sharp objects such as nails, metal shards and broken glass.
- Slippery surfaces.
- Steep grades.
- Uneven terrain.
- Unstable surfaces, such as walls that may cave in, or flooring that may give way.

Some safety hazards are a function of the work itself. For example, heavy equipment creates an additional hazard for workers in the vicinity of the operating equipment. Protective equipment can impair a worker's agility, hearing, and vision, which can result in an increased risk of an accident.

Accidents involving physical hazards can directly injure workers and can create additional hazards, for example, increased chemical exposure due to damaged protective equipment, or danger of explosion caused by the mixing of chemicals. Site personnel should constantly look out for potential safety hazards, and should immediately inform their supervisors of any new hazards so that mitigative action can be taken.

4.21 Electrical Hazards

Overhead power lines, downed electrical wires, and buried cables all pose a danger of shock or electrocution if workers contact or sever them during site operations. Electrical equipment used on site may also pose a hazard to workers. To help minimize this hazard, low-voltage equipment with ground-fault interrupters and water-tight, corrosion-resistant connecting cables should be used on site. In addition, lightning is a hazard during outdoor operations, particularly for workers handling metal containers or equipment. To eliminate this hazard, weather conditions should be monitored and work should be suspended during electrical storms. An additional electrical hazard involves capacitors that may retain a charge. All such items should be properly grounded before handling.

4.22 Heat Stress

Heat stress is a major hazard, especially for workers wearing protective clothing. The same protective materials that shield the body from chemical exposure also limit the dissipation of body heat and moisture. Personal protective clothing can therefore create a hazardous condition. Depending on the ambient conditions and the work being performed, heat stress can occur very rapidly within as little as 15 minutes. It can pose as great a danger to worker health as chemical exposure. In its early stages, heat stress can cause rashes, cramps discomfort and drowsiness, resulting in impaired functional ability that threatens the safety of both the individual and co-workers.

Continued heat stress can lead to heat stroke and death. Avoiding overprotection, providing careful training and frequent monitoring of personnel who wear protective clothing, judicious scheduling of work and rest periods, and frequent replacement of fluids can protect against this hazard.

4.22.1 Preventing Heat Stress

Excess heat can place an abnormal stress on your body. When your body temperature rises even a few degrees above normal (which is about 98.6°F), you can experience muscle cramps, become weak, disoriented, and dangerously ill unless you can help your body to cool down. If body temperature rises above 105°F, the condition can be fatal. Persons who work in hot environments (foundries, kitchens, laundries, etc.) must guard against heat stress. The following guidelines can help you keep your cool in the heat and avoid the dangerous consequences of heat stress.

4.22.2 Adapt to the Heat

The National Institute for Occupational Safety and Health (NIOSH) suggests that all workers exposed to extreme heat gradually adjust to their environment over a one-week period. This means that on your first day in a hot environment, you may only be able to do half the work that a fully adapted worker would do. Each day, your workload increases slightly until you are able to operate at “full steam”.

4.22.3 Drink Water Frequently

Perspiring is one of the ways your body cools itself down. Perspiration results in water loss and the only way to replace the loss and help your body continue to cool itself, is to drink water frequently. Ideally, you should drink at least 8 ounces of water every 20-30 minutes while working in hot environments.

4.22.4 Wear Personal Protective Equipment

Personal Protective Equipment (PPE) for hot environments can range from ordinary work clothes made from “breathable” fabrics to specially designed suits that are cooled by air, ice, and even portable air-conditioners. Check with your supervisor about the appropriate PPE for your specific task.

4.22.5 Use Engineering Controls

Your employer may also provide engineering controls such as fans, ventilators, exhaust systems, and air-coolant or conditioning systems. These controls can help reduce worksite temperatures to more adaptable levels. Other controls such as using heat shields and insulating heat-producing machinery can also help lower the environmental temperature.

4.22.6 Keep Cool

Persons who work in hot environments should become familiar with first aid techniques for heat stress. If you or someone you know suffers from heat exhaustion, cramps, or other signs of heat stress, get medical attention immediately. Keep your cool. Heat stress is dangerous, but it’s also preventable.

4.23 Cold Exposure

Cold injury (frostbite and hypothermia) and impaired ability to work are dangers at low temperatures and when the wind-chill factor is high. To guard against them, wear appropriate clothing, have warm shelter readily available, carefully schedule work and rest periods, and monitor workers’ physical conditions.

4.23.1 Preventing “Cold Stress” Hypothermia

When your body temperature drops even a few degrees below normal, which is about 98.6°F, you can begin to shiver uncontrollably, become weak, drowsy, disoriented, unconscious, even fatally ill. This loss of body heat is know as “cold stress” or hypothermia. Persons who work outdoors or who enjoy outdoor activities should learn about how to protect against loss of body heat. The following guidelines can help you keep your body warm and avoid the dangerous consequences of hypothermia.

4.23.2 Dress in Layers

Outdoors, indoors, in mild weather or in cold, it pays to dress in layers. Layering your clothes allows you to adjust what you're wearing to fit the temperature conditions.

In cold weather, wear cotton, polypropylene, or lightweight wool next to the skin, and wool layers over your undergarments. In warm weather, choose loose-fitting cotton clothing. For outdoor activities, choose outer garments made of waterproof, wind-resistant fabrics such as nylon. And, since a great deal of body heat is lost through the head, always wear a hat for added protection.

4.23.3 Keep Dry

Water chills your body far more rapidly than air or wind. Even in the heat of summer, failing into a 40°F lake can be fatal in a matter of minutes. Always take along a dry set of clothing whenever you are working or playing outdoors. Wear waterproof boots in damp or snowy weather and always pack raingear, even if the forecast calls for sunny skies.

4.23.4 Take a Companion

The effects of hypothermia can be gradual and often go unnoticed until its too late. If you know you'll be outdoors for an extended period of time, take along a companion. At the very least, let someone know where you'll be and what time you expect to return. Check each other frequently for overexposure to the cold. Check for shivering, slurred speech, mental confusion, drowsiness, and weakness. If either of you show any of the above symptoms, go indoors as soon as possible and warm up.

4.23.5 Warmth and Understanding

The key ingredients to preventing loss of body heat are staying warm and understanding what you can do to protect against conditions that can cause hypothermia. It can be fatal, but it can also be prevented.

4.24 Noise

Work around large equipment often creates excessive noise. The effects of noise can include:

- Workers being startled, annoyed, or distracted.
- Physical damage to the ear, pain, and temporary and/or permanent hearing loss.
- Communication interference that may increase potential hazards due to the inability to warn of danger and the proper safety precautions to be taken.

If employees are subjected to noise exceeding an 8-hour, time-weighted average sound level of 85 dBA or more feasible administrative or engineering controls must be utilized.

4.24.1 Choosing and Using Hearing Protection

Silence may be golden but not when it's permanent. Hearing loss is a condition that occurs over time from repeated exposure to excessive noise. We can't always prevent noise, but we can prevent hearing loss by following established safety procedures and using the appropriate hearing protection for the noise hazards we encounter each day. The following is a guide to the most common types of hearing protectors and the types of hazards they can guard against.

4.24.2 Earmuffs

Earmuffs come in many styles. Most are attached to spring-loaded headbands, while others are attached directly to safety headgear. Specialized muffs are also available for persons who work in high voltage exposures or who need to filter out hazardous noises while retaining acute hearing for normal sound ranges. Muffs cover the entire ear and can reduce noise by as much as 15-30 dBA. Muffs are often used in conjunction with ear plugs when a worker is exposed to extremely high noise levels 105 dBA and above.

4.24.3 Ear Plugs

Like muffs, ear plugs come in many varieties formidable, custom molded, disposable, reusable and may be made of many different types of materials such as acoustical fiber, silicone, rubber, or plastic. Ear plugs are positioned in the outer part of the ear and may reduce noise by as much as 30 dBA. Excessive noise is commonly defined as 85-90 dBA or more over an 8-hour period.

4.24.4 Canal Caps

As their name suggests, these hearing protectors cap off or close the ear canal at its opening. Like many muffs, canal caps are connected to a flexible headband that ensures a close fit. Canal caps are most commonly used when an individual is unable to use traditional ear plugs.

4.24.5 Using Hearing Protectors

Your supervisor can help determine the amount of noise you are exposed to on the job through various testing devices and will provide you with the appropriate type of hearing protection for the particular noise hazards you face. Remember, hearing protectors only work when you use them correctly and consistently. Depending on the type of hearing protectors you use, dispose of or replace them as necessary. For reusable protectors, follow the manufacturer's guidelines for cleaning and storage. When it comes to your hearing, an ounce of prevention is worth a pound of cure.

4.25 Chemical Exposure to your Body

Chemicals surround us at work or at home. Their effect on our health is determined by how poisonous the chemicals are and how much actually enters or contacts our body. Even super toxic chemicals cannot hurt us unless they gain entry into our bodies.

By identifying the primary routes of entry into the body for a particular product, workers can evaluate the adequacy of work practices to minimize exposure via that route. The first step in evaluating safe work practices is to identify routes of entry for the materials used in the work place.

4.26 Inhalation

One way chemicals enter our bodies is inhalation. The lungs are extremely vulnerable to chemical agents. Some toxic chemicals present in the atmosphere may not be detected by human senses, i.e., they may be colorless, odorless, and their toxic effects may not produce any immediate symptoms.

Respiratory protection is extremely important if there is any possibility that the work-site atmosphere may contain such hazardous substances. Chemicals can also enter the respiratory tract through punctured eardrums.

4.26.1 Dusts/Mists/Fumes

Coarse dusts, like most sawdust, are usually trapped in our nose and upper respiratory tract. These dusts can be blocked by simple filter masks. Smaller particles enter the airways but settle out by gravity onto the mucus coated walls of the airway tubes and are carried to the throat with the mucus flow. The very small particles, such as welding fumes and smoke particles, do not settle out in the airways but penetrate deep into the air sacs of the lungs where they can rapidly enter the blood if they are soluble. These very small particles are not blocked out by a simple paper filter mask. Improved ventilation is the best answer.

4.26.2 Vapors/Gases

Water soluble vapors and gases like ammonia will dissolve in the wet mucus coating of the upper airway surfaces. Often this condition causes initiation of the eyes, nose and throat if the mucus is made acidic or caustic. Gases and vapors which are less water soluble (such as chlorine or solvents) reach the deep lung in high concentrations. This allows rapid absorption into the blood or deep lung damage, depending on the properties of the chemical gas or vapor.

4.27 Swallowing Chemicals

Usually ingestion is the least important route of exposure at a site. But it is important to be aware of how this type of exposure can occur. Most ingestion is unintentional. Whenever hand to mouth contact, such as eating, smoking, or drinking occurs in an area where chemicals are handled, ingestion is possible. Wash contaminated hands and face prior to smoking, as well as before meals.

4.28 Cuts and Scrapes

Another route of chemical exposure is injection. Chemicals can be introduced into the body through puncture wounds by stepping or tripping and falling onto contaminated sharp objects. When blood is visible, chemicals can enter the body. Work practices should be evaluated to minimize risk of injury, e.g., separate disposal of sharp objects or, slash resistant personal protective equipment.

4.29 Skin

Direct contact of the skin and eyes by hazardous substances is another important route of exposure. Some chemicals directly injure the skin. Some pass through the skin into the blood stream where they are transported to vulnerable organs. Skin absorption is increased by abrasions, cuts, heat, and moisture. The eye is particularly vulnerable because airborne chemicals can dissolve in its moist surface and be carried to the rest of the body through the bloodstream. Wearing protective equipment, not using contact lenses in contaminated atmospheres since they may trap chemicals against the eye surface, keeping hands away from the face, and minimizing contact with liquid and solid chemicals can help protect against skin and eye contact.

Some chemicals damage the skin directly. Other chemicals will pass rapidly through the skin and enter the blood. Once in the blood they may effect other internal organs such as the brain, kidney or liver. Skin which is injured or chapped presents less of a barrier to chemicals.

4.29.1 Direct Skin Damage through Corrosive Materials

The oily barrier of the skin surface does not prevent penetration of strong caustics such as lye (caustic soda), because caustics combined with skin oils to create soaps. Caustic skin and eye burns can penetrate deep into the skin and may be quite severe before obvious pain is present. On contamination, wash immediately and thoroughly with water.

4.29.2 Skin Absorption

The oily skin surface is an effective barrier against water and most water-soluble chemicals. Many chemicals which are soluble in oil will rapidly dissolve in the oily skin surface and penetrate through to the blood, and thus travel to other organs. Greases and oils are much slower to penetrate than organic solvents like benzene (found in gasoline), mineral spirits, toluene, etc. Solvents also dissolve away the oily surface layer of the skin, which keeps the skin from drying out. Repeated skin contact can cause severe drying and cracking.

5 INCIDENT MANAGEMENT STRUCTURE

5.1 Objectives

At the conclusion of this module you should be able to do the following:

List the five major organizational activities within the Incident Command System and explain their primary functions.

Give the titles, and explain the duties of Command and General Staff members.

Match organizational units to appropriate Operations, Planning, Logistics, or Finance Sections.

Match supervisory titles with appropriate levels within the organization.

Describe the terms used to name major incident facilities, and state the function of each.

Describe what an Incident Action Plan is and how it is used at an incident.

Describe how span of control functions within the incident organization and in the use of resources.

Describe the common responsibilities (general instructions) associated with incident or event assignments.

Describe several applications for the use of ICS.

Although many systems exist throughout the nation for the command and control of resources at emergency, The Incident Command System (ICS) is a recognized system that has been successfully used in managing available resources at emergency operations.

The system consists of procedures for controlling personnel, facilities, equipment, and communications. It is designed to begin developing from the time an incident occurs until the requirement for management and operations no longer exists. The "Incident Commander" is a title, which can apply equally to an Engine Company Captain, or the Chief Operating Officer of a major Company, depending upon the situation. The structure of the ICS can be established and expanded depending upon the changing conditions of the incident. It is intended to be staffed and operated by qualified personnel from any emergency services agency and may involve personnel from a variety of agencies. As such, the system can be utilized for any type or size of emergency, ranging from a minor incident involving a single unit, to major emergency involving several agencies. The ICS allows agencies to communicate using **common terminology and operating procedures**. It also allows for the timely combining of resources during an emergency. The ICS is designed to be used in response to emergencies caused by fires, floods, earthquakes, hurricanes, riots, hazardous materials, or other natural or human-caused incidents.

The system has considerable internal flexibility. It can grow or shrink to meet differing needs. This makes it a very cost-effective and efficient management system. The system can be applied to a wide variety of emergency and non-emergency situations. Listed below are some examples of the kinds of incidents and events that can use the ICS:

Applications for the use of the Incident Command System:

- Fires, HAZMAT, and multi casualty incidents
- Multi jurisdiction and multi-agency disasters
- Wide-area search and rescue missions
- Pest eradication programs
- Oil spill response and recovery incidents
- Single and multi-agency law enforcement incidents
- Air, rail, water, or ground transportation accidents
- Planned events; e.g., celebrations, parades, concerts
- Private sector emergency management programs
- State or local major natural hazards Management

5.2 ICS Organization

Every incident or event has certain major management activities or actions that must be performed. Even if the event is very small, and only one or two people are involved, these activities will still always apply to some degree.

COMMAND

SETS OBJECTIVES AND PRIORITIES, HAS OVERALL RESPONSIBILITY AT THE INCIDENT OR EVENT

OPERATIONS

CONDUCTS TACTICAL OPERATIONS TO CARRY OUT THE PLAN, DEVELOPS THE TACTICAL OBJECTIVES, ORGANIZATION, AND DIRECTS ALL RESOURCES

PLANNING

DEVELOPS THE ACTION PLAN TO ACCOMPLISH THE OBJECTIVES, COLLECTS AND EVALUATES INFORMATION, AND MAINTAINS RESOURCE STATUS

LOGISTICS

PROVIDES SUPPORT TO MEET INCIDENT NEEDS, PROVIDES RESOURCES AND ALL OTHER SERVICES NEEDED TO SUPPORT THE INCIDENT

FINANCE/ADMINISTRATION

MONITORS COSTS RELATED TO INCIDENT, PROVIDES ACCOUNTING, PROCUREMENT, TIME RECORDING, AND COST ANALYSIS

These five major management activities are the foundation upon which the ICS organization develops. They apply whether you are handling a routine emergency, organizing for a major event, or managing a major response to a disaster. On small incidents, these major activities may all be managed by one person, the Incident Commander (IC). Large incidents usually require that they be set up as separate <u>Sections</u> within the organization as shown below.

Incident Command

Operations Section	Planning Section	Logistics Section	Finance/ Administration Section

Each of the primary ICS Sections may be sub-divided as needed. The ICS organization has the capability to expand or contract to meet the needs of the incident.

A basic ICS operating guideline is that the person at the top of the organization is responsible until the authority is delegated to another person. Thus, on smaller situations where additional persons are not required, the Incident Commander will directly manage all aspects of the incident organization.

Now we will look at each of the major functional entities of the ICS organization starting with the Incident Commander and the Command Staff.

5.3 Incident Commander

The Incident Commander is the person in charge at the incident, and must be fully qualified to manage the incident. As incidents grow in size or become more complex, a more highly qualified Incident Commander may be assigned by the responsible jurisdiction or agency. The Incident Commander may have one or more deputies from the same agency or from other agencies or jurisdictions. Deputies must always be as qualified as the person for whom they work.

The Incident Commander may assign personnel for both a Command Staff and a General Staff. The Command Staff provides Information, Safety, and Liaison services for the entire organization. The General Staff are assigned major functional authority for Operations, Planning, Logistics, and Finance/Administration.

Initially, assigning tactical resources and overseeing operations will be under the direct supervision of the Incident Commander. As incidents grow, the Incident Commander may delegate authority for performance of certain activities to others as required.

Taking over command at an incident always requires that there be a full briefing for the incoming Incident Commander, and notification that a change in command is taking place.

5.4 Command Staff

In addition to the primary incident response activities of Operations, Planning, Logistics, and Finance/Administration, the Incident Commander has responsibility for several other important services. Depending on the size and type of an incident or event, it may be necessary to designate personnel to handle these additional activities.

Persons filling these positions are designated as the Command Staff and are called Officers. There is only one command Staff position for each of these functions. The Command Staff does not have deputies. However, each of these positions may have one or more assistants if necessary. On large incidents or events, it is not uncommon to see several assistants working under Command Staff Officers.

Incident Command

Information Safety Liaison

Operations Section	Planning Section	Logistics Section	Finance/ Administration Section

INFORMATION OFFICER - The Information Officer will be the point of contact for the media, or other organizations seeking information directly from the incident or event. Although several agencies may assign personnel to an incident or event as Information Officers, there will only be one Incident Information Officer. Others will serve as assistants.

SAFETY OFFICER - This individual monitors safety conditions and develops measures for assuring the safety of all assigned personnel.

LIAISON OFFICER - On larger incidents or events, representatives from other agencies (usually called Agency Representatives) may be assigned to the incident to coordinate their agency's involvement. The Liaison Officer will be their primary contact.

5.5 The General Staff

The people who perform the four major activities of Operations, Logistics, Planning, and Finance/Administration are designated as the General Staff.

THE INCIDENT COMMAND SYSTEM GENERAL STAFF

Operations Section Chief

Planning Section Chief

Logistics Section Chief

Finance/Administration Section Chief

Each of the General Staff may have a deputy or more than one if necessary. The role of the deputy position is flexible. The deputy can work with the primary position, work in a relief capacity, or be assigned specific tasks. Deputies should always be as qualified as the person for whom they work.

In large events, especially where multiple agencies or jurisdictions are involved, the use of deputies from other agencies can greatly increase interagency coordination.

At the Section level, the person in charge will be designated as a Chief. For example, in the Logistics Section, the person in charge will always be called the Logistics Section Chief.

Within the ICS organization, there are a number of organizational elements, which can be activated as necessary. Each of the major Sections has the ability to expand internally to meet the needs of the situation.

Let's start with the Operations Section of the ICS organization.

The Incident Commander will determine the need for a separate Operations Section at an incident or event. Until Operations is established as a separate Section, the IC will have direct control of tactical resources.

When activating an Operations Section, the IC will assign an individual as the Operations Section Chief. The Operations Section Chief will develop and manage the Operations Section to accomplish the incident objectives.

There is only one Operations Section Chief for each operational period.

That person is normally (but not always) from the jurisdiction or agency which has the greatest involvement either in terms of resources assigned or area of concern. The Operations Section Chief may have deputies from the same agency, or from other agencies or jurisdictions. Using deputies from other agencies or jurisdictions. Using deputies form other agencies often helps in the coordination of actions.

Within the Operations Section, two additional levels of organization can be used as necessary. These are Divisions and/or Groups, and Branches.

5.6 Divisions

The Operations organization usually develops from the bottom up. This is due to the need to expand supervision as more and more resources are applied. For example, the Incident Commander or the Operations Section Chief on an incident may initially work with only a few single resources.

Operations Section Chief

Resources Resources Resources

As more resources are added to the incident, another layer of organization may be needed within the Operations Section to maintain proper span of control. Normally, this will be done at the Division or Group level.

Operations Section Chief

Division A Resources	Division B Resources

The goal is to keep the organization as simple and as streamlined as possible, and not to overextend the span of control.

A Division is established to divide an incident geographically. How that will be done will be determined by the needs of the incident. Divisions covering an area on the ground are usually labeled by letters of the alphabet. Within a building, divisions are often designated by floor numbers. The important thing to remember about ICS divisions is that they describe some geographical area related to incident operations.

5.7 Groups

Groups are established to describe functional areas of operation. The kind of group to be established will be determined by the needs of an incident. For example, in an earthquake incident with widespread structural damage, search and rescue activity would be organized geographically, using divisions.

A specialized resource team, using dogs or electronic equipment in an earthquake, or a salvage group in a maritime incident may be designated as functional groups. Groups will work wherever they are needed, and will not be assigned to any single division.

Divisions and Groups can be used together on an incident. Divisions and Groups are at an equal level in the organization. One does not supervise the other. When a functional group is working within a division on a special assignment, division and group supervisors must closely coordinate their activities. Division and group supervisors always report to the Incident Commander unless the Operations Section Chief and/or Branch Director positions have been established. Deputies are not used at the Division and Group level.

5.8 Branches

On some incidents, it may be necessary to establish another level of organization within the Operations Section called Branches.

There are generally three reasons to use Branches on an incident or an event.

Span of Control - If the number of divisions and groups exceeds the recommended span of control, another level of management is necessary. Span of control will be discussed in more detail later in this module.

Need for a Functional Branch Structure - Some kinds of incidents have multiple disciplines involved, e.g., police, fire, search and rescue, and medical, that may create the need to set up incident operations around a functional branch structure.

Multi-Jurisdictional Incidents - In some incidents it may be better to organize the incident around jurisdictional lines. In these situations, Branches may be set up to reflect differences in the agencies involved. For example, in flooding, earthquake, or wildfire incidents, federal, county, and city property all could be simultaneously affected. One way of organizing operations in these kinds of incidents is to designate a separate Branch for each of the agencies involved. Various kinds of Branch alignments are shown below:

Geographic Branches

Operations Section Chief

Branch 1 Branch 2

A Division
B Division

Functional Branches

Operations Section Chief

Medical Search Security

Each branch that is activated will have a Branch Director. Deputies may be used at the Branch level.

There are two other parts of the Operations Section that you may need to understand.

5.9 Air Operations

If established separately at an incident, air Operations will be activated at the Branch level within the Operations Section. Usually this is done on incidents which may have complex needs for the use of aircraft in both tactical and logistical operations.

5.10 Staging Areas

Staging Areas may be established wherever necessary to temporarily locate resources awaiting assignment. Staging Areas and the resources within them will always be under the control of the Operations Chief.

Staging Areas will be discussed later under incident facilities.

5.11 Summary

There is no one “best” way to organize an incident. The organization should develop to meet the functions required. The characteristics of the incident and the management needs of the Incident Commander will determine what organization may change over time to reflect the various phases of the incident.

PLANNING SECTION:

Resources Unit

Situation Unit

Documentation Unit

Demobilization Unit

Technical Specialist

Briefly stated, the major activities of the Planning Section are to:

- Collect, evaluate, and display information about the incident.
- Develop Incident Action Plans for each operational period, conduct long-range planning, and develop plans for demobilization at the end of the incident.
- Maintain resource status information on all equipment and personnel assigned to the incident.
- Maintain incident documentation.

The Planning Section is also the initial place of check-in for any Technical Specialist assigned to the incident. Depending on their assignment, Technical Specialist may work within the Planning Section, or be reassigned to other incident areas.

Several Planning Section Units may be established. Duties of each Unit are covered in other modules. Not all of the Units may be required, and they will be activated based upon need.

LOGISTICS SECTION:

Service Branch	**Support Branch**
Communications Unit	Supply Unit

Medical Unit	Facilities Unit
Food Unit	Ground Support Unit

The Logistics Section is responsible for all of the services and support needs of an incident, including obtaining and maintaining essential personnel, facilities, equipment, and supplies.

The Incident Commander will determine the need to establish a Logistics Section on the incident. This is usually determined by the size of the incident, complexity of support, and how long the incident may last. Once the IC determines that there is a need to establish a separate Logistics function, an individual will be assigned as the Logistics Section Chief.

Six functional units can be established within the Logistics Section. If necessary, a two-branch structure can be used to facilitate span of control. The titles of the units are self descriptive. Detailed duties of each unit are covered in other modules. Not all of the units may be required, and they will be established based upon need. Branches and Units in the Logistics Section.

FINANCE/ADMINISTRATION SECTION:

Time Unit

Procurement Unit

Compensation/Claims Unit

Cost Unit

The IC will determine if there is a need for a Finance/Administration Section, and designate an individual to perform that role. If no Finance Section is established, the IC will perform all finance functions.

The Finance/Administration Section is set up for any incident that may require on-site financial management. More and more, larger incidents are using a Finance/Administration Section to monitor costs.

Smaller incidents may also require certain Finance/Administration functions. For example, the Incident Commander may establish one or more units of the Finance/Administration Section for such things as procuring special equipment, contracting with a vendor, or for making cost estimates of alternative strategies.

The Finance Section may establish four units as necessary. Duties of each unit are covered in other modules. Not all of the units may be required, and they will be established based upon need.

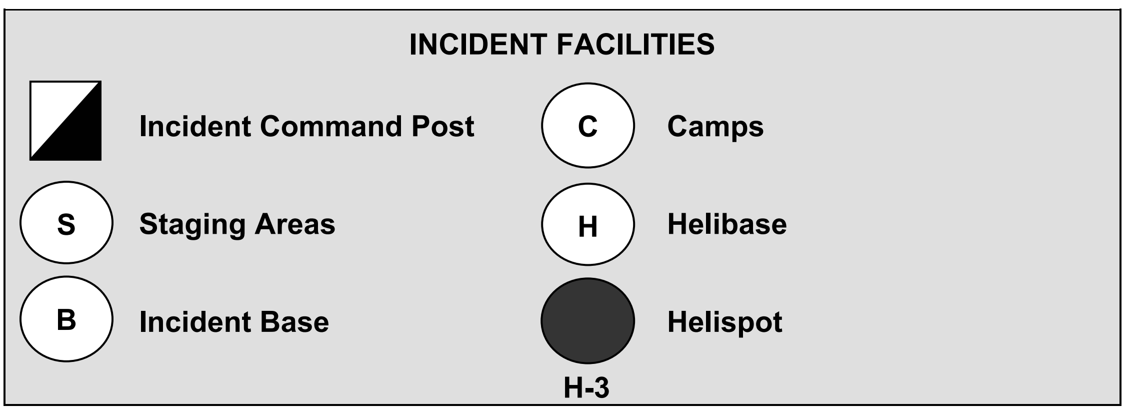
5.12 Organization Terminology

At each level in the ICS organization, individuals with primary responsibility positions have distinctive titles.

Primary Position	Title	Support Position
Incident Commander	Incident Commander	Deputy
Commander Staff	Officer	Assistant
Section	Chief	Deputy
Branch	Director	Deputy
Division/Group	Supervisor	N/A
Strike Team/Task Force	Leader	N/A
Unit	Leader Manager	
Single Resource	Use Unit Designation	N/A

5.13 Incident Facilities

Facilities will be established depending on the kind and complexity of the incident or event. It is important to know and understand the names and functions of the principal ICS facilities. Not all of those listed below will necessarily be used.



Each of the facilities is briefly described below:

Incident Command Post (ICP) - The location from which the incident Commander oversees all incident operations. There is only one ICP for each incident or event. Every incident or event must have some form of an Incident Command Post.

Staging Areas - Locations at which resources are kept while awaiting incident assignment. Most large incidents will have a Staging Area, and some incidents may have several. Staging Areas will be managed by a Staging Area Manager who reports to the Operations Section Chief or to the Incident Commander if an Operations Section has not been established.

Base - The location at the incident at which primary service and support activities are performed. Not all incidents will have a Base. There will only be one Base for each incident.

Camps - Incident locations where resources may be kept to support incident operations. Camps differ from Staging Areas in that essential support operations are done at Camps, and resources at Camps are not always immediately available for use. Not all incidents will have camps.

Helibase - A location in and around an incident area at which helicopters may be parked, maintained, fuelled, and equipped for incident operations. Very large incidents may require more than one Helibase.

Helispots - Helispots are temporary locations where helicopters can land and load and off-load personnel, equipment, and supplies. Large incidents may have several Helispots.

5.14 Incident Action Plan

Every incident **must** have an oral or written action plan. The purpose of the plan is to provide all incident supervisory personnel with direction for future actions.

Action plans which include the measurable tactical operations to be achieved are always prepared around a time frame called an Operational Period.

Operational periods can be of various lengths, but should be no longer than twenty-four hours. Twelve-hour Operational Periods are common on many large incidents. It is not unusual, however, to have much shorter Operational Periods covering, for example, two- or four-hour time periods. The length of an Operational Period will be based on the needs of the incident, and these can change over the course of the incident.

The planning for an Operational Period must be done far enough in advance to ensure that requested resources are available when the Operational Period begins. Large incidents, which involve a partial or full activation of the ICS organization, should have a written Incident Action Plan. Incidents extending through an Operational Period should also have a written Incident Action Plan to ensure continuity due to personnel changes The decision to have a written action plan will be made by the Incident Commander.

Essential elements in any written or oral Incident Action Plan are:

- Statement of Objectives - Appropriate to the overall incident.
- Organization - Describes what parts of the ICS organization will be in place for each Operational Period.
- Assignments to Accomplish the Objectives - These are normally prepared for each Division or Group and include the strategy, tactics, and resources to be used.
- Supporting Material - Examples can include a map of the incident, communications plan, medical plan, traffic plan, etc.

The Incident Action Plan must be made known to **all** incident supervisory personnel. This can be done through briefings, by distributing a written plan prior to the start of the Operational Period, or by both methods.

5.15 Span of Control

Span of Control means how many organizational elements may be directly managed by another person. Maintaining adequate Span of Control throughout the ICS organization is very important. Effective Span of Control may vary from three to seven, and a ratio of one to five reporting elements is recommended. If the number of reporting elements falls outside of those ranges, expansion or consolidation of the organization may be necessary. There will be exceptions, for example in some applications specially trained hand crews may utilize a larger Span of Control.

Maintain Span of Control at 1 to 5

Supervisor

1 2 3 4 5

5.16 Common Responsibilities

There are certain common responsibilities or instructions associated with an incident assignment that everyone assigned to an incident should follow. Following these simple guidelines will make your job easier and result in a more effective operation.

1. Receive your incident assignment from your organization. This should include, at a minimum, a reporting location and time, likely length of assignment, brief description of assignment, route information, and a designated communications link if necessary. Different agencies may have additional requirements.

2. Bring any specialized supplies or equipment required for your job. Be sure you have adequate personal supplies to last you for the expected stay.

3. Upon arrival, follow the Check-in procedure for the incident. Check-in locations may be found at:

   - Incident Command Post (at the Resources Unit)
   - Staging Areas
   - Base or Camps
   - Helibases
   - Division or Group Supervisors (for direct assignments)

4. Radio communications on an incident should use clear text, that is, **no** radio codes. Refer to incident facilities by the incident name, for example, Rossmoor Command Post, or 42nd Street Staging Area. Refer to personnel by ICS title, for example, Division C not numeric code or name.

5. Obtain a briefing from your immediate supervisor. Be sure you understand your assignment.

6. Acquire necessary work materials, locate, and set up your work station.

7. Organize and brief any subordinates assigned to you.

8. Brief your relief at the end of each Operational Period and, as necessary, at the time you are demobilized from the incident.

9. Complete required forms and reports and give them to your supervisor or to the Documentation Unit before you leave.

10. Demobilize according to plant.

6 PERSONAL PROTECTIVE EQUIPMENT

6.1 OBJECTIVES

At the conclusion of this module you should be able to do the following:

Identify the appropriate respiratory protection required for a given defensive option.

Identify the three types of respiratory protection and the advantages and limitations presented by the use of each at hazardous materials incidents.

Identify the four levels of chemical protection (EPA/NIOSH) and describe the equipment required for each level and the conditions under which each level is used.

Demonstrate proper methods for donning, doffing, and using all personal protective equipment provided by the authority having jurisdiction for use in hazardous materials response activities.

Understand the physical stress associated with protective clothing.

Be aware of performance requirements of protective clothing.

Understand the performance ratings of common materials used in protective clothing.

Understand the advantages and disadvantages of protective equipment and clothing.

Anyone entering a hazardous waste site must be protected against potential hazards. The purpose of personal protective clothing and equipment (PPE) is to shield or isolate individuals from the chemical, physical, and biologic hazards that may be encountered at a hazardous waste site. Careful selection and use of adequate PPE should protect the respiratory system, skin, eyes, face, hands, feet, head, body, and hearing.

No single piece of PPE or combination of protective equipment and clothing is capable of protecting against all hazards. Thus PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. In general, the greater the level of PPE protection, the greater is the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Over-protection as well as under-protection can be hazardous and should be avoided.

6.2 Developing a PPE Program

The two basic objectives of any PPE program should be to protect the wearer from safety and health hazards and to prevent injury to the wearer from incorrect use and/or malfunction of the PPE. To accomplish these goals, a comprehensive PPE program should include:

- Hazard identification
- Medical monitoring

- Environmental surveillance
- Selection, use, maintenance, decontamination, or disposal of PPE
- Training

The written PPE program should include policy statements, procedures, and guidelines. Copies should be made available to all employees and a reference copy should be available at each work site. Technical data on equipment, maintenance manuals, relevant regulations, and other essential information should also be made available.

6.3 Selection of Respiratory Equipment

Respiratory protection is of primary importance since inhalation is one of the major routes of exposure to chemical toxicants. Respiratory protective devices (respirators) consist of a face piece connected to either an air source or an air-purifying device. Respirators with an air source are called atmosphere-supplying respirators and consist of two types:

- **Self-Contained Breathing Apparatus** (SCBAs) which supply air from a source carried by the user.
- **Supplied-Air Respirators** (SARs) which supply air from a source located some distance away and connected to the user by an air line hose. Supplied air respirators are sometimes referred to as air line respirators.
- **Air-Purifying Respirators,** on the other hand, do not have a separate air source. Instead, they utilize ambient air which is “purified” through a filtering element prior to inhalation.

SCBAs, SARs, and air-purifying respirators are further differentiated by the type of air flow supplied to the face piece:

Positive-pressure respirators maintain a positive pressure in the face piece during both inhalation and exhalation. The two main types of positive-pressure respirators are pressure-demand and continuous flow. In pressure-demand respirators, a pressure regulator and an exhalation valve on the mask maintain the mask's positive pressure except during high breathing rates. If a leak develops in a pressure-demand respirator, the regulator sends a continuous flow of clean air into the face piece, preventing penetration by contaminated ambient air. Continuous-flow respirators, including some SARs and all powered air-purifying respirators (PAPRs), send a continuous stream of air into the face piece at all times. With SARs, the continuous flow of air prevents infiltration by ambient air, but uses the air supply much more rapidly than with pressure-demand respirators. Powered air-purifying respirators (PAPRs) are operated in a positive-pressure continuous flow mode utilizing filtered ambient air. However, at maximal breathing rates, a negative pressure may be created in the face piece of a PAPR.

Negative-pressure respirators draw air into the face piece via the negative pressure created by user inhalation. The main disadvantage of negative-pressure respirators is that if any leaks develop in the system, i.e., a crack in the hose or an ill-fitting mask or face piece, the user draws contaminated air into the face piece during inhalation. When atmosphere-supplying respirators are used, only those operated in the positive-pressure mode are recommended for work at hazardous waste sites.

Different types of face pieces are available for use with the various types of respirators. The types generally used at hazardous waste sites are full face pieces and half masks.

- Full face piece masks cover the face from the hairline to below the chin. They provide eye protection.
- Half masks cover the face from below the chin to over the nose and do not provide eye protection.

6.4 Hazard Determination and Selection of PPE

The adverse effects chemical substances may have on the human body necessitate the use of protective clothing. The predominant physical, chemical, or toxic property of the material dictates the type and degree of protection required. For example, protection against a corrosive compound is different than that for a compound, which releases a highly toxic vapor. The work function and the probability of exposure to the substance must also be considered when specifying protective clothing. As with the selection of proper respiratory protective apparatus, the hazards encountered must be thoroughly assessed before deciding on the protective clothing to be worn.

Once the specific hazard has been identified, appropriate clothing can be selected. Several factors must be considered, most important being the safety of the individual. The level of protection assigned must match the hazard confronted. Other factors include cost, availability, and compatibility with other equipment, suitability, and performance.

Protective clothing ensembles range from safety glasses, hard-hats, and safety shoes to fully encapsulating suits with a supplied source of breathing air. The variety of clothing includes disposable coveralls, fire-retardant clothing, and chemical splash suits. Different materials are used to provide a protective barrier against the hazard.

6.5 Physical Stress

Wearing chemical protective clothing can cause problems. These include heat stress, accident proneness, and fatigue.

6.5.1 Heat Stress

Heat stress is the major problem caused by protective clothing interfering with the body's ability to cool itself. Clothing that provides a barrier against chemicals contacting the skin prevents the efficient dissipation of body heat. Evaporation, the body's primary cooling mechanism, is reduced since ambient air is not in contact with the skin's surface. Other heat exchange mechanisms, convection and radiation, are also impeded. Additional strain is put on the body as it attempts to maintain its heat balance. This added stress can result in health effects ranging from transient heat fatigue to serious illness or death.

The smaller the area of the body exposed to the air, the greater the probability for heat stress. Fully encapsulating suits allow no ambient air to contact the skin's surfaces to aid in the evaporation of moisture. Heat in these suits builds up quickly. Splash suits may allow more body surface (head, neck and hands) to be cooled by the air, but if those areas are covered by hoods, gloves and respirators and the joints taped, the same conditions will exist as if wearing a fully encapsulating suit. Heat-related problems become more common as the ambient temperature rises above 70°F, but can occur at much lower temperatures. Although wearing protective clothing establishes conditions that are conducive to heat-related illness, individuals vary in their susceptibility to heat stress and their ability to withstand high temperatures.

Four environmental factors affect the amount of stress a worker faces in a hot work area, temperature, humidity, radiant heat, such as from the sun or a furnace, and air velocity. Perhaps most important to the level of stress an individual faces are personal characteristics such as age, weight, fitness, medical condition and acclimatization to the heat.

The body reacts to high external temperature by circulating blood to the skin which increases skin temperature and allows the body to give off its excess heat through the skin. However, if the muscles are being used for physical labor, less blood is available to flow to the skin and release the heat.

Of course there are many steps a person might choose to take to reduce the risk of heat stress, such as moving to a cooler place, reducing the work pace or load or removing or loosening some clothing.

If the body cannot dispose of excess heat, it will store it. When this happens the body's core temperature rises and the heart rate increases. As the body continues to store heat, the individual begins to lose concentration and has difficulty focusing on a task, may become irritable or sick and often loses the desire to drink. The next stage is most often fainting and then possible death if the person is not removed from the heat stress.

Heat stroke, the most serious health problem for workers in hot environments, is caused by the failure of the body's internal mechanism to regulate its core temperature. Sweating stops and the body can no longer rid itself of excess heat. Symptoms include:

- Mental confusion.
- Delirium.
- Loss of consciousness.
- Convulsions or coma.
- Body temperature of 106°F or higher.
- Hot dry skin which may be red, mottled or bluish.

Victims of heat stroke will die unless treated promptly. While medical help should be called, the victim must be removed immediately to a cool area. A cool towel on the nape (back of the neck) will effectively cause the hypothalamus (the body's thermostat) to reduce the body's temperature immediately by 2 - 4 degrees in a heat stress situation.

Prompt first aid can prevent permanent injury to the brain and other vital organs.

Heat exhaustion develops as a result of loss of fluid through perspiring when a worker has failed to drink enough fluids or take in enough salt or both. The worker with heat exhaustion still perspires, but experiences extreme weakness or fatigue, giddiness, nausea or headache. The skin is clammy and moist, the complexion pale or flushed and the body temperature normal or slightly higher. The victim should rest in a cool place and drink salted liquids. Severe cases involving victims who vomit or lose consciousness may require longer treatment under medical supervision.

Heat cramps, painful spasm of the bone muscles, are caused when workers drink large quantities of water but fail to replace their bodies' salt loss. Tired muscles, those used for performing the work, are usually the ones most susceptible to cramps. Cramps may occur during or after working hours and may be relieved by taking salted liquids by mouth or saline solutions intravenously for quicker relief, if medically determined to be required.

Fainting may be a problem for the worker not acclimatized to a hot environment who simply stands still in the heat. Victims usually recover quickly after a brief period of lying down. Moving around, rather than standing still, will usually reduce the possibility of fainting.

Heat rash, also known as prickly heat, may occur in hot and humid environments where sweat is not easily removed from the surface of the skin by evaporation. When extensive or complicated by infection, heat rash can be so uncomfortable that it inhibits sleep and impairs a workers performance or even results in temporary total disability. It can be prevented by resting in a cool place and allowing the skin to dry.

6.6 Preventing Heat Stress

Most heat related health problems can be prevented or the risk of developing them reduced. Following a few basic precautions should lessen heat stress.

Acclimatization to the heat through short exposures followed by longer periods of work in the hot environment can reduce heat stress. New employees and workers returning from an absence of two weeks or more should have a 5-day period of acclimatization. This period should begin with 50 percent of the normal workload and time exposure the first day and gradually building up to 100 percent on the fifth day.

A variety of engineering controls including general ventilation and spot cooling by local exhaust ventilation at points of high heat production may be helpful. Shielding is required as protection from radiant heat sources. Evaporative cooling and mechanical refrigeration are other ways to reduce heat. Cooling fans can also reduce heat in hot conditions. Eliminating steam leaks will also help. Equipment modifications, the use of power tools to reduce manual labor and using personal cooling devices or protective clothing are other ways to reduce heat exposure for workers.

Work practices such as providing a period of acclimatization for new workers and those returning from two week absences and making plenty of drinking water, as much as a quart per worker per hour, available at the workplace can help reduce the risk of heat disorders.

Training first aid workers to recognize and treat heat stress disorders and making the names of trained staff known to all workers is essential. Employers should also consider individual workers' physical conditions when determining their fitness for working in hot environments. Older workers, obese workers and personnel on some types of medication are at greater risk.

Alternating work and rest periods with longer rest periods in a cool area can help workers avoid heat strain. If possible, heavy work should be scheduled during the cooler parts of the day and appropriate protective clothing provided. Supervisors should be trained to detect early signs of heat strain and should permit workers to interrupt their work if they are extremely uncomfortable.

Employee education is vital so that workers are aware of the need to replace fluids and salt lost through sweat and can recognize dehydration, exhaustion, fainting, heat cramps, salt deficiency, heat exhaustion and heat stroke as heat disorders. Workers should also be informed of the importance of daily weighing before and after work to avoid dehydration.

Accident proneness also increases when wearing chemical protective clothing. Suits are heavy, cumbersome, decrease mobility and dexterity, lessen visual and audio acuity, and increase physical exertion. The severity of the problems depend on the style of clothing worn. These negative qualities increase the risk of common accidental injury, such as slips, falls, or being struck.

To minimize the adverse effects of physical stress, workers wearing protective clothing must change their normal work regimen. A medical surveillance program, including baseline physicals and routine medical monitoring, should be instituted. Personnel must be allowed to acclimatize to stressful environmentally factors by varying work and rest periods as needed. Projects should be scheduled for cooler periods of the day when possible. The intake of fluids must be maintained at levels to prevent dehydration, and body electrolytes replaced through added salting at mealtimes. Compensatory efforts such as these must be established as part of Standard Operating Safety Procedures on a site-specific basis to reduce the risks associated with wearing protective clothing.

6.7 Inspection of Protective Clothing

Before wearing chemical protective clothing it must be properly inspected. The following is a checklist for visually inspecting all types of chemical protective suits. Chemical suits should be inspected immediately before use and monthly when not in use.

<u>Inspection Procedures</u>

- Spread out suit on a flat surface.
- Examine the outside for the following:

  Abrasions, cuts, holes, or tears in the fabric.

  Retention of original flexibility and durability in the fabric.

Separations or holes in the seams.

Proper sealing and operation of zippers, buttons, storm flaps and other connecting devices.

Signs of previous chemical attack or incomplete decontamination such as unusual discoloration, rough surface, gummy feeling, cracks; elastic around wrists and ankles and the drawstrings on hoods are in good condition, if applicable.

- Fully encapsulating suits require additional inspection which includes checking:

Exhalation valves (positive pressure) for debris and proper functioning.

The suit face piece for poor visibility (cuts, scratches and dirt) and an adequate suit-to-suit seal.

Presence and condition of waist belts, Velcro adjustments (head and hips), and ankle straps.

Condition of integral gloves, boots, and leg gaiters.

Presence of hardhat or ratchet head suspension.

Presence and condition of air line attachment and hoses for cooling system.

For leaks and pinholes.

- If an air source is available, secure the suit and inflate it, then use a mild soap solution, look for bubbles on the surface or around seams.

- If an air source in not available, take the suit into a dark room, run a flashlight inside the suit and look for pinpoints of light from outside the suit.

Records should be maintained on each suit's inspection, use conditions and repair status.

These records are especially important for fully encapsulating suits (FES), which are usually not individually assigned but shared.

Suggestions for maintaining records include:

1. Inspection - who, when and any problems.

2. Use conditions - where, activity and chemicals, if known.

3. Repaired - date of repair, nature of repair.

NOTE: Tag the suit “out of service” if not repaired.

6.8 Types of Protective Clothing

Protective materials are available for specific chemical contaminants, but there is no single material, which provides protection against all types of contaminants.

Several layers of protection should be considered when more than one contaminant is present or the hazards are unknown. Disposable boots, gloves and splash suits are another way to provide an extra layer of protection.

The selection of appropriate protective gear is based on the hazards anticipated or recognized. Complete protection calls for assembling a set of gear including hard-hat, safety glasses or face shield (preferably both), body covering (coveralls, pants and jacket), gloves and safety shoes (steel toe and shank). Omitting one item may compromise the individual's safety.

Some pieces of protective equipment, such as hard-hats and boots, have specific standards for manufacture and only those items meeting these standards should be used.

6.8.1 Head Protection

The hard-hat, a basic piece of safety equipment used in any work operations, must meet ANSI Z89.1-1969 specifications for protection. Manufacturers have adapted hard-hats so that ear protection and face shields may be easily attached. Hard-hats are adjustable so a liner can be worn during cold weather. A chinstrap is advantageous when work involves bending and ducking. It also helps secure the hard-hat to the head when full-face masks are worn.

Face shields that attach to hard-hats provide added protection. A combination that leaves no gap between the shield and the brim of the cap is best because it prevents overhead splashes from running down inside the face shield. The face shield must meet ANSI Z87.1-1968 specifications.

6.8.2 Eye Protection

Safety glasses must also meet ANSI Z87.1-1968. They should be standard safety gear when the respiratory protection is a half-face mask with no face shield. Both safety glasses and a face shield are advisable as long as they do not impair visibility. Safety glasses should be of the type that incorporates face shields.

6.8.3 Ear Protection

Earplugs or muffs should be issued when noise may be a problem, such as around heavy machinery and impact tools.

6.8.4 Foot Protection

Footwear worn during site activities (including leather work boots and rubber boots) must meet the specifications of ANSI Z41.1-1969. The material used to make the boots is not subject to any standards.

Protection against liquid hazardous chemicals requires a boot of neoprene, PVC, butyl rubber, or some other chemical resistant material.

Boots are available in two styles: pullover and shoe boot. Pullovers may be inexpensive enough to be considered disposable; otherwise they must be completely decontaminated. With chemical resistant boots, the pant leg should be outside and over the boots to prevent liquids from entering.

6.8.5 Hand Protection

The hands are as susceptible to contamination as the feet. Gloves must resist puncturing and tearing as well as provide the necessary chemical resistance. Most of the materials discussed earlier can be used in gloves. Heavy leather gloves may be worn over chemical protective gloves when doing heavy work. If they become contaminated, they should be discarded because leather is difficult to decontaminate.

Jacket cuffs should be worn over glove cuffs to prevent any liquid from spilling into the gloves. If hands are elevated above the head during work, the gloves should be sealed with tape to the coveralls or splash suit.

When selecting gloves consider thickness and cuff length. The thicker and longer the glove the greater the protection. However, the material should not be so thick that it interferes with the necessary dexterity.

Two pair of gloves should also be considered for extra protection of the hands if the outer glove is torn or permeated. A pair of inner gloves also adds an extra layer of protection for the hands during the removal of outer gloves and other chemically protective items.

6.8.6 Body Protection

Clothing to protect the body against hazardous liquids, gases, or vapors is available in a variety of styles and materials.

If the hazard present is known to be minor or simply a nuisance, minimal protection is warranted. This may be in the form of garments of Tyvek, which are disposable, or Nomex, which are durable. Both are available as coveralls suitable for field use. As the hazards to the body increase, so does the level of protection needed. A splash suit made of PVC is suitable for a liquid such as an acid or base or when there will be minimal contact with organic materials. Some are inexpensive enough to be disposable.

If the material is more toxic, then more protection must be utilized. Splash suits similar in design to the PVC splash suits are good barriers against toxic hazards. These are made of neoprene and butyl rubber.

Toxic vapor/gases require the most complete protection, the best being fully encapsulating suits. The suit must not allow any penetration or permeation. Zippers must be properly sealed and seams properly connected and sealed to protect against vapors. Fully encapsulating suits also require the basic safety items such as safety boots and hard-hat, along with a source of breathing air.

Wearing protective clothing creates some problems, the main one being that the body is shielded from normal circulation of air. Perspiration does not evaporate, thus eliminating the body's main mechanism for cooling. A cool towel on the nape (back of the neck) will effectively cause the hypothalamus (the body's thermostat to reduce the body's temperature immediately by 2 - 4 degrees in a heat stress situation. With that gone, the body is prone to heat stress, including heat stroke, which can be fatal. Heat-related problems are very common when temperature rises above 75°F. Work schedules for persons wearing fully encapsulating clothing must be closely and conservatively regulated lest heat stress becomes more of a threat than the chemical hazard itself.

The best way to combat heat stress is to allow the body to cool normally. The most efficient body cooling process is by evaporation. Someone wearing protective clothing that has no ventilation perspires profusely. If the perspiration remains in contact with the skin, it has a better chance of evaporating and cooling the body surface. If the perspiration is allowed to run off the body quickly, less evaporation occurs. This happens when shorts are worn under a fully encapsulating suit. Also, the suit material can become very hot and cause severe burns if it contacts the wearer's bare skin. Long cotton underwear is the best choice.

Long cotton underwear clings to the body when soaked with perspiration, thus allowing the greatest amount of cooling by evaporation and also protects the body from burns caused by the suit itself.

During extended periods of work in fully encapsulating suits, some sort of “cooling” must be provided to the wearer. The best method is to schedule frequent rest periods. If this is not adequate, a cooling device should be employed. Effective cooling units are available for use with supplied-air units. A vortex tube separates the air into cool and warm components, releasing the warm air outside the suit. When self-contained air is used for breathing, the cooling device must also be self-contained. For example, vests have been designed to carry ice packs. There are other commercial devices available to combat heat generated by fully encapsulating suits.

Many workers spend some part of their working day in a hot environment. Workers in foundries, laundries, construction projects, and bakeries, to name a few industries, often face hot conditions which pose special hazards to safety and health.

6.9 Performance Requirements

Protective clothing protects primarily because of the material from which it is made. In selecting the protective material, the following should be considered:

Chemical Resistance, which is the most important. When clothing contacts a hazardous material, it must maintain its structural integrity and protective qualities.

- **Strength**, which is based on resistance to tears, punctures, and abrasions, as well as tensile strength.

- **Flexibility**, clothing easy to move in and work in. Flexibility is especially important in glove materials.

- **Thermal limits** affect the ability of clothing to maintain its protective capacity in temperature extremes. Thermal limits also affect mobility in cold weather and transfer of heat to the wearer in hot weather.

- **Clean ability**, difficult and expensive if protective clothing is not cleanable. Some materials are nearly impossible to clean adequately under any circumstances. Disposable clothing is sometimes used.

- **Lifespan**, which is the ability to resist aging, especially in severe conditions over time. This should be balanced against the initial cost of the garment.

Protective material must be able to resist *degradation, penetration,* and *permeation* by the contaminant. Any of these actions may result upon contact, depending on factors such as concentration and contact time.

Degradation is the result of a chemical reaction between the contaminant and the protective material. Damage to the material may be slight or as severe as complete deterioration. The reaction may cause the material to shrink or swell, become brittle or very soft, or completely change its chemical and physical structure. Changes such as these may enhance or restrict permeation or allow penetration by the contaminant.

A chemical **penetrates** a protective garment because of its design and construction imperfections, not because of the inherent material from which it is made. Stitched seams, buttonholes, porous fabric, and zippers can provide an avenue for the contaminant to penetrate the garment. A well-designed and constructed protective suit with self-sealing zippers and lapped seams made of a non-porous degradation resistant material prevents penetration, but as soon as the suit is ripped or punctured it loses its ability to prevent penetration. A material may also be easily penetrated once degraded.

The ability of a protective material to resist **permeation** is an inherent property. A contaminant in contact with the protective material establishes a concentration gradient. The concentration is high on the contact surface and low inside. Because the tendency is to establish equilibrium, diffusion and other molecular forces “drive” the contaminant into the material.

When the contaminant passes through the material to the inside surface, it condenses there. The process of permeation continues as long as the concentration remains greater at the contact surface. The permeation rate is based on several factors. Rate is inversely proportional to the thickness of the material and directly proportional to the concentration of the contaminant.

The amount or degree of permeation is related to the exposure conditions, especially contact time, which ultimately dictates how much of the contaminant permeates the protective material. Thus a conscious effort should be made to avoid prolonged exposure or contact with any hazardous contaminant, even when wearing protective clothing. <u>No material resists permeation by all agents</u>.

6.10 Chemical Resistance Charts

Tables are available indicating relative effectiveness of various protective materials against generic classes of chemicals. Most tables only reflect ability to resist degradation. A protective material may resist degradation by a contaminant, but still be very permeable to it. Such charts are useful when used with discretion and when the seriousness of the hazard is properly evaluated. If a chemical is extremely toxic, then any activity involving it should be re-evaluated.

Permeability data are available from manufacturers and independent testing laboratories. If there is a question about permeability of a material in contact with a specific contaminant, a sample swatch of the material should be tested by a recognized laboratory for permeability to that chemical.

EFFECTIVENESS OF PROTECTIVE MATERIALS AGAINST CHEMICAL DEGRADATION				
Generic Class	**Butyl Rubber**	**Polyvinyl Chloride**	**Neoprene**	**Natural Rubber**
Alcohols	E	E	E	E
Aldehydes	E-G	G-F	E-G	E-F
Amines	E-F	G-F	E-G	G-F
Esters	G-F	P	G	F-P
Ethers	G-F	G	E-G	G-F
Fuels	F-P	G-P	E-G	F-P
Halogenated Hydrocarbons	G-P	G-P	G-F	F-P
Hydrocarbons	F-P	F	G-F	F-P
Inorganic acids	G-F	E	E-G	F-P
Inorganic bases and salts	E	E	E	E
Ketones	E	P	G-F	G-F
Natural fats and oils	G-F	G	E-G	G-F
Organic acids	E	E	E	E
E – Excellent F – Fair G – Good P - Poor				

6.11 Characteristics of Protective Materials

Materials such as Tyvek offer little or no protection against hazardous liquid or vapor contaminants. Such materials can, however, protect against particulate contaminants and other nuisances. Tyvek is often used as an outer covering over the primary protective gear such as splash gear or fully-encapsulating suits. Although Tyvek provides little chemical resistance, it does limit the amount of direct contamination on the primary protective gear. The Tyvek can then be discarded.

Ellastomers (polymeric materials that, after being stretched, return to about their original length) provide the best protection against chemical degradation, permeation, and penetration from toxic and corrosive liquids or gases. Elastomers are used in boots, gloves, coveralls, and fully-encapsulating suits. They are sometimes combined with a flame-resistant fabric called Nomex to enhance durability and protection.

Chemical protective clothing manufacturers have developed a technique of **layering materials** to improve chemical resistance. Essentially one suit is designed with multiple layers. Some examples of layered fully-encapsulating suits are **viton/butyl (Trellborg), viton/neoprene (MSA Vautex and Draeger), and butyl/neoprene (MSA Betex)**.

6.12 Protection Factors to Consider

The abilities of elastomers to resist degradation and permeation range from poor to excellent. The selection of a particular material should be based on its resistance to chemical degradation, as well as on its ability to resist permeation and the other performance characteristics discussed earlier. Other factors to be considered include:

Temperature of Service: Higher temperatures increase the effects of all chemicals on elastomers. The increase varies with the material and chemical. A material quite suitable at room temperature could fail at elevated temperatures. Extreme temperatures may also affect the physical properties of many polymer compounds. For example, some materials tend to become brittle and crack when cold, or become overly soft when warm. Of the two primary types of materials used for protective clothing -- plastics and synthetic rubbers -- plastics are generally more affected by temperature extremes.

Conditions of Service: A material, which swells upon contact with the chemical may function well in a test situation, but may fail in actual use.

Grade of the Elastomer: Elastomers are manufactured in different grades, each providing different degrees of protection. Grades vary from lot to lot due to process changes, curing times, and overall quality control.

6.13 Materials used in Protective Clothing

There are a wide variety of protective materials. The following is a list of the more common materials used in CPC segregated as elastomers or non-elastomers. The elastomers are not listed in any particular priority. The classes of chemicals rated as “good for” or “poor for” represent test data for both permeation breakthrough and permeation rate. They are general recommendations; there are many exceptions within each chemical class. Sources consulted for this information included Guidelines for the Selection of Chemical Protective Clothing (ACGIH, Vol. 1, 1985) and manufacturer’s literature. Suppliers should be consulted for current prices.

Butyl Rubber (Synthetic Rubber) (Isobutylene/Isoprene Copolymer). Resists degradation by many contaminants except halogenated Hydrocarbons and petroleum compounds, a common deficiency of most protective materials. It is especially resistant to permeation by vapors and gases. A relatively expensive material used in boots, gloves, splash suits, aprons, and fully-encapsulating suits.

Good for:

- Bases and many organics
- Heat and ozone resistance
- Decontamination

Poor for:

- Aliphatic and aromatic Hydrocarbons

– Gasoline
– Halogenated Hydrocarbons - abrasion resistance

Chloropell (Plastic) also referred to as CPE or chlorinated Polyethylene. ILC Dover product. Used in splash suits and fully encapsulating suits. No data on permeability.

Good for:

– Aliphatic Hydrocarbons
– Acids and bases
– Alcohols, phenols
– Abrasion and ozone

Poor for:

– Amines, ester, ketones
– Halogenated Hydrocarbons
– Cold temperature (becomes rigid)

Natural rubber (Polyisoprene). This is also a synthetic latex. Resists degradation by alcohols and caustics. Used in boots and gloves.

Good for:

– Alcohols
– Dilute acids and bases
– Flexibility

Poor for:

– Organic chemicals
– Aging (affected by ozone)

Neoprene (Synthetic rubber) resists degradation by caustics, acids, alcohols, and oils. Used in boots, gloves, and respirator face pieces and breathing hoses. Commonly available and inexpensive.

Good for:

– Bases and dilute acids
– Peroxides
– Fuels and oils
– Aliphatic Hydrocarbons
– Alcohols
– Glycols
– Phenols
– Abrasion and cut resistance

Poor for:

– Halogenated Hydrocarbons
– Aromatic Hydrocarbons
– Ketones
– Concentrated acids

Nitrile (Synthetic rubber) also referred to as Buna-N, milled nitrile, nitrile latex, NBR. Resists degradation by petroleum compounds, gasoline, alcohols, acids, and caustics. Also reasonably good for some chlorinated compounds. Used in boots and gloves. Commonly available and inexpensive.

Good for:

- Phenols
- PCBs
- Oils and fuels
- Alcohols
- Amines
- Bases
- Peroxides
- Abrasion and cut resistance
- Flexibility

Poor for:

- Aromatic and halogenated Hydrocarbons
- Amines
- Ketones
- Esters
- Cold temperature

NOTE: The higher the acrylonitrile concentration, the better the chemical resistance; but also increases stiffness. Nomex (Product of Dupont) Aromatic polyamide fiber. Non-combustible and flame resistant up to 428°F, thus providing good thermal protection. Very durable and acid resistant. Used in fire fighters' turnout gear and some fully encapsulating suits as a base for the rubber.

Polyethylene (Plastic) used as a coating on polyolefin material such as Tyvek, increasing resistance to acids, bases, and salts. Provides limited chemical protection against concentrated liquids and vapors. Useful against low concentrations and those activities which do not create a high risk of splash; also worn over COC to prevent gross contamination of non-disposables. The disposable poly is considered good "inner liners" and assists decontamination procedures. Also used in disposable gloves and boot covers.

Good for:

- Acids and bases
- Alcohols
- Phenols
- Aldehydes
- Decontamination (disposable)
- Lightweight

Poor for:

- Halogenated Hydrocarbons
- Aliphatic and aromatic Hydrocarbons
- Physical properties (durability)
- Penetration (stitched seams)

PVA (Plastic) Polyvinyl alcohol. Resists degradation and permeation by aromatic and chlorinated Hydrocarbons and petroleum compounds. Major drawback is its solubility in water. Used in gloves.

Good for:

- Almost all organics
- Ozone resistance

Poor for:

- Esters
- Ethers
- Acids and bases
- Water and water solutions
- Flexibility

PVC (Plastic) Polyvinyl chloride. Resists degradation by acids and caustics, used in boots, gloves, aprons, splash suits, and fully encapsulating suits.

Good for:

- Acids and bases
- Some organics
- Amines, peroxides

Poor for:

- Most organic compounds
- Cut and heat resistance
- Decontamination

Saranex made of Saran, a Dow product, coated on Tyvek. Very good general-purpose disposable material. Provides greater chemical resistance and overall protection compared to polyethylene-coated Tyvek; used to prevent contamination of non-disposable clothing.

Good for:

- Acids and bases
- Ammes
- Some organics
- PCBs
- Decontamination (disposable)
- Lightweight durability

Poor for:

- Halogenated Hydrocarbons
- Aromatic Hydrocarbons
- Stitched seams (penetration may occur)

Teflon has become available for chemical protective suits. Limited permeation test data is published on Teflon. Teflon, similar to **Viton,** is thought to afford excellent chemical resistance against most chemicals.

Tyvek is a product of Dupont. Spun-bonded non-woven polyethylene fibers. Has reasonable tear, puncture, and abrasion resistance. Provides excellent protection against particulate contaminants. Inexpensive and suitable for disposable garments. Worn over other protective clothing to prevent gross contamination of non-disposable items and under suits to replace cotton.

Good for:

- Dry particulate and dust protection
- Decontamination (disposable)
- Lightweight

Poor for:

- Chemical resistance (penetration/degradation)
- Durability

Viton (Plastic) is a product of Dupont. Fluoroelastomer similar to Teflon. Excellent resistance to degradation and permeation by aromatic and chlorinated Hydrocarbons and petroleum compounds. Very resistant to oxidizers. Extremely expensive material used in gloves and fully-encapsulating suits. Degraded by some rather common materials such as Acetone.

Good for:

- Aliphatic and aromatic Hydrocarbons
- Halogenated Hydrocarbons
- Acids
- Decontamination
- Physical properties

Poor for:

- Aldehydes
- Ketones
- Esters (oxygenated solvents)
- Amines

It is evident that protective materials are available for specific chemical contaminants, but there is no one material, which provides protection against all types of contaminants. Thus several layers of protection should be considered when more than one contaminant is present or the hazards are unknown. Disposable boots, gloves, and splash suits are another way to provide an extra layer of protection.

The selection of appropriate protective gear is based on the hazards anticipated or recognized. Complete protection calls for assembling a set of gear including hard-hat, safety glasses or face shield (preferably both), body covering (coveralls or pants and jacket), gloves, and safety shoes (steel toe and shank). Omitting one item may compromise the individual’s safety. Some pieces of protective equipment such as hard-hats and boots have specific standards for manufacture, and only those items meeting these standards should be used. Selections must be based upon judgment.

Each type of protective clothing has a specific purpose, as well as limitations. The following are common problems associated with the use of protective clothing:

- No clothing is resistant to all chemicals.
- Workers have decreased manual dexterity and/or mobility.
- Vision is often impaired.
- Heat stress may result from the prevention of normal body heat exchange mechanisms.

6.14 EPA Levels of Protection

U.S. Environmental Protection Agency levels of protection can be used as a starting point for assembly of protective clothing ensembles. However, each ensemble must be tailored to the specific situation to provide the most appropriate level of protection.

The type of environment and the overall level of protection should be re-evaluated periodically as the amount of information about the site increases and as workers are required to perform different tasks.

Reasons to Upgrade:

- Known or suspected presence of dermal hazards.
- Occurrence or likely occurrence of gas or vapor emission.
- Change in work task that will increase contact or potential contact with hazardous materials.
- Request of the individual performing the task.

Reasons to downgrade:

- New information indicating that the situation is less hazardous than was originally thought.
- Change in site conditions that decrease the hazard.
- Change in work task that will reduce contact with hazardous materials.

6.15 Levels of Protection

When response activities are conducted where atmospheric contamination is known or suspected to exist, personal protective equipment must be worn.

Personal protective equipment is designed to prevent/reduce skin and eye contact as well as inhalation or ingestion of the chemical substance. Protective equipment to protect the body against contact with known or anticipated chemical hazards has been divided into four categories.

6.15.1 Level A

Level A protection should be worn when the highest level of respiratory, skin, eye and mucous membrane protection is needed.

Personal Protective Equipment

- Positive-pressure (pressure demand), self-contained breathing apparatus.
- Fully-encapsulating chemical resistant suit.
- Gloves, inner, chemical resistant.
- Gloves, outer, chemical resistant.
- Boots, chemical resistant, steel toe and shank, (depending on suit boot construction, worn over or under suit boot).
- Underwear, cotton, long-john type. *
- Hard-hat (under suit). *
- Coveralls (under suit). *
- Two-way radio communications (intrinsically safe/non-sparking).

* Optional.

6.15.2 Level B

Level B protection should be selected when the highest level of respiratory protection is needed, but a lesser level of skin and eye protection. Level B protection is the minimum level recommended on initial site entries until the hazards have been further identified and defined by monitoring, sampling, and other reliable methods of analysis, and equipment corresponding with those findings utilized.

Personal Protective Equipment

- Positive-pressure (pressure-demand), self-contained breathing apparatus.
- Chemical resistant clothing (overalls and long-sleeved jacket, coveralls, hooded two-piece chemical splash suit, disposable chemical resistant coveralls).
- Coveralls (under splash suit). *
- Gloves, outer, chemical resistant.
- Gloves, inner, chemical resistant.
- Boots, outer, chemical resistant, steel toe and shank.
- Boots, outer, chemical resistant. *
- Two-way radio communications (intrinsically safe).
- Hardhat. *

* Optional

6.15.3 Level C

Level C protection should be selected when the type of airborne substance is known, concentration measured, criteria for using air-purifying respirators met, and skin and eye exposure is unlikely. Periodic monitoring of the air must be performed.

<u>Personal Protective Equipment</u>

- Full-face, air-purifying respirator.
- Chemical resistant clothing (one-piece coverall, hooded two piece chemical splash suit, chemical resistant hood and apron, disposable chemical resistant coveralls).
- Gloves, outer, chemical resistant.
- Gloves, inner, chemical resistant.
- Boots, steel toe and shank, chemical resistant.
- Boots, outer, chemical resistant. *
- Cloth coveralls (inside chemical protective clothing). *
- Two-way radio communications (intrinsically safe).
- Hardhat. *
- Escape mask. *

* Optional

6.15.4 Level D

Level D is primarily a work uniform. It should not be worn on any site where respiratory or skin hazards exist. Refer to the Office of Emergency and Remedial Response. Environmental Response, Division. See “Interim Standard Operating Safety Procedures” for full details.

The need for protective clothing and equipment is obvious for those of us who may work in hostile environments. Since one particular type of equipment or clothing will not fill the needs for all conditions, we will discuss some types and designs of protective equipment and clothing available.

<u>Fully-Encapsulating Suits</u>

The encapsulating type of body covering is most advantageous because most are impervious to dusts, liquids, and vapors. This type is a must in some atmospheres.

Possible advantages:

- Impervious.
- Internal pressure.
- May be used with an air pack and/or air manifold.

Possible disadvantages:

- Bulky.
- Takes time for donning.
- Donning is difficult for one person.

Acid-Resistant Suits

Most acid-resistant suits do not offer the "seal" that encapsulating suits have. Some acid-resistant suits have a hood cover for the head and may have exhalation valves, which allow liquid to seep into the suit.

Possible advantages:

- Resistant to corrosive material.
- Internal pressure.
- Some may be used with air pack and/or air manifold.

Possible disadvantages:

- Bulky.
- Takes time for donning.
- Poor "seal".

Fire Suits

Aluminized fire suits are designed for heat reflection and the prevention of body contact with pyrophoric materials. These fire suits are not to be used in hazardous atmospheres other than those for which they were designed.

Possible advantages:

- Reflects heat.
- Barrier between body and pyrophoric material.
- Fairly easy to don.

Possible disadvantages:

- Limited use.
- Short lifespan.

Plastic Suits

Rainwear and cloth-like plastics have a role in protective clothing with limitations. Plastics possess a barrier against many hazardous materials as pesticides and corrosives, but is a poor barrier in heat situations. The wrists, neck and ankle must be taped for a vapor barrier.

Possible advantages:

- Availability.
- Cost.
- Light-weight.

Possible disadvantages:

- Poor seal.
- Thin, will tear.

Bunker Suits

Firefighter's bunker suits have built-in vapor barrier liners and are designed to reflect the heat. The outer fabric material can become impregnated with products such as pesticides. Bunker suits are very popular and can be used in some hostile environments with proper modifications.

Possible advantages:

- Design.
- Cost.
- Vapor Barrier.

Possible disadvantages:

- Poor seal.
- Fiber material.

Hard-Hats

Hard-hats are needed for obvious reasons. Those that can be worn over a hood or have liners will offer protection from some materials.

Possible advantages:

- Barrier to liquids.
- Protection from failing objects.

Possible disadvantages:

- Does not encapsulate the head.

Gloves

Gloves that are designed for fire-fighting should not be used if the gloves will absorb the spilled material or be porous to liquids and vapors. Hand coverings should also be compatible with the hazardous material. The gloves can be fastened to the coat with Velcro or be taped.

Possible advantages:

- Hand protection.
- Permits the use of hands.

Possible disadvantages:

- Poor “seal”.
- May not be compatible with all products.

<u>Boots</u>

Some protective clothing suits are not equipped with boots. Therefore, boot selection must match the type of clothing. Boots with steel insoles will prevent cuts and punctures. Taping clothing or wrapping and taping plastic bags to boots provides a good seal.

Possible advantages:

- Feet and leg protection.

Possible disadvantages:

- May not be compatible with hazardous material.
- Poor “seal”.

<u>Respirators</u>

Some respirators are basically designed for escape from a hazardous atmosphere or to be used in an atmosphere <u>above 19.5% oxygen level</u>. Because of their simple construction and lightweight, respirators are very popular, but are not as versatile as other types of breathing equipment.

Possible advantages:

- Size and weight.
- Donning time.
- Cost.

Possible disadvantages:

- Should not be used in an atmosphere less than 19.5% oxygen.
- Limited to types of hazardous atmosphere.
- Time limit on the filter.

<u>SCBA</u>

The self-contained breathing apparatus (SCBA) type of breathing equipment will fit the needs of most hazardous atmosphere and oxygen-deprived air. They are more complex in their construction, operation and maintenance than the filter kind

Possible advantages:

- Versatile.
- May be used in an atmosphere less than 19.5% oxygen.

Possible disadvantages:

- Cost.
- Weight.

- Oxygen and air containers must be refilled.

Duct Tape

Duct Tape, although very useful, during hazardous waste site and similar operations, has its limitations according to an article by Captain John Maleta of the L.A. County Fire Department titled, “From Baling Wire to Duct Tape” in industrial Fire World of October 1987. Duct tape is used to seal zippers, to seal gloves, to seal boots, to seal breathing apparatus face piece to the suit and patch holes in suits.

Captain Maleta says that duct tape has some resistance to most solvents; however, the adhesive on the duct tape is not designed for sealing of personal protective equipment from thousands of chemicals and is soluble in almost every type of solvent known. Restriction bands made from tire tubes or rubber bands as suggested in this article, may also be affected by chemicals, and the additional restriction around the wrists may further impede movement and cause numbness.

CSHO's should be aware of the above problems and the potential exposures from leakage that may be caused from duct tape failure during emergency response, at hazardous waste site, and other similar operations where duct tape may be used with PPE or Personal Protective Clothing (PPC).

FROM BALING WIRE TO DUCT TAPE by John Maleta

Living in the space age is so confusing! You ask why? Well, we put mechanical hearts in humans, use lasers for bloodless operations, and put every kind of conceivable information on thin floppy disks. I would say these were great and far-reaching accomplishments for the scientific community so then, why can't we with all of this technology, design and produce a fully leak proof suit that can resist harmful chemicals.

Having attended many seminars and hazardous materials classes, I have found one of the most talked about subjects is the personal protective equipment (PPE) manufactured for the first responders. One point of great importance to the responder or wearer is the various degrees or classification of the PPE. They range from full turnout gear to encapsulated TEFLON suits.

In the past 5-10 years the production and use of PPE has increased dramatically. Thus, manufacturers and those wearing PPE may not have experience they need. This could be causing a false sense of security for those wearing PPE, as it does not protect against every hazardous material incident. Use of the pressure or light test will show how PPE may not protect as completely as it should. First, the exhaust ports are very difficult to check for leakage, and secondly, all suits leak in some way or another. In my opinion, we should always use a positive pressure air system with our PPE to keep the “methyl ethyl bad stuff” out.

Now that we have lost confidence in our chemical suits, what do we do next? Who do we turn to? As usual, we do not look to the scientific community. No, we resourceful devils look to the cupboards or go to the local hardware store to correct the leakage problem. Yes, you guessed it: good old duct tape. This product has been used to patch holes in radiator hoses, hold vehicle bumpers in place, keep windshields together ,and yes even patch HAZMAT suits!

Because the PPE that we purchase is very expensive to use duct tape to seal zippers, the over-gloves to the wrists, the ankle area to the boots, breathing apparatus face piece to the suit and actually patch holes in suits causes me much concern. One of the concerns is that when you see tape around the wearer's wrists, which is usually wrapped tightly to hold the gloves on, it becomes very difficult to take the gloves off. It might work if you leave a pull-tab, but when working with two sets of gloves and trying to grab a small tab - give me a break! If the gloves are taped to an encapsulating suit and the wearer wants to do some emergency adjustments to his breathing apparatus inside the suit, it is close to impossible. The same goes for taping the cuffs of the suit to the boots. If for some reason your boots leak, you could have a long delay getting the boots off. I can see a first responder being so taped up that he would have to carry a survival knife to literally cut himself out when he has a problem.

I feel very strongly that the wearer of PPE should have the option of doffing his suit easily if and when he has a problem. The use of duct tape for sealing purposes could definitely cause a problem in this area. Envision yourself wrapped up in tough fabric with your wrists and ankles taped tightly and you want out!

I feel that duct tape can be used, but only if absolutely necessary ... and preferably only in conjunction with a disposable suit.

This domestic tape, duct tape as we know it, is made of polyethylene coated cloth ... yes, cloth, with a rubber resin adhesive. The cloth/poly combination can end up acting like a sponge and the polyethylene also has a problem with caustics. It may cause softening of the backing and weaken the adhesive bond, but it does have some resistance to most solvents. On the other had, the adhesive, which is not designed for use in sealing off personal protective equipment form thousands of chemicals that the responder might come in contact with, is soluble in almost every type of solvent known. Pesticides which have a Hydrocarbon as a solvent/canier are one example where the rubber resin adhesive is soluble. When a responder walks into a spill, it is possible that the rubber resin will start to liquefy. The sticky mess that would result would be very difficult to decontaminate.

If this were to happen in the wrist area, which is very vulnerable to liquid attack, the sticky mess could run down into and onto the inner glove. Then you would have to clean both pairs of gloves. If the responder had to raise his arms during his work the mess could run down to his arm past the elbow. It would not be practical to use more solvent to remove the rubbery, sticky residue and if the residue is not removed you could, with a lot of use, accumulate a film or build-up of various chemicals which could ruin the suit.

One of the major U.S. manufacturers was contacted and their representative stated that their product was not designed for chemical mishaps. He also stated some of the approved uses; reduced noise transmission when used as a flexible connect or; sealing fiberglass insulation or to cover thermal insulation and a waterproof cover over pipe insulation. This tape which is primarily used for sealing ductwork, will withstand 180°F for extended periods and up to 200°F intermittently ... But nothing was stated about resistance to chemicals.

It alarms me that we purchase these suits, check the charts for chemical compatibility and then patch or seal them with the cure-all. Thirty years ago it was baling wire, today it is duct tape. This is wrong!

In place of duct tape, restriction bands made form tire tubes or rubber bands could be used to secure that second pair of gloves. These bands could then be discarded after use. Yes, the chemical might pass through and under the restriction band and cause some damage to the inner gloves, but those can be discarded or decontaminated. Remember, at least now you don't have a sticky mess with which to contend. Another advantage is that the wearer can easily pull his hand out of the gloves to make adjustments to the equipment or suit. This, in my opinion, is an important factor - it seems we rarely teach escape and retreat procedures. Also keep in mind that this product can be used in some vapor/gas situations with no problems.

Duct tape can continue to make its mark in replacing baling wire and doing a very good job - but in the heating and air conditioning world for where it was designed!

The opinions expressed are mine and mine only. Please send inquiries to me at the address below:

Captain John Maleta
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6.16 Donning and Doffing Fully-Encapsulating Suits

In responding to episodes involving hazardous substances, it may be necessary for response personnel to wear self-contained breathing apparatus (SCBA) and fully-encapsulating suits to protect against toxic environments. Donning and doffing of both is a relatively simple task, but a routine must be established and practiced frequently. Not only do correct procedures help instill confidence in the wearer of the suit, they reduce the risk of exposure and the possibility of damage to the suit. It is especially important to remove the equipment systematically so as to prevent or minimize the transfer of contaminants from suit to wearer.

The following procedures for donning and doffing apply to certain types of suits. They should be modified if a different suit or extra boots and gloves are worn. These procedures also assume that:

- The wearer has been trained in the SCBA.
- The SCBA has been inspected and tested.
- Appropriate decontamination steps have been taken prior to removal of the suit or other components.
- Sufficient air is available for routine decontamination and doffing of the suit.

Donning and doffing an encapsulating suit is more difficult if the user has to do it alone because of the physical effort required. The possibility of the wearer being exposed to contaminants or damaging the suit is also greatly increased. Therefore, assistance should be used in donning and doffing the equipment.

6.16.1 Donning

Before donning the suit, thoroughly inspect it for deficiencies that will decrease its effectiveness as the primary barrier for protecting the body.

Do not use any suit with holes, rips, malfunctioning closures or cracked masks. If the suit contains a hood piece, or a hard hat is worn, adjust it to fit the user's head. If the suit has a back enclosure for changing air bottles, open it. Use a moderate amount of talcum powder or cornstarch to prevent chafing and increase comfort. Both also reduce rubber binding.

Use an antifog preparation on the suit and mask face pieces.

6.16.2 Donning the Suit

While sitting, step into the legs, place your feet properly, and gather the suit around your waist.

While sitting, put on the chemical-resistant, steel toe and shank boots over the feet of the suit. Properly attach and seal suit leg over the top of the boot. For one-piece suits with heavy-soled protective feet, wear leather or short rubber safety boots inside suit. Wear an additional pair of disposable boot protectors if appropriate.

Put on the SCBA air tank and harness assembly. Don the face piece and adjust it securely yet comfortably. Do not connect breathing hose. Open the valve to the air tank. (The air tank and harness assembly could also be put on before stepping into the legs of the suit.)

Depending on the type of suit either put on the inner gloves, or for suits with detachable gloves, secure the gloves to the sleeves. (In some cases, extra gloves are worn over suit gloves.)

While standing, put your arms into the sleeves, and then your head into the hood of the suit. The helper pulls the suit up and over the SCBA, resting the hood on top of the SCBA and adjusting suit around SCBA backpack and user's shoulders to assure unrestricted motion. To ease entry into the suit, bend at the knees as hood is placed over wearer's head. Avoid bending at the waist, as this motion tends to use up room in the suit rather than provide slack. For a tall or stout person, it is easier to put on the hood of the suit before getting into the sleeve.

Begin to secure the suit by closing all fasteners until there is only room to connect the breathing hose. Also, secure all belts and/or adjustable leg, head and waistbands. Connect breathing hose while opening the main valve.

When you are breathing properly in the SCBA, finish closing the suit.

The helper should observe for a time to assure that the wearer is comfortable and equipment is functioning properly.

6.16.3 Doffing

Exact procedures must be established and followed to remove the fully-encapsulating suit and SCBA. Adherence to these procedures is necessary to minimize or prevent contamination (or possible contamination) of the wearer through contacting the outside surface of the suit.

The following procedures assume that before the suit is removed, it has been properly decontaminated, considering the type and extent of contamination, and that a suitably attired helper is available.

- Remove any extraneous or disposable clothing, boot covers, or gloves.
- If possible, wearer kicks off chemical-resistant boots unassisted. To achieve this, oversized boots are often selected. Otherwise, helper loosens and removes chemical-resistant boots.
- Helper opens front of suit to allow access to SCBA regulator. As long as there is sufficient air pressure, hose is not disconnected.
- Helper lifts hood of the suit over wearer's head and rests hood on top of SCBA air tank. For a tall or stout person it is easier to remove the arms from the sleeves of the suit prior to removing the hood.
- Remove external gloves.
- To minimize contact with contaminated clothing, helper touches only the outside of the suit, and the wearer touches only the inside. Remove arms, one at a time, from suit. Helper lifts suit up and away from SCBA backpack, avoiding any contact between outside surface of suit and wearer's body. Helper lays suit out flat behind wearer.
- While sitting (preferably), remove both legs from suit.
- After suit is completely removed, roll internal gloves off your hands, inside out.
- Walk to clean area and follow procedure for doffing SCBA.
- Remove inner clothing, clean body thoroughly.

6.16.4 Additional Considerations

If the worksite is very dirty or the potential for contamination is extremely high, wear disposable Tyvek or PVC coveralls over a fully-encapsulating suit. Make a slit in back to fit around the bulge of the SCBA backpack.

Wear clothing under the suit appropriate to outside temperatures. Even in hot weather, wear long cotton underwear, which absorbs perspiration and acts as a wick for evaporation, thus aiding body cooling. Long underwear also protects skin from contact with the hot surfaces of the suit, reducing the possibility of burns in hot weather.

Monitor the wearer for heat stress.

If a cooling device is used, modify the donning and doffing procedure.

If the low-pressure warning alarm sounds signifying approximately five minutes of air remaining, signal your partner and get out of the hazard area.

7 DECONTAMINATION

7.1 Objectives

At the conclusion of this module you should be able to do the following:

Identify the advantages and limitations of each of the following decontamination methods:

- Absorption
- Chemical degradation
- Dilution

Explain the need for decontamination procedures at hazardous materials incidents.

Identify the considerations associated with the placement, location and setup of the decontamination corridor.

Understand basic considerations for decontamination during medical emergencies.

7.2 Decontamination

Personnel responding to hazardous substance incidents may become contaminated in a number of ways including:

- Contacting vapors, gases, mists, or particulates in the air.
- Being splashed by materials while sampling or opening containers.
- Walking through puddles of liquids or on contaminated soil.
- Using contaminated instruments or equipment.

Protective clothing and respirators help prevent the wearer from becoming contaminated or inhaling contaminants. Good work practices help reduce contamination on protective clothing, instruments, and equipment.

Even with these safeguards, contamination may occur. Harmful materials can be transferred into clean areas, exposing unprotected personnel. In removing contaminated clothing, personnel may touch contaminants on the clothing or inhale them. To prevent such occurrences, methods to reduce contamination, and decontamination procedures, must be developed and implemented before anyone enters a site and must continue (modified when necessary) throughout site operations.

Decontamination consists of physically removing contaminants or changing their chemical nature to innocuous substances. Decontamination methods and the extent of decontamination performed depends on a number of factors, the most important being the type of contaminants involved. The more harmful the contaminant, the more extensive and thorough decontamination must be. Less harmful contaminants may require less decontamination.

Decontamination, proper doffing of personal protective equipment, and the use of site work zones minimizes cross-contamination from protective clothing to the wearer, equipment to personnel, and one area to another. Only general guidance can be given on methods and techniques for decontamination. The exact procedure must be determined after evaluating a number of factors specific to the incident.

7.3 Incident Safety Practices

The most hazardous part of an emergency incident is, typically, the scene itself. The most hazardous time for the responders is generally when they arrive, primarily due to the many unknowns at that point. One of the most important points of Hazardous Materials Emergency Response (HMRT) is to steer away from the typical idea of “rushing right in to take care of the problem”. This recklessness must be avoided!

A good, safe practice to follow when responding to HAZMAT emergencies is to approach from uphill and upwind, making sure to leave a clear escape route. Driving through or past a vapor cloud, visible spill or flow of product should never be attempted.

First responders should quickly control access to the hazard area. When this is accomplished, the area around the hazard itself can be secured. Finally, practical access/egress points can be reestablished based upon the size and scale of the incident and the resource and the resources needed to control it.

At this point, the Incident Commander should establish zones for the safe operation of Emergency Responders. These zones will not only help to bring order to an often chaotic scene, but will also help prevent personnel from entering contaminated or hazardous areas or from spreading contaminants to other responders. These zones are expandable in size and can be delineated by the use of traffic cones, banner tape, apparatus placement or geographic landmarks.

The three zones that need to be established are:

Hot Zone - Exclusion Zone

The area which is potentially hazardous to life and/or health and necessitates the use of appropriate protective clothing and having rescue teams standing by to ensure entry.

Warm Zone - Contamination Reduction Zone

The intermediary area between the hot zone and a safe area where the decontamination area is set up and rescue teams stand by.

Cold Zone - Support Zone

The safe area directly outside the warm zone where a majority of the Hazard Sector work takes place. This is separated from support activities, including the command post, to reduce confusion and interference during critical entry and decontamination operations.

After the three zones have been established, work should be started on setting up a decontamination area. The specifics of this area will depend upon the nature of the material involved, the number of persons potentially exposed and the type of decontamination procedure that will be used.

7.4 Initial Planning

The initial decontamination plan assumes all personnel and equipment leaving the Exclusion Zone (area of potential contamination) are grossly contaminated. A system is then set up for personnel decontamination to wash and rinse, at least once, all the protective equipment worn. This is done in combination with a sequential doffing of protective equipment, starting at the first station with the most heavily contaminated item and progressing to the last station with the least contaminated article. Each piece requires a separate station.

The spread of contaminants during the washing and doffing process is further reduced by separating each decontamination station by a minimum of three feet. Ideally, contamination should decrease as a person moves from one station to another further along in the line.

While planning site operations, methods should be developed to prevent the contamination of people and equipment. For example, using remote sampling techniques, not opening containers by hand, bagging monitoring instruments, using drum grapplers, watering down dusty areas, and not walking through areas of obvious contamination would reduce the probability of becoming contaminated and require a less elaborate decontamination procedure.

The initial decontamination plan is based on a worst-case situation or assumes no information is available about the incident. Specific conditions at the site are then evaluated, including:

- Type of contaminant.
- The amount of contamination.
- Levels of protection required.
- Work function being performed.
- Location of contamination.
- Reason for leaving the site.

There are two key questions from a health and safety standpoint that are answered lo determine which physical or chemical decontamination method should be used.

- What method is most effective for the specific substance?
- Does the method itself pose any hazards?

The initial decontamination plan is then modified, eliminating unnecessary stations or otherwise adapting it to site conditions. For instance, the initial plan might require a complete wash and rinse of chemical protective garments. If disposable garments are worn, the wash/rinse step could be omitted. Wearing disposable boot covers and gloves could eliminate washing and rinsing these items and reduce the number of stations needed.

An area within the Contamination Reduction Zone is designated the Contamination Reduction Corridor (CRC). The CRC controls access into and out of the Exclusion Zone and confines decontamination activities to limited area. The size of the corridor depends on the number of stations in the decontamination procedure. A corridor of 75 feet should be adequate for full decontamination. Whenever possible, it should be a straight path.

The CRC boundaries should be conspicuously marked, with entry and exit restricted. The far end is the hotline, the boundary between the Exclusion Zone and the Contamination Reduction Zone. Personnel leaving the Exclusion Zone must go through the CRC. Anyone in the CRC should be wearing the Level of Protection designated for the decontamination crew. Another corridor may be required for heavy equipment needing decontamination. Within the CRC, distinct areas are set aside for decontamination of personnel, portable field equipment, removed clothing, etc. These areas should be marked and personnel restricted to those wearing the appropriate level of protection. All activities within the corridor are confined to decontamination.

Personal protective clothing, respirators, monitoring equipment, and sampling supplies are all maintained outside of the CRC. Personnel don their protective equipment away from the CRC and enter the Exclusion Zone through a separate access control point at the hotline.

Once decontamination procedures have been established, all personnel requiring decontamination must be given precise instructions (and practice, if necessary). Compliance must be frequently checked. The time it takes for decontamination must be ascertained. Personnel wearing SCBAs must leave their work area with sufficient air to walk to CRC and go through decontamination.

7.5 Extent of Decontamination Required

The original decontamination plan must be adapted to specific conditions found at incidents. These conditions may require more or less personnel decontamination than planned, depending on a number of factors.

- **Type of Contaminant -** The extent of personnel decontamination depends on the effects and degree of toxicity (or other hazard). Whenever it is known or suspected that personnel can become contaminated with highly toxic or skin-damaging substances, a full decontamination must be performed. Depending on the materials involved, the procedure can be down-graded.

- **Amount of Contamination -** The amount of contamination on protective clothing is usually determined visually. If it is badly contaminated, a thorough decontamination is generally required. Hazardous material residue may degrade or permeate clothing. This likelihood increases with higher air concentrations and greater amounts of liquid contamination. Gross contamination also increases the probability of personnel contact. Swipe tests may help determine the type and quantity of surface contaminants.

There are five major factors that affect the extent of permeation of contaminants into personal protective equipment.

1. Contact time.
2. Concentration.
3. Temperature.
4. Size of the contaminant molecules and size of the pores.
5. Physical state of the waste/hazardous material.

7.6 Level of Protection

The Level of Protection and specific pieces of clothing worn determine, on a preliminary basis, the layout of the decontamination line. Each Level of Protection incorporates different problems in decontamination and doffing of the equipment. For example: decontamination of the harness straps and backpack assembly of the self-contained breathing apparatus is difficult. A butyl rubber apron worn over the harness makes decontamination easier. Clothing variations and different Levels of Protection may require adding or deleting stations in the original decontamination procedure.

7.7 Work Function

The work each person does determines the potential for contact with hazardous materials. In turn, this dictates the layout of the decontamination line. For example. observers, photographers, operators of air samplers, or others in the Exclusion Zone performing tasks that will not bring them in contact with contaminants may not need to have their garments washed and rinsed. Others in the Exclusion Zone with a potential for direct contact with the hazardous material will require more thorough decontamination. Different decontamination lines could be set up for different job functions, or certain stations in a line could be omitted for personnel performing certain tasks.

7.8 Location of Contamination

Contamination on the upper areas of protective clothing poses a greater risk to the worker because volatile compounds may generate a hazardous breathing concentration both for the worker and for the decontamination personnel. There is also an increased probability of contact with skin when doffing the upper part of clothing.

7.9 Reason for Leaving Site

The reason for leaving the Exclusion Zone also determines the need and extent of decontamination. A worker leaving the Exclusion Zone to pick up or drop off tools or instruments and immediately returning may not require decontamination. A worker leaving to get a new air cylinder or to change a respirator or canister, however, may require some degree of decontamination. Individuals departing the CRC for a break, lunch, or at the end of the day, must be thoroughly decontaminated.

7.10 Effectiveness of Decontamination

There is no method to immediately determine how effective decontamination is in removing contaminants. Signs of surface contamination visible to the eye in natural light are discolorations, stains, corrosive effects, alterations in the clothing fabric and substances adhering to objects. However, observable effects only indicate surface contamination and not permeation (absorption) into clothing. Also many contaminants are not easily observed.

A method for determining the effectiveness of surface decontamination is swipe testing. Cloth or paper patches called swipes are wiped over predetermined surfaces of the suspect object and analyzed in a laboratory. Both the inner and outer surfaces of protective clothing should be swipe tested. Positive indications of both sets of swipes would indicate surface contamination has not been removed and substances have penetrated or permeated through the garment. Swipe tests can also be done on skin or inside clothing. Permeation of protective garments requires laboratory analysis of a piece of the material. Both swipe and permeation testing provide after-the-fact information. Along with visual observations, results of these tests can help evaluate the effectiveness of decontamination.

7.11 Decontamination Solution

Personal protective equipment, sampling tools, and other equipment are usually decontaminated by scrubbing with detergent-water using a soft-bristle brush followed by rinsing with copious amounts of water. While this process may not be fully effective in removing some contaminants (or in a few cases, contaminants may react with water), it is a relatively safe option compared with using a chemical decontaminating solution. This requires that the contaminant be identified. A decontamination chemical is then needed that will change the contaminant into a less harmful substance. Especially troublesome are unknown substances or mixtures from a variety of known or unknown substances. The appropriate decontamination solution must be selected in consultation with an experienced chemist or other trained professional.

Decontamination equipment, materials, and supplies are generally selected based on availability. Other considerations are ease of equipment decontamination or disposability. Most equipment and supplies can be easily procured. For example, soft-bristle scrub brushes or long-handled brushes are used to remove contaminants. Water in buckets or garden sprayers are used for rinsing. Large galvanized washtubs or stock tanks can hold wash-and-rinse solutions. Children's wading pools can also be used. Large plastic garbage cans or other similar containers lined with plastic bags store contaminated clothing and equipment. Contaminated liquids can be stored temporarily in metal or plastic cans or drums. Other gear includes paper or cloth towels for drying protective clothing and equipment.

7.12 Decontamination Methods

Dilution is the use of water to flush hazardous material from protective clothing and equipment. Before this method is used, consideration must be given to the water reactivity potential of the spilled material and the possibility of pollution caused by the runoff water. Also, it must be remembered that although the application of water to most hazardous materials will generally reduce the concentration, it will not change the material chemically.

Absorption is the process of absorbing or "picking up" the hazardous material to prevent enlargement of the contaminated area. The material used for absorption should be chemically inert. The most readily available absorbent is soil and should be as dry as possible. Other examples include sand, clay or commercially produced absorption products.

Chemical Degradation alters the chemical structure of the hazardous material. The most commonly used degradation chemicals are sodium hypochlorite (bleach), sodium Hydroxide (lye), sodium carbonate slurry (washing soda), calcium oxide slurry (hydrated lime), liquid detergents (household), and ethyl alcohol. Technical advice for chemical degradation should be obtained from the manufacturer of the product whenever possible. The principle advantage of chemical degradation is that the hazardous material is rendered less harmful than it was prior to decontamination.

NOTE: When it is not possible to decontaminate equipment or materials, the final remedy is disposal and isolation.

7.13 Decontamination Solutions

Solution A	5% Sodium Carbonate 5% Trisodium Phosphate
Solution B	Calcium Hypochlorite or HTH
Solution C	5% Trisodium Phosphate (General Purpose Rinse)
Solution D	1 Pint Hydrochloric Acid to Ten Gallons of Water
Solution E	Tide or Other Detergent and Water Mixed Into a Paste

7.14 Decontamination of Equipment

Measures should be taken to prevent contamination of sampling and monitoring equipment. Sampling devices become contaminated, but monitoring instruments, unless they are splashed, usually do not. Once contaminated, instruments are difficult to clean without damaging them. Any delicate instrument which cannot be easily decontaminated should be protected while it is being used. It should be placed in a clear plastic bag, and the bag taped and secured around the instrument. Openings are made in the bag for sample intake.

Wood tools are difficult to decontaminate because they absorb chemicals. If they must be used, they should be kept on site and handled only by protected workers. At the end of the response, wooden tools should be discarded. For decontaminating other tools. Regional Laboratories should be consulted.

Certain parts of contaminated respirators, such as the harness assembly and leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may have to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Regulators must be maintained according to manufacturer's recommendations. Persons responsible for decontaminating respirators should be thoroughly trained in respirator maintenance.

Bulldozers, trucks, back-hoes, bulking chambers, and other heavy equipment are difficult to decontaminate. The method generally used is to wash them with water under high pressure and/or to scrub accessible parts with a detergent-and-water solution, under pressure if possible. In some cases shovels, scoops, and lifts have been sand-blasted or steam-cleaned. Particular care must be given to those components in direct contact with contaminants such as tires and scoops. Swipe tests should be used to measure the effectiveness of the decontamination effort.

It is to be noted that this by-products of any equipment cleansing must be considered **hazardous waste** and be contained and disposed of in the proper manner.

7.15 Sanitizing of Personal Protection Equipment

Respirators, reusable protective clothing, and other personal articles not only must be decontaminated before being reused, but also sanitized. The inside of masks and clothing becomes soiled due to exhalation, body oils, and perspiration. The manufacturer's instructions should be used to sanitize the respirator mask. If practical, protective clothing should be machine-washed after a thorough decontamination; otherwise it must be cleaned by hand.

7.16 Persistent Contamination

In some instances, clothing and equipment will become contaminated with substances that cannot be removed by normal decontamination procedures. A solvent may be used to remove such contamination from equipment if it does not destroy or degrade the protective material. If persistent contamination is expected, disposable garments should be used. Testing for persistent contamination of protective clothing and appropriate decontamination must be done by qualified laboratory personnel.

7.17 Disposal of Contaminated Materials

All materials and equipment used for decontamination must be disposed of properly. Clothing, tools, buckets, brushes, and all other equipment that are contaminated must be secured in drums or other containers and labeled. Clothing not completely decontaminated on-site should be secured in plastic bags before being removed from the site.

Contaminated wash and rinse solutions should be contained by using step-in containers (for example, child's wading pool) to hold spent solutions. Another containment method is to dig a trench about four inches deep and line it with plastic. In both cases the spent solutions are transferred to drums, which are labeled and disposed of with other substances on site, for proper disposal.

7.18 Decontamination During Medical Emergencies

Basic Considerations

Part of overall planning for incident response is managing medical emergencies. The plan should provide for:

- Response team members fully trained in first aid and CPR.
- Arrangements with the nearest medical facility for transportation and treatment of the injured, and for treatment of personnel suffering from exposure to chemicals.
- Consultation services with a toxicologist.
- Emergency eye washes, showers and/or wash stations.
- First aid kits, blankets, stretcher, and resuscitator.

In addition, the plan should establish methods for decontaminating personnel with medical problems and injuries. There is the possibility that the decontamination may aggravate or cause more serious health effects. If prompt life-saving first aid and medical treatment is required, minimal decontamination procedures should be followed. Whenever possible, response personnel should accompany contaminated victims to the medical facility to advise on matters involving decontamination.

Physical injuries can range from a sprained ankle to a compound fracture; from a minor cut to massive bleeding. Depending on the seriousness of the injury, treatment may be given at the site by trained response personnel. For more serious injuries, additional assistance may be required at the site or the victim may have to be treated at a medical facility.

Life-saving care should be instituted immediately with consideration to decontamination. The outside garments ran be removed (depending on the weather) if they do not cause delays, interfere with treatment, or aggravate the problem. Respirators and backpack assemblies must always be removed. Fully encapsulating suits or chemical resistance clothing can be cut away. If the outer contaminated garments cannot be safely removed, the individual should be wrapped in plastic, rubber, or blankets to help prevent contaminating medical personnel and the inside of ambulances. Outside garments are then removed at the medical facility. One exception would be if it is known that the individual has been contaminated with an extremely toxic or corrosive material which could also cause severe injury or loss of life. For minor medical problems or injuries, the normal decontamination procedure should be followed.

7.19 Chemical Exposure

Exposure to chemicals can be divided into two categories:

- Injuries from direct contact, such as acid burns or inhalation of toxic chemicals.
- Potential injuries due to gross contamination on clothing or equipment.

For inhaled contaminants, treatment can only be by qualified physicians. If the contaminant in on the skin or in the eyes, immediate measures must be taken to counteract the substance's effect. First aid treatment usually is flooding the affected area with water, however, for a few chemicals, water may cause more severe problems.

When protective clothing is grossly contaminated, contaminants may be transferred to treatment personnel or the wearer and cause injuries. Unless severe medical problems have occurred simultaneously with splashes, the protective clothing should be washed off as rapidly as possible and carefully removed.

7.20 Protection for Decontamination Workers

The **Level of Protection** worn by decontamination workers is determined by:

1. Expected or visible contamination on workers.
2. Type of contaminant and associated respiratory and skin hazards.
3. Total vapor/gas concentrations in the contamination reduction corridor.
4. Particulates and specific inorganic or organic vapors in the CRC.
5. Results of swipe tests.

8 TERMINATION PROCEDURE

8.1 Objectives

At the conclusion of this module you should be able to do the following:

Understand the goals of a proper debriefing.

Understand the topics that should be addressed during a debriefing.

Understand the principles a good critique mentally promotes.

8.2 Purpose of Termination Procedures

Proper termination activities help ensure the safety of emergency response personnel and the general public and ensure that lessons learned are shared with other emergency response organizations.

8.3 Components

Termination activities are divided into several phases, including debriefing and critiquing the incident.

8.4 Scope

Initially, the group most concerned is a small number of emergency responders who may be briefed in the signs and symptoms of a particular poison or on special decon procedures. On larger incidents, the number of people with a need to know expands and may even include the investigation team or representatives from contractors or other agencies.

Potential negative outcomes of failure to properly terminate an incident:

Incorrect hazard data could result in illness to those exposed, improper clean-up techniques, and unsafe disposal procedures.

8.5 Debriefing

A debriefing distributes the right amount of information to the right people before they leave the incident scene.

<u>Goals</u>

An effective debriefing should:

1. Inform responders about exactly which hazardous materials were involved and the signs and symptoms of exposure.
2. Provide information for personal exposure records.
3. Identify equipment damage and unsafe conditions requiring immediate attention or isolation for further evaluation.
4. Assign information-gathering responsibilities for a post-incident analysis and critique.
5. Summarize the activities performed by each section, including topics for follow-up.

Debriefings should begin as soon as the emergency phase of the operation is ended. Ideally, this should be before first responders leave the scene.

Debriefings should include the regional response team, section chiefs, branch directors, and other key players such as public information officers and those agency representatives who the incident commander determines have a need to know.

Debriefings should be conducted in buildings or vehicles that are free from distractions such as cold or hot temperature, emergency service radios, and loud generators.

Debriefings should be conducted by one person acting as the chairperson and limited to a maximum of 45 minutes.

Topics to be addressed are:

- Provide health information.
- Equipment and apparatus exposure.
- Follow-up contact person.
- Problems requiring immediate action

SAY THANK YOU

8.6 Critique

An effective critique program is supported by top management as a positive way to outline lessons learned. The more severe the incident, the more important it is to share what you have learned. A commitment to critique all HAZMAT responses will improve emergency response personnel performance by improving efficiency and pinpointing weaknesses.

<u>A good critique mentality promotes</u>:

- Trust in the response system as being self-correcting.
- Willingness to cooperate through teamwork.
- Continuing training in skills and techniques.
- Pre-planning for significant incidents.
- Sharing information between response agencies.

Never use a critique to assign blame (public meetings are the worst time to discipline personnel).

Do use critiques as a valuable learning experience everyone came to the incident with good intentions.

8.7 Summary

The proper management of any emergency incident whether police, fire, medical, or natural disaster requires continuing training and education of response personnel. When an incident also involves hazardous materials, the scope of what constitutes proper management only increases in complexity. Establishing and following formal termination procedures through debriefings and critiques helps ensure the safety of emergency response personnel and the general public and ensures that lessons learned are shared with other emergency response organizations.

9 METERING

9.1 Objectives

At the conclusion of this module you should be able to do the following:

Understand the use and limitations of Direct-Reading Instruments.

Understand the variables that affect exposure at a hazardous material site.

Use the information gathered to select personal protective equipment.

Delineate areas where protection is needed.

Assess the potential health effects of exposure.

Determine the need for specific medical monitoring.

9.2 Metering

Airborne contaminants can present a significant threat to worker health and safety. Thus, identification and quantification of these contaminants through air monitoring is an essential component of a health and safety program at a hazardous waste site. Reliable measurements of airborne contaminants are useful for:

- Selecting personal protective equipment.
- Delineating areas where protection is needed.
- Assessing the potential health effects of exposure.
- Determining the need for specific medical monitoring.

9.3 Measuring Instruments

The purpose of air monitoring is to identify and quantify airborne contaminants in order to determine the level of worker protection needed. Initial screening for identification is often qualitative, i.e., the contaminant, or the class to which it belongs, is demonstrated to be present by the determination of its concentration (quantification) must await subsequent testing. Two principal approaches are available for identifying and/or quantifying airborne contaminants:

- The on-site use of direct-reading instruments.
- Laboratory analysis of air samples obtained by gas sampling bag, filter, sorbent, or wet-contaminant collection methods.

9.3.1 Direct-Reading Instruments

Direct-reading instruments were developed as early warning devices for use in industrial settings, where a leak or an accident could release a high concentration of a known chemical into the ambient atmosphere. Today, some direct-reading instruments can detect contaminants in concentrations down to one part contaminant per million parts of air (ppm), although quantitative data are difficult to obtain when multiple contaminants are present. Unlike air sampling devices which are used to collect samples for subsequent analysis in a laboratory, direct-reading instruments provide information at the time of sampling, enabling rapid decision-making.

Direct-reading instruments may be used to rapidly detect the following:

- ➢ Flammable or explosive atmospheres.
- ➢ Oxygen deficiency.
- ➢ Certain gas and vapors.
- ➢ Ionizing radiation.

They are the primary tools of initial site characterization. The information provided by direct-reading instruments can be used to institute appropriate protective measures (e.g., personal protective equipment, and evacuation), to determine the most appropriate equipment for further monitoring, and to develop optimum sampling and analytical protocols.

All direct-reading instruments have inherent constraints in their ability to detect hazards:

1. They usually detect and/or measure only specific classes of chemicals.
2. Generally, they are not designed to measure and/or detect airborne concentrations below 1 ppm.
3. Many of the direct-reading instruments that have been designed to detect one particular substance also detect other substances (interference) and, consequently, may give false readings.

It is imperative that direct-reading instruments be operated and their data interpreted by qualified individuals who are thoroughly familiar with the particular device's operating principles and limitations. The individual should also be knowledgeable of current operating instructions and calibration curves. At hazardous waste sites, where unknown and multiple contaminants are the rule rather than the exception instrument readings should be interpreted conservatively.

The following guidelines may facilitate accurate recording and interpretation:

a) Calibrate instruments according to the manufacturer's instructions before and after every use.
b) Develop chemical response curves if these are not provided by the instrument manufacturer.
c) Remember that the instrument's readings have limited value where contaminants are unknown. When recording readings of unknown contaminants, report them as "needle deflection" or "positive instrument response" rather than specific concentration (i.e., ppm). Conduct additional monitoring at any location where a positive response occurs.
d) A reading of zero should be reported as "no instrument response" rather than "clean" because quantities of chemicals may be present that are not detectable by the instrument.
e) The survey should be repeated with several detection systems to maximize the number of chemicals detected.

Tables 1 and 2 list several direct-reading instruments and the conditions and/or substances they measure. The flame ionization detector (FID) and the photo-ionization detector (PID) are commonly used at hazardous waste sites.

However, some of these devices may not detect some particularly toxic agents, including hydrogen cyanide and hydrogen sulfide. Thus, these devices must be supplemented with either methods of detection.

TABLE 1

Examples of Direct-Reading Instruments for General Survey

Instrument	Hazard Monitored	Application	Detection Method	Limitations	Ease of Operation	General Care and Maintenance	Typical Operating Times
Combustible Gas Indicator (CGI)	Combustible gases and vapors.	Measures the concentration of a combustible gas or vapor.	A filament, usually made of platinum, is heated by burning the combustible gas or vapor. The increase in heat is measured.	Accuracy depends, in part, on the difference between the calibration and sampling temperatures. Sensitivity is a function of the differences in the chemical and physical properties between the calibration gas and the gas being sampled. The filament can be damaged by certain compounds such as silicones, halides, tetraethyl lead, and oxygen-enriched atmospheres. Does not provide a valid reading under oxygen-deficient conditions.	Effective use requires that the operator understand the operating principles and procedures.	Recharge or replace battery. Calibrate immediately before use.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.
Flame Ionization Detector (FID) with Gas Chromatography Option	Many organic gases and vapors.	In survey mode, detects the total concentrations of many organic gases and vapors. In gas chromatography (GC) mode, identifies and measures specific compounds. In survey mode, all the organic compounds are ionized and detected at the same time. In GC mode, volatile species are separated.	Gases and vapors are idonized in a flame. A current is produced in proportion to the number of carbon atoms present.	Does not detect inorganic gases and vapors, or some synthetics. Sensitivity depends on the compound. Should not be used at temperatures less than 40°F (4°C). Difficult to absolutely identify compounds. High concentrations of contaminants or oxygen-deficient atmospheres require system modification. In survey mode, readings can be only reported relative to the calibration standard used.	Requires experience to interpret data correctly, especially in the GC mode. Specific identification requires calibration with the specific analyte of interest.	Recharge or replace battery. Monitor fuel and/or combustion air supply gauges. Perform routine maintenance as described in the manual. Check for leaks	8 hours; 3 hours with strip chart recorder.

TABLE 1 (cont'd)

Examples of Direct-Reading Instruments for General Survey

Instrument	Hazard Monitored	Application	Detection Method	Limitations	Ease of Operation	General Care and Maintenance	Typical Operating Times
Portable Infrared (IR) Spectro-photometer	Many gases and vapors	Measures concentration of many gases and vapors in air. Designed to quantify one or two component mixtures.	Passes different frequencies of IR through the sample. The frequencies absorbed are specific for each compound.	In the field, must make repeated passes to achieve reliable results. Requires 115-volt AC power. Not approved or use in a potentially flammable or explosive atmosphere. Interference by water vapor and carbon dioxide. Certain vapors and high moisture may attack the instrument's optics, which must then be replaced.	Requires personnel with extensive experience in IR spectro-phometry.	As specified by manufacturer.	
Ultraviolet (UV) Photo-ionization Detector (PID)	Many organic and some inorganic gases and vapors	Detects total concentration of many organic and some inorganic gases and vapors. Some identification of compound is possible if more than one probe is used.	Ionizes molecules using UV radiation; produces a current that is proportional to the number of ions.	Does not detect methane. Does not detect a compound if the probe used has a lower energy level than the compound's ionization potential. Response many change when gases are mixed. Other voltage sources may interfere with measurements. Readings can only be reported relative to the calibration standard used. Response is affected by high humidity.	Effective use requires that the operator understand the operating principles and procedures, and be competent in calibrating, reading and interpreting the instrument.	Recharge or replace battery. Regularly clean lamp window. Regularly clean and maintain the instrument and accessories.	10 hours; 5 hours with strip chart recorder.
Gamma Radiation Survey Instrument	Gamma Radiation	Environmental Radiation Monitor.	Scintillation Detector.	Does not measure alpha or beta radiation.	Extremely easy to operate, but requires experience to interpret data. Rugged, good in field use.	Must be calibrated annually at a specialized facility.	Can be used for as long as the battery lasts, or for the recommended interval between calibrations, whichever is less.

TABLE 2							
Examples of Direct-Reading Instruments for General Survey							
Instrument	**Hazard Monitored**	**Application**	**Detection Method**	**Limitations**	**Ease of Operation**	**General Care and Maintenance**	**Typical Operating Times**
Direct-Reading Colorimetric Indicator Tube	Specific gases and vapors	Measures concentrations of specific gases and vapors	The compound reacts with the indicator chemical in the tube, producing a stain whose length or color change is proportional to the compound's concentration.	The measured concentration of the same compound may vary among different manufacturer's tubes. Many similar chemicals interfere. Greatest sources of error are: (1) how the operator judges stain's end-point, and (2) the tube's limited accuracy affected by high humidity.	Minimal operator training and expertise required.	Do not use a previously opened tube even if the indicator chemical is not stained. Check pump for leaks before and after use. Refrigerate prior to use to maintain shelf life of about 2 years. Check expiration date of tubes. Calibrate pump volume at least quarterly. Avoid rough handling which may cause channeling.	
Oxygen Meter	Oxygen $(0)_2$	Measures the percentage of O_2 in air	Uses an electrochemical sensor to measure the partial pressure of O_2 in the air and converts that reading to O_2 concentration.	Must be calibrated prior to use to compensate for altitude and barometric pressure. Certain gases, especially oxidants such as ozone, can affect readings. Carbon dioxide (CO_2) poisons the detector cell.	Effective use requires that the operator understand the operating principles and procedures.	Replace detector cell according to manufacturer's recommendations. Recharge or replace batteries prior to expiration of the specified interval. If the ambient air is more than 0.5% CO_2, replace or rejuvenate the O_2 detector cell frequently.	8 to 12 hours.

9.4 Laboratory Analysis

Direct-reading personal monitors are available for only a few specific substances and are rarely sensitive enough to measure the minute quantities of contaminants, which may include health changes. Thus to detect relatively low-level concentrations of contaminants, long-term or “full-shift” personal air samples must be analyzed in a laboratory. Full-shift air samples for some chemicals may be collected with passive dosimeters or by means of a pump which draws air through a filter or sorbent. Table 3 lists some sampling and analytical techniques used at hazardous sites.

Selection of the appropriate sampling media largely depends on the physical state of the contaminants. For example, chemicals such as PCBs (polychlorinated biphenyls) and PNAs (polynuclear aromatic Hydrocarbons) occur as both vapors and particulate-bound contaminants. A dual-media system is needed to measure both forms of these substances. The volatile component is collected on a solid absorbent and the non-volatile component is collected on a filter. More than two dozen dual-media sampling techniques have been evaluated by NIOSH.

Mobile laboratories may be brought on site to classify hazardous wastes for disposal. A mobile laboratory is generally a trailer truck that houses analytical instruments capable of rapidly classifying contaminants by a variety of techniques.

Usually, a few of the field samples collected are analyzed on site to provide rapid estimates of the concentration of airborne contaminants. These data can be used to determine the initial level of worker personal protection necessary to modify field sampling procedures and to guide the fixed-base laboratory analysis. If necessary, samples screened in the mobile laboratory can be subsequently re-analyzed in sophisticated fixed-base laboratories.

9.5 Site Monitoring

Priorities for air monitoring should be based on the information gathered during initial site characterization. This information serves as the basis for selecting the appropriate monitoring equipment and personal protective equipment (PPE) to use when conducting site monitoring. Depending on site conditions and project goals, four categories of site monitoring may be necessary: monitoring for IDLH and other dangerous conditions, general on-site monitoring, perimeter monitoring, and periodic monitoring.

9.5.1 Monitoring IDLH and Other Dangerous Conditions

As a first step, air monitoring should be conducted to identify any IDLH and other dangerous conditions, such as flammable or explosive atmospheres, oxygen-deficient environments, and highly toxic levels of airborne contaminants. Direct-reading monitoring instruments will normally include combustible gas indicators, oxygen meters, calorimetric indicator tubes, and organic vapor monitors. Other monitoring instruments may be necessary based on the initial site characterization. Monitoring personnel should be aware that conditions can suddenly change from non-hazardous to hazardous.

Acutely hazardous concentrations of chemicals may persist in confined and low-lying spaces for long periods of time. Look for any natural or artificial barriers, such as hills, tall buildings, or tanks, behind which air might be still, allowing concentrations to build up. Examine any confined spaces such as cargo holds, mine shafts, silos, storage tanks, box cars, buildings, bulk tanks, and dumps where chemical exposures capable of causing acute health effects are likely to accumulate. Low-lying areas, such as hollows and trenches, are also suspect. Monitor these spaces for IDLH and other dangerous conditions.

In open spaces, toxic materials tend to be emitted into the atmosphere, transported away from the source, and dispersed. Thus acutely hazardous conditions are not likely to persist in open spaces for extended periods of time unless there is a very large (and hence, readily identifiable) source, such as an overturned tank car. Open spaces are therefore generally given a lower monitoring priority.

TABLE 3

Some Sample Collection and Analytical Methods

Substance	Collection Device[a]	Analytical Method	Typical Detection Limit of Analytic Instrument (g)
Anions: Bromide Chloride Fluoride Nitrate Phosphate Sulfate	Prewashed Silica Gel Tube	Ion Chromatography	10
Aliphatic Amines	Silica Gel	GC/NPD	10
Asbestos	MCEF	PCM	100[c]
Metals	MCEF	ICP-AES	0.5
Organics	Charcoal tube	GC/MS	10
Nitrosamines	Thermosorb/N	GC/TEA	0.01
Particulates	MCEF	Gravimetric	
PCBs	GF filter and florisil tube	GC-ECD	0.001
Pesticides	13-mm GF filter and chromosorb 102 Tube	GC/MS	0.05

[a]MCEF = mixed Cellulose ester filter. GF - glass fibre filter.

[b]GC/NPD = gas chromatography and nitrogen/phosphorus detector;
PCM = phase contrast microscopy;
ICP-AES = inductively coupled plasma atomic emission spectrometry;
GM/MS = gas chromatography using an electrical conductivity detector.

[c]Unites in fibers per mm^2 of filter (Method No. 7400 from the NIOSH Manual of Analytical Methods, 3rd edition).

9.5.2 General On-Site Monitoring

Air sampling should be conducted using a variety of media to identify the major classes of airborne contaminants and their concentrations. The following sampling pattern can be used as a guideline. First, after visually identifying the sources of possible generation, collect air samples downwind from the designated source along the axis of the wind direction. Work upwind, until reaching or getting as close as possible to the source. Level B protection should be worn during this initial sampling. Levels of protection for subsequent sampling should be based upon the results obtained and the potential for an unexpected release of chemicals.

9.5.3 Perimeter Monitoring

Fixed-location monitoring at the “fence line” or perimeter, where personal protective equipment is no longer required, measures contaminant migration away from the site and enables the Site Safety Officer to evaluate the integrity of the site’s clean areas. Since the fixed-location samples may reflect exposures either upwind or downwind from the site, wind speed and direction data are needed to interpret the sample results.

9.5.4 Periodic Monitoring

Site conditions and atmospheric chemical conditions may change following the initial characterization. For this reason, monitoring should be repeated periodically, especially when:

- Work begins on a different portion of the site.
- Different contaminants are being handled.
- A markedly different type of operation is initiated.
- Workers are handling leaking drums or working in areas with obvious liquid contamination.

9.5.5 Personal Monitoring

The selective monitoring of high-risk workers, i.e., those who are closest to the source of contaminant generation, is highly recommended. This approach is based on the rationale that the chance of significant exposure varies in direct proportion to the distance from the source. If workers closest to the source are not significantly exposed they probably do not need to be monitored.

Since occupational exposures are linked closely with active material handling, personal air sampling should not be necessary until site mitigation has begun. Personal monitoring samples should be collected in the breathing zone and if workers are wearing respiratory protective equipment outside the face piece.

Personal monitoring may require the use of a variety of sampling media. Unfortunately, single workers cannot carry multiple sampling media because of the added strain and because it is not usually possible to draw air through different sampling media using a single portable, battery-operated pump. Consequently, several days may be required to measure the exposure of a specific individual using each of the media. Alternatively, if workers are in teams, a different monitoring device can be assigned to each team member.

10 HAZMAT SPILL CONTROL

10.1 Objectives

At the conclusion of this program the candidate will demonstrate through a series of tests and practical applications the skills required to safely respond to and control a hazardous material incident.

State the difference between containment and confinement.

State the 5 steps in spill/leak response.

Understand different control methods and materials and their limitations for:

- Covering
- Containerizing
- Diking
- Diverting
- Damming
- Absorbing

10.2 Purpose

We will look at the purpose of controlling releases, the various steps that are involved, as well as the different methods that are used throughout the hazardous materials emergency response industry.

10.3 Purpose of Controlling Hazardous Material Releases:

Emergency responders must know how to use techniques to minimize or prevent harm to life, environment, or property.

10.4 Outcome Considerations

10.4.1 Spills Must Be Handled Properly

An improper action, regardless of good intentions, can risk the lives and health of many people and cause permanent environmental damage.

10.4.2 Where Spills Can Occur

Hazardous material spills can occur at any time in the chemical's life cycle “from cradle to grave”.

10.4.3 Outcomes of Inappropriate Control Methods

Emergency responders, in handling hazardous material spills, often create, most unwittingly, tremendous environmental clean-up problems.

Goal: To prevent harm to the environment

The goal of spill control is to prevent or at least to minimize environmental damage resulting from exposure to a released hazardous substance.

Preventing environmental damage is more important than preventing property damage.

10.5 Objectives

10.5.1 Containment

The first objective is to prevent a hazardous substance from escaping from a damaged container - to stop the flow of the material from its original container, this is known as “containment”.

10.5.2 Confinement

The second objective is to control where a hazardous material that has already been spilled or otherwise released from its container is going.

10.6 Steps in Spill/Leak Response

a) Identify the material and its association hazards.

b) Use proper protective clothing and equipment.

c) Stop the flow and the source ("Confinement").

d) Confine spilled material to the immediate area ("Confinement").

e) Recover spilled material (utilizing a professional clean-up company).

10.7 Control Methods

10.7.1 Containment

Containment refers to controlling the flow at the source. This means either preventing the release or stopping the flow at the container itself.

10.7.2 Confinement

Confinement is any action employed to control where a spilled hazardous material is going. Confinement methods vary with the state of the substance when released from its container:

– solid

– liquid, or

– gas

10.8 Solids

Containerization

Containerizing refers to the technique of confining the spilled material by placing the chemical and/or its container in a larger, intact container.

Covering

Covering a powdered hazardous material can easily be done by using a tarp, plastic sheeting, soil, etc.

NOTE: Whatever you use to cover the solid, be sure it is compatible with the chemical!

Using water spray to dampen dusts or powders to prevent them from becoming wind born may also facilitate their absorption into the soil and thus into the water table below.

10.9 Liquids Retaining

When liquids are being discharged from an elevated source - such as from a pipe or above ground leak - they can be collected in a temporary basin, bucket, portable dump, etc., for later disposal.

10.10 Dikes

When a liquid is spilled, it tends to seek the lowest level of the terrain. Use dikes to direct the flow of a spilled liquid either away from a critical exposure or toward a desirable location for holding the chemical.

Dikes can be built of soil, clay, soil-filled plastic bags, and so on. Even a fire hose filled with water can act as a dike.

Try to avoid digging holes or trenches in the path of the liquid to contain or direct it. This tends to increase the rate of soil permeation and groundwater contamination.

Protect storm drains by covering them with plastic sheeting or tarp, and lining the edges with dirt or heavy objects.

Diverting the flow of a spilled liquid by building dikes and isolating it in a particular area is an interim method that can be used so that final confinement and recovery of the material can be accomplished more easily.

10.11 Absorption

Absorption refers to a technique that utilizes any solid capable of absorbing a liquid several times its own weight and mass.

The sorbent must be compatible with the spilled substance.

The sorbent will become contaminated with chemicals and will have to be transported to the disposal site. Contaminated sorbent materials possess all of the hazards of the chemicals they have absorbed:

- flammability,
- toxicity,
- reactivity, etc.

10.11.1 Sorbent Materials

Dirt is much more absorbent than sand.

Sawdust can react with some materials, and does not hold onto the absorbed material for very long.

Vermiculite is extremely effective and is usually available in quantity at places that supply materials for lightweight concrete, “cottage-cheese ceilings”, insulators, etc.

The key to obtaining resources such as absorbent clay is to identify local agencies and businesses with the resource as normal "in-house" stock that is accessible 24 hours a day.

Diatomaceous earth is available in quantities from local suppliers. Sorbent and imbibing materials retain the spilled material until put through a chemical process to reverse molecular adhesion.

10.12 Dams

Dams are a barrier built to hold back flowing water or material. They are effective for controlling water and hazardous material movement through drainage or ditches.

10.12.1 Simple Dams

A simple dam is a wall that keeps the chemically contaminated water in one place. Simple dams are built by shoveling dirt into a natural eddy or drainage ditch to allow pooling of the material.

Dirt dams are only a temporary solution, they require constant monitoring and reinforcement. The chemical may readily permeate the soil; and they are easily eroded by pressure as the liquid level rises.

Simple dirt dams can be improved by lining them with plastic sheeting, or by placing the soil in plastic garbage bags before placement.

10.12.2 Complex Dams

There are two types of complex dams.

Overflow Dams

<u>Overflow Dams</u> are used for immiscible substances that tend to sink in water. Overflow dams are designed to allow the water to <u>overflow</u> the dam wall while trapping the heavier liquid chemical.

<u>Underflow Dams</u> work on the opposite principle. Designed for use with immiscible substances that tend to float on water, they allow the water to flow <u>under</u> the dam wall while trapping the lighter chemical behind at the top.

Prior to constructing either type of separation dam, build a "confinement area" using simple dams or dikes to buy time while the complex dams are being constructed. In some cases, it may be necessary to build two or more confinement areas, each a little farther downstream, to buy sufficient lead time to complete larger, complex separation dams.

10.13 Covering

Covering a spilled liquid will reduce vapor production dramatically. Liquids can be covered with plastic sheeting; or in the case of high-density liquids (that tend to sink) water or foam may be used to cover them. Whatever material is used to cover the spilled liquid, be sure it is compatible with the chemical before applying it.

10.14 Gases and Vapors

Gases tend to engulf an area in all directions at once. Gases with a vapor density less than 1.0 have a tendency to rise in air, while those greater than 1.0 have a tendency to sink.

10.14.1 Gases Escaping Indoors

Heavier-than-air gases escaping in an above-ground building will tend to drift to lower floors, while lighter-than air gases escaping at ground level or below will rise in a building to upper floors.

10.14.2 Gases Escaping Outdoors

Gases that are released from their containers and vapors that are formed from evaporating liquids and solids are more difficult to control. Gases will dissipate in the atmosphere over time. This process can be facilitated by using portable fans or water fog spray.

Remember the steps in spill/leak response

1. Identify the material and its associated hazards.
2. Use proper protective clothing and equipment.
3. Stop the flow at the source.
4. Confine spilled material to the immediate area, recover spill.

The personnel who are attempting to handle the spill leak response must be in positive pressure self-contained breathing apparatus and protective clothing compatible with the involved material.

The initial mitigation strategy should focus on controlling the spill/leak, the source. If you can't stop the leak with available resources and common sense then at least confine the spilled material, secure the scene, and request qualified assistance.

10.15 Recovery of Hazardous Materials

Recovery of hazardous materials is a very important phase of the response to a chemical release. There are a number of ways in which recovery of hazardous material may be accomplished, but one must be careful to match the recovery techniques and equipment with the physical and chemical properties of the material involved.

The following text will review some of the techniques and equipment, which may be used in recovering hazardous materials.

10.15.1 Sinking Products

Sinking products are those with a specific gravity greater than 1.0. They pose special recovery problems when spilled into watercourses.

Dredging may be feasible if:

– The boundary of the spilled product is known.

– Special precautions are taken for the chemical involved.

– Disposal and treatment of the solid waste can be accomplished.

10.15.2 Mechanical Dredges (Clamshell, Dipper and Bucket)

Advantages:

– Good for deep-water excavation.

– Works well in confined areas.

– Does not create a large excess of material.

Disadvantages:

– No storage capabilities.

– Not useful on free liquids.

10.15.3 Pneumatic Dredges (Hydraulic Pipeline Systems)

Advantages:

– No depth restriction.

– Portability.

Disadvantages:

– Cables and pipelines cause navigational obstructions.

10.16 Water Soluble Products

Water-soluble products are materials that can be mixed in water. They require total removal of the contaminated water if the product is present in harmful quantities and cannot be treated where it is confined. Various types of pumping devices such as depression pumps may be used, taking into consideration the properties of containment and the possible fire explosive or toxic problems, which could result.

10.17 Floating Products

Products that float in water are recovered in many instances using techniques and equipment designed for recovery of crude-oil-related products. The potential hazards of many chemicals, however, are considerably greater from both a toxic and flammability standpoint than crude oil. Many hazardous floating chemicals are more difficult to detect and monitor than oil and present a greater problem in this regard as well.

10.18 Sorbent

Sorbent can be used to pick up spills of certain hazardous material on the surface of the water, below the surface of the water (if the sorbent is sufficiently Hydrophobic), and on land. Sorbents are only cost effective on smaller spills and for final polishing. Storage, transport, disposal and possible reuse are problems, which should be addressed when considering the use of sorbents.

Sorbents work in two ways:

Absorption - the material is pulled into the body of the sorbent, such as a pad or sponge.

Adsorption - the material adheres or clings to the surface of the sorbent.

There are three classes of sorbents:

a) Natural Materials,

b) Mineral Materials, and

c) Synthetic Materials.

a) **Natural Materials -** straw, sawdust, rice hulls

Advantages:

- Cheap
- Readily available

Disadvantages:

- Absorbs water and will sink.
- Not compatible with some hazardous materials.
- Low sorption capacity (3 to 6 times sorbent weight).

b) **Mineral Materials -** vermiculite, perlite, volcanic ash:

Advantages:

- Relatively cheap

– Available

– Does not absorb water

– Floats indefinitely

– Sorbent capacity (4 to 8 times sorbent weight)

Disadvantages:

– Dusty

– Hard to recover

c) **Synthetic Materials** polyurethane, polypropylene, polyethylene, cross-linked polymers

Advantages:

– Sorption capacity (25 to 30 times sorbent weight)

– Many forms

– Reusable

– Hydrophobic and Hydrophilic forms available

Disadvantages:

– Cost

– Availability

– Ultimate disposal

10.18.1 Forms of Commercial Sorbents

Loose Material - Fast absorption, must be confined.

Sorbent Pads - Easy to work with, good for wiping off equipment and small spill pick-up.

Sorbent Pillows - Used as “sandbags”, drain filtration, large sorbent area.

Sorbent Sweeps - Good for corralling thin spills or scattered patches.

Sorbent Rolls - Shoreline protection, material can be torn to any size.

Sorbent Booms - Good for some containment, useful as backup to containment boom, can be used to soak up small spills.

Foam Generation - Urethane foam, easily stored, must be shredded, very expensive.

10.18.2 Specialty Sorbents

Dow Imbiber Beads - Cross linked polymeric beads, no water absorption, absorbed material cannot be squeezed from beads, lessens vapors, many forms.

Usage

For light fuels, chlorinated solvents, aromatic solvents, many polar compounds. Will not absorb viscous oils, low molecular weight alcohols or highly polar materials.

Diamond Shamrock Hazorb - for land spills, low toxicity inorganic foam.

Usage

Wide application: acids, alkalies, solvents, Hydrocarbons; absorbs water, not reusable.

3M-LSM - Many forms, 12 times body weight absorption, effective on almost any liquid.

Usage

Works well on fuels, lubricants, coolants, acids, bases, emulsions, oils.

10.18.3 Gelling Agents

Permasorb - Free-flowing granular solid, chemically inert under most conditions, can gel up to 200 times weight of water, high ionic strength or extreme pHs reduce absorbent capacity, will retain 80% at 2 psi, effective only on water-based materials or emulsions.

10.19 Conclusion

Recovery of products can be accomplished under some conditions by using equipment or materials compatible with the hazardous material that has been spilled. Floating products or those contained on land are easiest to remove, while recovery of sinking or miscible products present a much more difficult task in cases involving spills into watercourses. Oil spill recovery technology and equipment can be applied effectively to most floating product in most cases, simple common sense and ingenuity are your best resources when devising means of controlling hazardous material releases.

Remember, however, that “preplanning” prevents poor performance especially when handling hazardous materials incidents.

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11 TRANSPORTATION OF HAZARDOUS WASTE

11.1 Objectives

At the conclusion of this module you should be able to do the following:

Identify when the word "waste" must precede the DOT proper shipping name.

Identify the requirements associated with the use of the lab pack provision.

Define the packaging reuse provision applicable to hazardous waste.

Select the additional marking requirements for packages of hazardous waste.

Recognize that the EPA Hazardous Waste Code Number can be used to identify the package constituent or hazardous substance.

Recognize the appropriate shipping paper required for a shipment of hazardous waste.

Define the shipping paper entry requirements for the Uniform Hazardous Waste Manifest (Manifest)

Identify the spill requirements for hazardous waste as addressed by the EPA in 40 CFR part 263.

Determine the difference between hazardous waste transportation in the United States and Canada.

11.2 Uniform Hazardous Waste Manifest

A generator of hazardous waste is required to complete a Uniform Hazardous Waste Manifest (UHWM)(EPA 8700-22), which will accompany your shipment of hazardous waste

The Uniform Hazardous Waste Manifest (UHWM) is the most important document that you will use. This document tracks your hazardous waste from the moment it leaves a facility until it is safely disposed of. Special attention must be given to this form. It must be filled out accurately and completely.

No person may offer, transport, transfer, or deliver a hazardous waste unless an EPA Form 8700-22 and 8700-22A (when necessary) hazardous waste manifest is prepared in accordance with 40 CFR 262.20 and is signed, carried, and given as required of that person.

The shipper (generator) shall prepare the manifest in accordance with 40 CFR part 262.

The original copy of the manifest must be dated by, and bear the handwritten signature of, the person representing:

(1) The shipper (generator) of the waste at the time it is offered for transportation, and

(2) The initial carrier accepting the waste for transportation.

A copy of the manifest must be dated by, and bear the handwritten signature of the person representing:

(1) Each subsequent carrier accepting the waste for transportation, at the time of acceptance.

(2) The designated facility receiving the waste, upon receipt.

A copy of the manifest bearing all required dates and signatures must be:

(1) Given to a person representing each carrier accepting the waste for transportation.

(2) Carried during transportation in the same manner as required by The Hazardous Materials Regulations for shipping papers,

(3) Given to a person representing the designated facility receiving the waste,

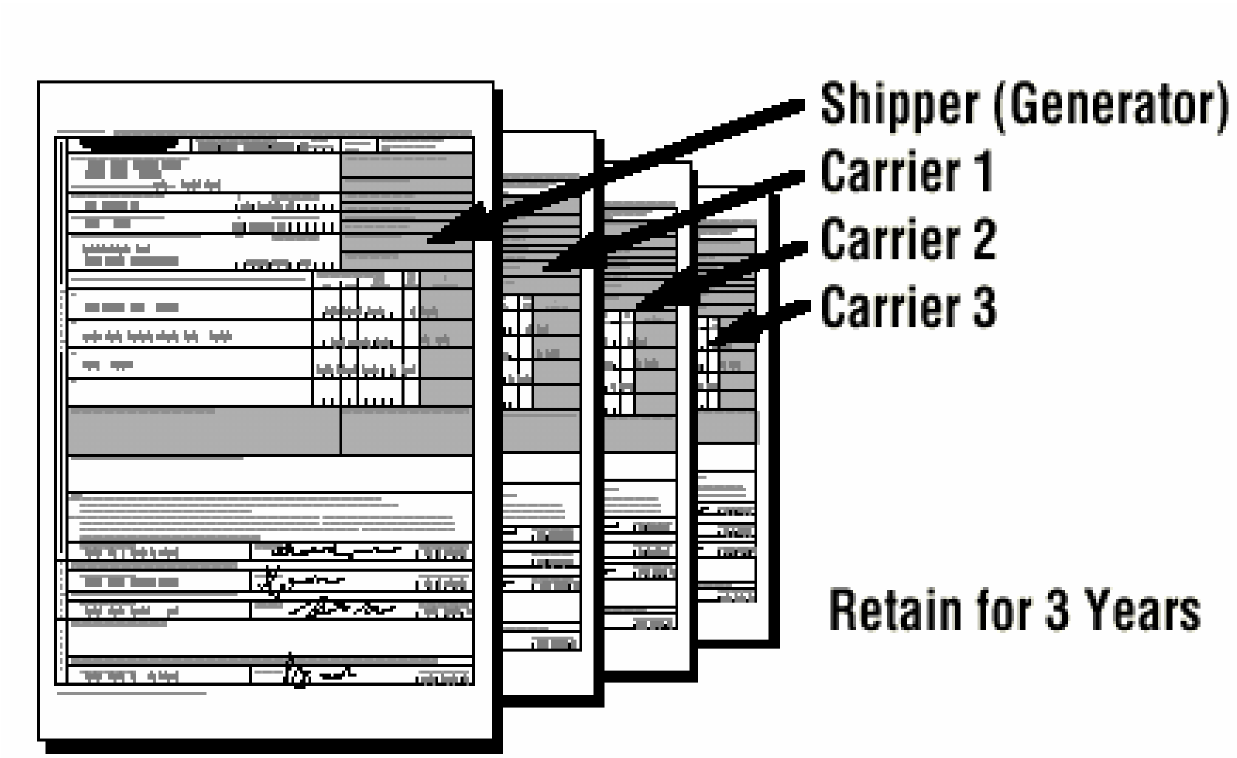
(4) Retained by the shipper (generator) and by the initial and each subsequent carrier for three years from the date the waste was accepted by the initial carrier. Each retained copy must bear all required signatures and dates up to and including those entered by the next person who received the waste.

A generator of hazardous waste is fully responsible and liable for the wastes they produce. They must accurately complete a manifest form and must ensure a notice is received when the wastes have been delivered to a licensed hazardous waste facility.

States may print their own version of the manifest. These versions may require you to supply additional information. The following pages provide you with line-by-line instructions for completing your Uniform Hazardous Waste Manifest (UHWM) filled with a completed example form.

11.3 Sample Uniform Hazardous Waste Manifest

The following is an example of a uniform Hazardous Waste Manifest.



11.3.1 Instructions For Completing The Uniform Hazardous Waste Manifest

Item 1. Generator's U.S. EPA ID Number-Manifest Document Number: Enter the generator's U.S. EPA twelve digit identification number and in the space to the right of this line, enter a five-digit number of your choice.

Item 2. Page 1 of ______: Enter the total number of pages used to complete this Manifest plus the number of continuation sheets, if any.

Item 3. Generator's Name and Mailing Address: Enter the name and mailing address of the generator. The address should be the location that will manage the returned Manifest forms.

Item 4. Generator's Phone Number: Enter a telephone number where an authorized agent of the generator may be reached in the event of an emergency.

Item 5. Transporter-1 Company Name: Enter the company name of the first transporter who will transport the waste.

Item 6. U.S. EPA ID Number: Enter the U.S. EPA twelve-digit identification number of the first transporter identified in Item 5.

Item 7. Transporter-2 Company Name: Enter the company name of the second transporter who will transport the waste. If more than two transporters are used to transport the waste, use a continuation sheet(s) and list the transporters in the order they will be transporting the waste.

Item 8. U.S. EPA ID Number: If applicable, enter the U.S. EPA twelve-digit identification number of the second transporter identified in Item 7.

Item 9. Designated Facility Name and Site Address: Enter the company name and site address of the facility designated to receive the waste listed on this Manifest. The address must be the site address which may differ from the company mailing address.

Item 10. U.S. EPA ID Number: Enter the U.S. EPA twelve -digit identification number of the designated facility identified in item 9.

Item 11. U.S. DOT Description: Enter the U.S. Dot Proper Shipping Name, Hazard Class, and ID number (UN/NA) for each waste as identified in 49 CFR 171 through 177.

Item 12. Containers (No. and Type): Enter the number of containers for each waste and the appropriate abbreviation from Table Item (below) for the type of container.

Table I - Types of Containers

DM = Metal drums, barrels, kegs
DW = Wooden drums, barrels, kegs
DF = Fiberboard or plastic drums, barrels, kegs
CW = Wooden boxes, cartons, cases
CF = Fiber or plastic boxes, cartons, cases
BA = Burlap, cloth, paper or plastic bags
TP = Tanks, portable
TT = Cargo tanks (tank trucks)
TC = Tank cars
DT = Dump truck
CY = Cylinders
CM = Metal Boxes, Cartons, Cases (including roll-offs)

Item 13. Total Quantity: Enter the total quantity of waste described on each line.

Item 14. Unit (Wt./Vol.): Enter the appropriate abbreviation from Table II Item(below) for the unit of measure.

Table II - Unit of Measure

G = Gallons (liquids only)
P = Pounds
T = Tons (2000 lbs.)
Y = Cubic yards
L = Liters (liquids only)
K = Kilograms
M = Metric tons (1000 kg)
N = Cubic Meters

Item 15. Special Handling Instructions and Additional Information: Generators may use this space to indicate special transportation, treatment, storage, or disposal information or Bill of Lading information. For international shipments, generators must enter in this space the point of departure (City and State) for those shipments destined for treatment, storage, or disposal outside the jurisdiction of the United States.

Item 16. Generator's Certification: The generator must read, sign (by hand), and date the certification statement. If a mode other than highway is used, the word "highway" would be lined out and the appropriate mode (rail, water or air) inserted in the space below. If another mode in addition to the highway mode is used, enter the appropriate additional mode (e.g., and rail) in the space below.

Instructions For Transporters

Item 17. Transporter 1 - Acknowledgment of Receipt of Materials: Enter the name of the person accepting the waste on behalf of the first transporter. That person must acknowledge acceptance of the waste described on the Manifest by signing and entering the date of receipt.

Item 18. Transporter 1 - Acknowledgment of Receipt of Materials: Enter, if applicable, the name of the person accepting the waste on behalf of the second transporter. That person must acknowledge acceptance of the waste described on the Manifest by signing and entering the date of receipt.

Note - International Shipments
Transporter Responsibilities: Exports - Transporters must sign and enter the date the waste left the United states in Item 15 of Form 8700-22. Imports-Shipments of hazardous waste regulated by RCRA and transported into the United States from another country are responsible for completing the Manifest (40 CFR 263.10(c)(1)).

Instructions For Owners Or Operators Of Treatment, Storage, Or Disposal Facilities

Item 19. Discrepancy Indication Space: In this space you must note any significant discrepancy between the waste described on the manifest and the waste you actually received. If you cannot resolve significant discrepancy within 15 days of receiving the waste, you must submit a letter to your Department of Health Services describing the discrepancy and your attempts to reconcile it. A copy of the manifest at issue must be enclosed with the letter.

Item 20. Facility Owner or Operator: Certification of Receipt of Hazardous Material Covered by This Manifest Except as Noted in Item 19. Print or type the name of the person accepting the waste on behalf of the owner or operator of the facility. That person must acknowledge acceptance of the waste described on the Manifest by signing and entering the date of receipt.

11.4 Transport of Waste in Canada

Hazardous waste handling/disposal in Canada, is governed under both Federal and Provincial regulations. This section, while focusing on compliance to Federal Regulations , will list the applicable Provincial documents and detail requirements in the Province of Ontario (as an example only). Although this section has been set up to contain all applicable acts and regulations, the information as printed is in no way intended to be an exact quote from, or duplication of the acts in question. All questions not answered by this section, or any further interpretations required to determine compliance with the law should be referred to the acts and regulations for further interpretation.

11.4.1 Federal

Transport Canada regulates the transportation of waste under the “Transportation of Dangerous Goods Act” and the "Transportation of Dangerous Goods Regulations”. Of particular interest here is part nine of the Regulations. Part nine details the requirements for shipping Dangerous Goods from the U.S.A. to destinations within Canada.

9. (part nine TDGR)
9.1 Transporting Dangerous Goods from the United States into Canada (Reciprocity)

1) The handling, offering for transport, or transporting by road vehicle of dangerous goods from a place in the United States to a place in Canada, or from a place in the United States through Canada to a place outside Canada, are exempt from these regulations if they are done in accordance with 49 CFR. However the requirements in these regulations apply:
   (a) Part 3, Shipping Documents
   (b) Section 4.4 of part 4 for retro reflective placards and orange panels.
   (c) Part 7, Emergency Response Assistance Plan; and
   (d) Part 8, Actual or Imminent Accidental Release Reporting requirements.
2) Subsection (1) does not apply if the dangerous goods
   (a) are not listed or defined by criteria in 49 CFR
   (b) are listed and designated as not regulated (NR) in 49 CFR
   (c) are exempt in 49 CFR or
   (d) are prohibited for handling , offering for transport or transporting by these regulations

11.4.2 Shipping Documents

Routine shipments of Dangerous Goods would be handled with standard bills of lading and other applicable documentation. For waste we need to consider additional regulations dealing specifically with this subject area. In particular the “ Canadian Environmental Protection Act” and under it the “ Export and Import of Hazardous Waste Regulations-SOR/92-637”

The regulation SOR/92-637 details the specifics on all aspects of importing or exporting hazardous waste into and out of Canada. Applicable highlights are listed below:

1) Notice- by hand delivery, registered mail or facsimile:
   - shall contain a reference number unique to that notice provided by the chief. (chief refers to the chief of the hazardous waste division, Office of waste management, Department of the environment)
   - notice period to be within one year before the export or import of the hazardous waste
2) Conditions on Imports

   An importer may import a hazardous waste only if:
   - the waste is not prohibited under the laws of Canada
   - the importer is the disposer of the hazardous waste in Canada
   - signed written contract between the importer and exporter

11.4.3 Waste Manifest

- this is a three part document (A,B,C)
- the reference number is put on the manifest
- the exporter completes and signs part A of the manifest in accordance with the TDG regulations and sends the manifest as per part IV of the same regulations
- the carrier completes and signs part B of the manifest
- the exporter ensures that part C will be completed, signed, and sent as per part IV of the regulations.

11.4.4 Retroreflective placards and orange panels:

TGDR 4.4

Visibility, Legibility , Color, and Retroreflectivity

Dangerous goods safety marks must be:
1) visible and legible
2) durable and weather resistant to withstand the conditions to which they will be exposed without substantial detachment or alteration to color symbols text or numbers.
3) displayed in the colors specified. The colors must correspond to the following standards in the Pantone R matching System Color Formula Guide 1000.
4) for placards and orange panels for dangerous goods that require an emergency response assistance plan, retroreflective with a minimum rating of level 2, as established in Canadian standards

11.4.5 Labels and Placard - Size and how to display

1) Labels and placards must be displayed on a means of containment square on a point.
2) Each side of a label must be at least 100 mm with a line running 5 mm inside the edge and the four sides must be of equal length. However if this size label cannot be displayed due to the configuration or size of the small means of containment , each side of the label may be reduced to not less than 30mm. As an option the reduced labels may be affixed to a tag, made of durable material securely attached to the means of containment.
3) Each side of a placard must be at least 250 mm with a line running 12.5 mm inside the edge and the four sides must be of equal length. (as above the size may be reduced to no less than 100 mm based on the size of the containment)
4) Each required placard and UN number must be displayed on or adjacent to each side and each end of a large means of containment.

11.4.6 Dangerous Goods Safety Marks on a Small Means of Containment

1) Before being placed in a transport , a label must be displayed on a small means of containment for the primary class of each of the dangerous goods that are contained in the small means of containment
2) Before being placed in a transport a label must be displayed for the first subsidiary class as listed in the regulations.

3) When required a label must be displayed on any side of the outer surface of a small means of containment, other than the side on which it will rest or be stacked.

11.4.7 Emergency response Assistance plan

Before importing dangerous goods or allowing the initial carrier to pick up dangerous goods, the consignor must have an emergency response assistance plan (ERAP) approved by the Minister, or a person designated by the regulations to do this for dangerous goods that require a ERAP.

- provisional approval may be given based on a summary of a ERAP submitted that indicates that the ERAP appears capable of being implemented, and of being effective for use in responding to an accident involving the dangerous goods.
- approval of the ERAP expires on the date indicated on the document issuing the ERAP registration number.
- the Minister or a designated person may approve an extension of the ERAP.
- rejection of an ERAP must be done in writing and must contain the reasons for rejection

11.4.8 Contents of a Summary of an ERAP

1) name, address and phone number of the consignor (the plan holder)
2) name, address, phone number and function of the person submitting the summary
3) the classification of the dangerous goods to which the summary relates
4) the type and size of the means of containment of the dangerous goods
5) the geographical area to which the ERAP relates
6) a telephone number to be called to immediately activate the ERAP
7) a description of the emergency response capabilities, of /or arranged to be available to the consignor including
   a) number of persons qualified to give technical advice by telephone about the dangerous goods
   b) number of persons qualified and available to provide advice and assistance at the scene of an emergency
   c) a list of emergency equipment that can be transferred to the site for use a general description of the response actions capable of being taken at the scene
   d) a description of the transportation arrangements to bring specialized emergency response personnel and equipment to the site of an emergency
   e) a description of the communication systems that made available at the site
8) the signature of the person submitting the summary

11.4.9 Contents of an ERAP

1) a general analysis of how an accidental release could occur
2) a general identification of the consequences of a release
3) the action the plan holder expects to take in the event of an accidental release, or an imminent accidental release including an accidental release considered imminent by an inspector
4) a copy of any formal agreement with a third party for the provision of assistance

11.4.10 Actual or Imminent Accidental Release Reporting Requirements

In the event of an accidental release the person who has the charge, management, or control of the dangerous goods at that time must immediately report the release to :

1) The local Police... - except for North West Territories call 867-920-8130
Yukon Territory... 867- 667-7244
Manitoba ... the local police, or fire department, and the Department of the Environment at 204-945-4888
2) the person's employer
3) the consignor of the dangerous goods
4) for a road vehicle the owner, lessee or charterer
5) for a railway vehicle.. CHEMTREC 613-996-6666
6) for a ship... CHEMTREC
8) for an aircraft, aerodrome or air cargo facility.... the nearest Regional Civil Aviation
9) Office of civil aviation of the Department of Transport or CHEMTREC

This would be followed by a detailed report (within 30 days) of the incident to the Director General. This report would be submitted by the employer of the person who had charge, management, or control of the dangerous goods that were subject to immediate reporting, and were released. This report would include:
1) name address and phone number of the employer
2) date time and location of the incident, including possible causes and factors
3) name and address of the consignor's place of business
4) the classification of the dangerous goods
5) quantity released and the total quantity before the release
6) a description of the means of containment involved based on identification markings, and a description of the failure or damage to the containment

11.4.11 Provincial Acts

Alberta: Environmental Protection and Enhancement Act
The waste Control Regulations
British Columbia: Waste management Act
Special Waste Regulation
Manitoba: Environment Act
New Brunswick: Clean Environment Act
Newfoundland: Waste Material Disposal Act
Northwest Territories: Environmental Protection Act
Nova Scotia: Environment Act, section 84, Handling waste dangerous Goods
Prince Edward Island: Environmental Protection Act
Quebec: Loi Sur la Qualite de l'environment (environment quality act)
Hazardous Waste Regulation
Saskatchewan: Environmental Management and Protection Act
Hazardous Substances and Waste Dangerous Goods Regulations
Yukon: The Environmental Act Part 7
Ontario: Ontario Regulation 347, Waste Management
- a regulation under the environmental protection act

11.4.12 The Paper Trail

The waste manifest is the shipping document
The manifest has 6 copies and three sections
Each section has to be completed by a specified individual with completeness and accuracy critical for compliance
Distribution of the manifest ensures compliance with Reg 347, as each individual identified on the manifest must mail one copy of the manifest to the Ministry of the Environment and keep one copy on file for 2 years

In summary, compliance with 49 CFR brings one very close to compliance with Canadian Regulations. Minor differences exist in the areas identified in this training module.

11.5 Transport of Waste in the United States

Hazardous waste handling and disposal in the United States is governed by both Federal and State regulations. This section will focus on the Federal Regulations only. The transportation of hazardous waste is regulated by 49 CFR - 100-180. You must first determine if the product to be transported is hazardous. This is accomplished by consulting the Hazardous Materials Table in 49 CFR - 172-101. This table is divided into 10 columns as follows:

§172.101 HAZARDOUS MATERIALS TABLE

Symbols	Hazardous materials descriptions and proper shipping names	Hazard class or Division	Identification Numbers	Packing group	Label(s) required (if not excepted)	Special provisions	(8) Packaging authorizations (§173.***)			(9) Quantity limitations		(10) Vessel stowage requirements	
							Exceptions	Non-bulk packaging	Bulk packaging	Passenger aircraft or railcar	Cargo aircraft only	Vessel stowage	Other stowage provisions
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(8C)	(9A)	(9B)	(10A)	(10B)

11.5.1 Explanation of Columns of Hazardous Materials Table

Column 1: Symbols The letter **G** identifies proper shipping names for which one or more technical names of the hazardous material must be entered in parentheses, in association with the basic description.

Column 2: Hazardous materials descriptions and proper shipping names: Proper shipping names are limited to those shown in Roman type (not italics). Hazardous wastes. If the word waste is not included in the hazardous material description, the proper shipping name shall include the word *Waste* preceding the proper shipping name of the material. For example: *Waste acetone*.

Column 3: Hazard class or Division contains a designation of the hazard class or division (i.e. 8 or 3) corresponding to each proper shipping name.

Column 4: Identification number Proper shipping names preceded by the letters *UN* are considered appropriate for international transportation as well as domestic transportation. Those preceded by the letters *NA* are not recognized for international transportation, except to and from Canada.

Column 5: Packing group specifies one or more packing groups assigned to a material corresponding to the proper shipping name and hazard class for that material. <u>Classes 1, 2 and 7 materials, combustible liquids, and ORM-D</u> materials do not have packing groups. Packing Groups I, II and III indicate the degree of danger of the material **great, medium** or **minor**, respectively.

Column 6: Labels required specifies codes which represent the hazard warning labels required for a package filled with a material conforming to the associated hazard class and proper shipping name The first code is indicative of the primary hazard of the material. Additional label codes are indicative of subsidiary hazards. The codes are defined according to the following table:

Label code	Label name
1..................................	EXPLOSIVE.
1.1 \1\............................	EXPLOSIVE 1.1 \1\
1.2 \1\............................	EXPLOSIVE 1.2 \1\
1.3 \1\............................	EXPLOSIVE 1.3 \1\
1.4 \1\............................	EXPLOSIVE 1.4 \1\
1.5 \1\............................	EXPLOSIVE 1.5 \1\
1.6 \1\............................	EXPLOSIVE 1.6 \1\
2.1................................	FLAMMABLE GAS
2.2................................	NON-FLAMMABLE GAS
2.3................................	POISON GAS
3..................................	FLAMMABLE LIQUID
4.1................................	FLAMMABLE SOLID
4.2................................	SPONTANEOUSLY COMBUSTIBLE
4.3................................	DANGEROUS WHEN WET
5.1................................	OXIDIZER
5.2................................	ORGANIC PEROXIDE
6.1(I) Zone A&B PIH \2\.....	POISON INHALATION HAZARD
6.1(I) not PIH \2\..............	TOXIC/ POISON
6.1(II) not PIH \2\..............	TOXIC/ POISON
6.1(III)	KEEP AWAY FROM FOOD
6.2................................	INFECTIOUS SUBSTANCE
7..................................	RADIOACTIVE
8..................................	CORROSIVE
9..................................	CLASS 9

\1\ Refers to the appropriate compatibility group letter.
\2\ The packing group for a material is indicated in column 5 of the Table.

Column 7: Special provisions specifies codes for special provisions applicable to hazardous materials.

1) A code consisting only of numbers (for example 2) is multi-modal in application and may apply to bulk and non-bulk packages.
2) A code containing the letter A refers to a special provision which applies only to transportation by aircraft.
3) A code containing the letter B refers to a special provision which applies only to bulk packaging requirements. Unless otherwise provided these special provisions do not apply to IM portable tanks.
4) A code containing the letter H refers to a special provision which applies only to transportation by highway.
5) A code containing the letter N refers to a special provision which applies only to non-bulk packaging requirements.
6) A code containing the letter R refers to a special provision which applies only to transportation by rail.
7) A code containing the letter T refers to a special provision which applies only to transportation in IM portable tanks.
8) A code containing the letter W refers to a special provision which applies only to transportation by water.

Column 8: Packaging (173*)** Columns 8A, 8B and 8C specify the applicable sections for *exceptions, non-bulk packaging requirements and bulk packaging requirements*, respectively .

1) Exceptions. Column 8A contains exceptions from some of the requirements. *None* in this column means any packaging exceptions are authorized, except as may be provided by special provisions in Column 7.
2) Non-bulk packaging Column 8B references packaging requirements for non-bulk packages. A *None* in this column means non-bulk packages are not authorized, except as may be provided by special provisions in Column 7.
3) Bulk packaging Column 8C specifies the packaging requirements for bulk packaging other than IM and IBC portable tanks. A *None* in this column means bulk packages are not authorized, except as may be provided by special provisions in Column 7. Authorizations for use of IM portable tanks are set forth in Column 7.

Column 9: Quantity limitations Columns 9A and 9B specify the maximum quantities that may be offered for transportation in one package by passenger-carrying aircraft or passenger-carrying rail car and cargo aircraft.

Column 10: Vessel stowage Column 10A *[Location]* specifies the authorized stowage locations on board cargo and passenger vessels. Column 10B *[Other]* specifies codes for stowage requirements for specific hazardous materials.

11.5.2 Appendix A List of Hazardous Substances and Reportable Quantities

This Appendix is divided into two TABLES which are entitled TABLE 1-HAZARDOUS SUBSTANCES OTHER THAN RADIO NUCLIDES and TABLE 2-RADIO NUCLIDES.

Column 1 of TABLE 1, entitled *Hazardous substance*, contains the names of those elements and compounds that are hazardous substances.
Column 2 of TABLE 1, entitled *Reportable quantity (RQ)*, contains the reportable quantity (RQ), in pounds and kilograms.

Table 1. Hazardous Substances Other Than RADIO NUCLIDES

Hazardous substance	Reportable quantity (RQ) pounds (kilograms)
------------------------	----------------------
D001 Unlisted Hazardous Wastes Characteristic of Ignitability	100 (45.4)
D002 Unlisted Hazardous Wastes Characteristic of Corrosivity	100 (45.4)
D003 Unlisted Hazardous Wastes Characteristic of Reactivity	100 (45.4)
D004-D043 Unlisted Hazardous Wastes Characteristic of Toxicity	
D004 Arsenic	1 (0.454)
D005 Barium	1000 (454)
D006 Cadmium	10 (4.54)
D007 Chromium	10 (4.54)
D008 Lead	10 (4.54)
D009 Mercury	1 (0.454)
D010 Selenium	10 (4.54)
D011 Silver1	(0.454)
D014 Methoxychlor	1 (0.454)
D016 2,4-D	100 (45.4)
D018 Benzene	10 (4.54)
D019 Carbon tetrachloride	10 (4.54)
D021 Chlorobenzene	100 (45.4)
D022 Chloroform	10 (4.54)
D023 o-Cresol	100 (45.4)
D026 Cresol	100 (45.4)
D027 1,4-Dichlorobenzene	100 (45.4)
D028 1,2-Dichloroethane	100 (45.4)
D029 1,1-Dichloroethylene	100 (45.4)
D035 Methyl ethyl ketone	5000 (2270)
D036 Nitrobenzene	1000 (454)
D037 Pentachlorophenol	10 (4.54)
D038 Pyridine	1000 (454)
D039 Tetrachloroethylene	100 (45.4)
D040 Tricholorethylene	100 (45.4)
D043 Vinyl chloride	1 (0.454)
F001	

The following spent halogenated solvents used in degreasing; all spent solvent mixtures/blends used in degreasing containing, before use, a total of ten percent or more (by volume) of one or more of the below listed halogenated solvents or those solvents listed in F002, F004 and F--5; and still

bottoms from the recovery of these spent solvents and spent solvent mixtures of these spent solvents and spent solvent mixtures	10 (4.54)
(a) Tetrachloroethylene	100 (45.4)
(b) Trichloroethylene	100 (45.4)
(c) Methylene chloride	1000 (454)
(d) 1,1,1-Trichloroethane	1000 (454)
(e) Carbon tetrachloride	10 (4.54)
(f) Chlorinated fluorocarbons	5000 (2270)
F002	
The following spent halogenated solvents; all spent solvent mixtures/blends containing, before use, a total of ten percent or more (by volume) of one or more of the below listed halogenated solvents or those listed in F001, F004, F005; and still bottoms from the recovery of these spent solvents and spent solvent mixtures.	10 (4.54)
(a) Tetrachloroethylene	100 (45.4)
(b) Methylene chloride	1000 (454)
(c) Trichloroethylene	100 (45.4)
(d) 1,1,1-Trichloroethane	1000 (454)
(e) Chlorobenzene	100 (45.4)
(f) 1,1,2-Trichloro-1,2,2-trifluoroethane	5000 (2270)
(g) o-Dichlorobenzene	100 (45.4)
(h) Trichlorofluoromethane	5000 (2270)
(i) 1,1,2 Trichloroethane	100 (45.4)
F003	
The following spent non-halogenated solvents and solvents:	100 (45.4)
(a) Xylene	1000 (454)
(b) Acetone	5000 (2270)
(c) Ethyl acetate	5000 (2270)
(d) Ethylbenzene	1000 (454)
(e) Ethyl ether	100 (45.4)
(f) Methyl isobutyl ketone	5000 (2270)
(g) n-Butyl alcohol	5000 (2270)
(h) Cyclohexanone	5000 (2270)
(i) Methanol	5000 (2270)
F004	100 (45.4)
The following spent non-halogenated solvents and the still bottoms from the recovery of these solvents:	
(a) Cresols/Cresylic acid	1000 (454)
(b) Nitrobenzene	100 (45.4)
F005	
The following spent non-halogenated solvents and the still bottoms from the recovery of these solvents	100 (45.4)
(a) Toluene	1000 (454)
(b) Methyl ethyl ketone	5000 (2270)
(c) Carbon disulfide	100 (45.4)
(d) Isobutanol	5000 (2270)
(e) Pyridine	1000 (454)

F006	
Wastewater treatment sludges from electroplating operations except from the following processes: (1) sulfuric acid anodizing of aluminum, (2) tin plating on carbon steel, (3) zinc plating (segregated basis) on carbon steel, (4) aluminum zinc-aluminum plating on carbon steel, (5) cleaning/stripping associated with tin, zinc and aluminum plating on carbon steel, and (6) chemical etching and milling of aluminum	10 (4.54)
F007	
Spent cyanide plating bath solutions from electroplating operations	10 (4.54)
F039 Multi source leachate	1 (0.454)
K001	
Bottom sediment sludge from the treatment of wastewaters from wood preserving processes that use creosote and/or pentachlorophenol	1 (0.454)
K035	
Wastewater treatment sludges generated in the production of creosote	1 (0.454)
K061	
Emission control dust/sludge from the primary production of steel in electric furnaces	10 (4.54)
K062	
Spent pickle liquor generated by steel finishing operations of facilities within the iron and steel industry	10 (4.54)
K087	
Decanter tank tar sludge from coking operations	100 (45.4)
K088	
Spent pot liners from primary aluminum reduction	10 (4.54)
K104	
Combined wastewater streams generated from nitrobenzene/aniline chlorobenzenes	10 (4.54)
K142	1 (0.454)

11.5.3 SHIPPING PAPERS

The shipping description of a hazardous material on the shipping paper must include:

1) The proper shipping name
2) The hazard class or division
3) The identification number
4) The packing group

Except for empty packaging, cylinders for Class 2 materials and bulk packaging, the total quantity (net or gross mass) and the unit of measurement, must be shone (e.g., “800 lbs”, “55 gal.”, “3629 kg”, or “208 L”).

The basic description must be shown in this sequence with no additional information inserted. For example*:*

- ***Waste Flammable Liquid, n.o.s. (D001) 3, UN1993 III***

The total quantity of the material must appear before or after the basic description. The type of packaging and designation marks may be entered in any appropriate manner before or after the basic description.

Abbreviations may be used to specify the type of packaging and unit of measurement for total quantity.

The required shipping description on a shipping paper and all copies thereof used for transportation purposes, must be legible and printed in English, may not contain any unauthorized code or abbreviation and additional information must be placed after the basic description.

The name of the hazardous substance must be entered in parentheses in association with the basic description. If the material contains two or more hazardous substances, at least two hazardous substances, including the two with the lowest reportable quantities (RQs), must be identified. For a hazardous waste, the waste code (e.g., D001), if appropriate, may be used to identify the hazardous substance.

The letters *"RQ"* shall be entered on the shipping paper either before or after, the basic description for each hazardous substance. For example:

- **RQ Waste Flammable Liquid, n.o.s. (D001)3, UN 1993 III**

Shipper's Certification

Shippers who offer a hazardous material for transportation shall certify that the material is offered for transportation in accordance with the Hazardous Material Regulations by printing (manually or mechanically) on the shipping paper the following certification:

> *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*
>
> Signature__________________________
>
> *Must be legibly signed manually*

11.5.4 Packages

Forbidden material and packages:

1) A material in the same packaging, freight container or over pack with another material, the mixing of which is likely to cause a dangerous evolution of heat, or flammable or poisonous gases or vapors, or to produce corrosive materials.
2) A package containing a material which is likely to decompose or polymerize with and will produce an evolution of a dangerous quantity of heat or gas unless the material is stabilized or inhibited in a manner to preclude such occurrence.

Salvage packaging must be marked with the proper shipping name of the hazardous material inside the packaging and the name and address of the consignee. In addition, the packaging must be marked **"SALVAGE** or **SALVAGE DRUM"**. A salvage packaging marked with a "T" in accordance with applicable provisions in the UN Recommendations may be used.

Non-reusable containers. A packaging marked as NRC according to the DOT specification or UN standard requirements of part 178 of this subchapter may be reused for the shipment of any material not required by this subchapter to be shipped in a DOT specification or UN standard packaging.

Exceptions for shipment of waste materials.

Open head drums. If a hazardous waste is to be shipped in a closed head or less bung opening) and the hazardous waste contains solids or semisolids that make its placement in a closed head drum impracticable, an equivalent open head drum may be used for the hazardous waste.

Lab packs.

Waste materials classed as Class or Division 3, 4.1, 4.2, 4.3, 5.1, 6.1, 8, or 9 are excepted from the specification packaging for combination packaging if packaged in accordance with this paragraph and transported for disposal or recovery by highway only. In addition, a generic description from the Hazardous Material Table may be used in place of specific chemical names, when two or more chemically compatible waste materials in the same hazard class are packaged in the same outside packaging

Additional packaging requirements are as follows:

The outer packaging must be a UN 1A2 or UN 1B2 metal drum, a UN 1D plywood drum, a UN 1G fiber drum or a UN 1H2 plastic drum tested and marked at least for the Packing Group III performance level for liquids or solids;

The inner packaging must be either glass, not exceeding 1 gallon rated capacity, or metal or plastic, not exceeding 5.3 gallons rated capacity;

Each outer packaging may contain only one class of hazardous material;

Inner packaging containing liquid must be surrounded by a chemically compatible absorbent material in sufficient quantity to absorb the total liquid contents; and

Gross weight of the complete package may not exceed 452 lbs

Prohibited materials. Materials meeting the definition of Division 6.1, Packing Group I, or Division 4.2, Packing Group I, and bromine pentafluoride; bromine trifluoride; chloric acid; and oleum (fuming sulfuric acid) may not be packaged or described under the provisions of this paragraph.

Reuse of packaging. A previously used packaging may be reused for the shipment of hazardous waste to designated facilities, not subject to the reconditioning and reuse provisions under the following conditions:

Transportation is performed by highway only.

A package is not offered for transportation less than 24 hours after it is finally closed for transportation, and each package is inspected for leakage and is found to be free from leaks immediately prior to being offered for transportation.

Each package is loaded by the shipper and unloaded by the consignee, unless the motor carrier is a private or contract carrier.

The packaging may be used only once under this paragraph and may not be used again for shipment of hazardous materials except in accordance with §173.28.

Technical names for n.o.s. descriptions. The requirements for the inclusion of technical names for n.o.s. descriptions on shipping papers and package markings, §§172.203 and 172.301 of this subchapter, respectively, do not apply to packaging prepared in accordance with paragraph (b) of this section, except as follows:

Packages containing materials meeting the definition of a hazardous substance must be described and marked accordingly.

11.5.5 Labels

Labels must:

1) Be printed on or affixed to a surface (other than the bottom) of the package or containment device containing the hazardous material.
2) Be located on the same surface of the package and near the proper shipping name marking, if the package dimensions are adequate.

Exceptions. A label may be printed on or placed on a securely affixed tag, or may be affixed by other suitable means to:

1) A package that contains no radioactive material and which has dimensions less than those of the required label.
2) A cylinder
3) A package which has such an irregular surface that a label cannot be satisfactorily affixed.

Placement of multiple labels. When primary labels, **NUMBER AT THE BOTTOM**, and subsidiary hazard labels, **NO NUMBER AT THE BOTTOM**, are required, they must be displayed next to each other. Placement conforms to this requirement if labels are within 150 mm (6 inches) of one another.

Contrasting background. Each label must be printed on or affixed to a background of contrasting color, or must have a dotted or solid line outer border.

11.5.6 Marking

Each person who offers for transportation a hazardous material in a non-bulk packaging shall mark the package with the proper shipping name and identification number (preceded by ``UN'' or ``NA'', as appropriate) for the material.

All Marking must:
1) Must be durable, in English and printed on or affixed to the surface of a package
2) or on a label, tag, or sign.
3) Must be displayed on a background of sharply contrasting color;
4) Must be un-obscured by labels or attachments; and
5) Must be located away from any other marking (such as advertising) that could substantially reduce its effectiveness.

Technical names. Non-bulk packaging containing hazardous materials shall be marked with the technical name in parentheses in association with the proper shipping name.

For a hazardous waste the word **"Waste" must** precede the proper shipping name on packages except when using the EPA's prescribed marking.

The letters "RQ" **shall be** marked on the package in association with the proper shipping name.

Liquid hazardous materials in non-bulk packages. Non-bulk combination package having inner packages containing liquid hazardous materials must be:
(1) Packed with closures upward.
(2) Legibly marked, with package orientation markings on two opposite vertical sides of the package with the arrows pointing in the correct upright direction.
This does not apply to a non-bulk package with inner packages which are cylinders.

NOTE: A package which has been previously marked for the material it contains and on which the marking remains legible, need not be remarked.

11.5.7 Placards

Large quantities of hazardous material in non-bulk packages. A transport vehicle or freight container containing 4,000 kg (8,820 pounds) or more aggregate gross weight of a hazardous material having a single identification number must be marked with the **identification number.**

For a cargo tank transported on or in a transport vehicle or freight container, if the identification number marking on the cargo tank is not visible, the transport vehicle or freight container must be marked on each side and each end with the **identification number**.

For a bulk packaging contained in or on a transport vehicle or freight container, if the **identification number** marking on the bulk packaging (e.g., an IBC) is not visible, the transport vehicle or freight container must be marked on each side and each end with the **identification number.**

Placarding for subsidiary hazards

NOTE: Hazardous materials from table 2 that possess secondary hazards may exhibit subsidiary placards.

Table 2

Category of material (Hazard class or division number and additional description, as appropriate)	Placard name
1.4	EXPLOSIVES 1.4
1.5	EXPLOSIVES 1.5
1.6	EXPLOSIVES 1.6
2.1	FLAMMABLE GAS
2.2	NON-FLAMMABLE GAS
3	FLAMMABLE
Combustible liquid	COMBUSTIBLE
4.1	FLAMMABLE SOLID
4.2	SPONTANEOUSLY COMBUSTIBLE
5.1	OXIDIZER
5.2 (Other than organic peroxide, Type B, liquid or solid, temperature controlled)	ORGANIC PEROXIDE
6.1 (other than inhalation	POISON
6.2	None
8	CORROSIVE
9	CLASS 9
ORM-D	None

11.5.8 Emergency Response Information

The term **"emergency response information"** means information that can be used in the mitigation of an incident involving hazardous materials and, as a minimum, must contain the following information:

1) The basic description and technical name of the hazardous material
2) Immediate hazards to health
3) Risks of fire or explosion
4) Immediate precautions to be taken in the event of an accident or incident
5) Immediate methods for handling fires
6) Initial methods for handling spills or leaks in the absence of fire
7) Preliminary first aid measures

Form of information. The information required for a hazardous material must be:

1) (Printed legibly in English.
2) Available for use away from the package containing the hazardous material.
3) Presented-
   a) On a shipping paper
   b) In a document, other than a shipping paper,(e.g., a material safety data sheet).
   c) Related to the information on a shipping paper, a written notification to pilot-in-command, or a dangerous cargo manifest.

11.5.9 Emergency Response Telephone Number

A person who offers a hazardous material for transportation must provide a 24-hour emergency response telephone number (including the area code) for use in the event of an emergency involving the hazardous material. The telephone number must be-

1) Monitored at all times the hazardous material is in transportation, including storage incidental to transportation.
2) The number of a person who is either knowledgeable of the hazardous material being shipped and has comprehensive emergency response and incident mitigation information for that material, or has immediate access to a person who possesses such knowledge and information.
3) Entered on a shipping paper, as follows:
   a) Immediately following the description of the hazardous material.
   b) Entered once on the shipping paper in a clearly visible location. This provision may be used only if the telephone number applies to each hazardous material entered on the shipping paper, and if it is indicated that the telephone number is for emergency response information (for example: "EMERGENCY CONTACT: ***).

The telephone number must be the number of the person offering the hazardous material for transportation or the number of an agency or organization capable of, and accepting responsibility for, providing the detailed information concerning the hazardous material. A person offering a hazardous material for transportation who lists the telephone number of an agency or organization shall ensure that agency or organization has received current information on the material, before it is offered for transportation.

11.5.10 Segregation Table for Hazardous Materials

SEGREGATION TABLE FOR HAZARDOUS MATERIALS

Class or division	Note	1.1 1.2	1.3	1.4	1.5	1.6	2.1	2..2	2.3 Zone A	2.3 Zone B	3	4.1	4.2	4.3	5.1	5.2	6.1PGI ZONE A	7	8 Liq
1.1 and 1.2	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
*1.3		*	*	*	*	*	X		X	X	X		X	X	X	X	X		X
1.4		*	*	*	*	*	O		O	O	O		O				O		O
1.5	A	*	*	*	*	*	X	X	X	X	X	X	X	X	X	X	X	X	X
1.6		*	*	*	*	*													
2.1		X	X	O	X				X	O							O	O	
2.2		X			X														
2.3 Zone A		X	X	O	X		X				X	X	X	X	X	X			X
2.3 Zone B		X	X	O	X		O				O	O	O	O	O	O			O
3		X	X	O	X				X	O					O		X		
4.1		X			X				X	O							X		O
4.2		X	X	O	X				X	O							X		X
4.3		X	X		X				X	O							X		O
5.1	A	X	X		X				X	O	O						X		O
5.2		X	X		X				X	O							X		O
6.1 PGI Zone A		X	X	O	X		O				X	X	X	X	X	X			X
7		X			X		O												
8		X	X	O	X				X	O		O	X	O	O	O	X		

The following are the instructions for the use of the segregation table

1) The absence of any hazard class or division or a blank space in the Table indicates that no restrictions apply.

2) The letter **“X"** in the Table indicates that these materials may not be loaded, transported. or stored together in the same transport vehicle or storage facility during the course of transportation.

3) The letter **“O"** in the Table indicates that these materials may not be loaded, transported, or stored together in the same transport vehicle or storage facility during the course of transportation unless separated in a manner that, in the event of leakage from packages under conditions normally incident to transportation, commingling of hazardous materials would not occur. *Notwithstanding the methods of separation employed, Class 8 (corrosive) liquids may not be loaded above or adjacent to Class 4 (flammable) or Class 5 (oxidizing) materials;* except that shippers may load truckload shipments of such materials together when it is known that the mixture of contents would not cause a fire or a dangerous evolution of heat or gas.

4) The asterisk (*) in the Table indicates that segregation among different Class 1 (explosive) materials is governed by the compatibility table.

5) The note **“A"** in the second column of the Table means that, notwithstanding the requirements of the letter **“X"**, ammonium nitrate fertilizer may be loaded or stored with Division 1.1 (Class A explosive) or Division 1.5 (blasting agents) materials.

***When The Hazardous Material Table requires a package to bear a subsidiary hazard label, segregation appropriate to the subsidiary hazard must be applied when that segregation is more restrictive than that required by the primary hazard. However, hazardous materials of the same class may be stowed together without regard to segregation required for any secondary hazard if the materials are not capable of reacting dangerously with each other and causing combustion or dangerous evolution of heat. evolution of flammable. poisonous. or asphyxiant gases, or formation of corrosive or unstable materials*.**

Hazardous Waste Discharges
Immediate action.

In the event of a discharge of hazardous waste during transportation, the transporter must take appropriate immediate action to protect human health and the environment (e.g., notify local authorities, dike the discharge area).

If a discharge of hazardous waste occurs during transportation and an official (State or local government or a Federal Agency) acting within the scope of his official responsibilities determines that immediate removal of the waste is necessary to protect human health or the environment, that official may authorize the removal of the waste by transporters who do not have EPA identification numbers and without the preparation of a manifest.

An air, rail, highway, or water transporter who has discharged hazardous waste must:

Give notice, if required by 49 CFR 171.15, to the National Response Center (800-424-8802 or 202-426-2675)

Report in writing as required by 49 CFR 171.16 to the Director, Office of Hazardous Materials Regulations, Materials Transportation Bureau, Department of Transportation, Washington, DC 20590.

Discharge clean up.
A transporter must clean up any hazardous waste discharge that occurs during transportation or take such action as may be required or approved by Federal, State, or local officials so that the hazardous waste discharge no longer presents a hazard to human health or the environment**.**

12 COURSE MATERIAL QUESTIONS

Mark Question

MODULE #1

MSDS ASSIGNMENT

INSTRUCTIONS:

This exercise is based on a Material Safety Data Sheet. Read the scenario below and the questions carefully before answering them. In each case, indicate the section of the MSDS in which you found the answer.

SCENARIO:

As you are working for an Equipment Company, one of the employees reports that there has been a spill in the storage shed. After you report the incident, you go to the scene to take charge. Someone hands you a Material Safety Data Sheet for the spilled material, which is

________________________.

1. What is likely to happen to your skin if it comes in contact with this chemical?

Answer:

Objective: Module 3, Objective #1

Reference: Module 2, pages 14, 15

2. If this spilled chemical reaches a waterway, will it dissolve or remain intact?

Answer:

Objective: Module 2, Objective #1

Reference: Module 2, pages 14, 15

Mark	Question	
	3.	Near the spill in the custodian's shed there are bottles of sulfuric acid. Will sulfuric acid react with the spilled materials?
	Answer:	
	Objective:	Module 2, Objective #1
	Reference:	Module2, pages 14, 15
	4.	Are the vapors from this chemical likely to rise in air and disperse, or stay close to the ground?
	Answer:	
	Objective:	Module 2, Objective #1
	Reference:	Module 2, pages 14, 15
	5.	At what temperature will this chemical produce sufficient vapors to ignite?
	Answer:	
	Objective:	Module 2, Objective #1
	Reference:	Module 2, pages 14, 15

Mark Question

MODULE #2

NIOSH ASSIGNMENT

1. After receiving information about a spill, the only clue to the material is its CAS number, which is 1310-73-2. To what page would you turn to find the information on this product?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

2. How many columns are there in the NIOSH Guidebook?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

3. After looking up the product sodium hydroxide, what are the target organs this chemical affects?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

4. What is the IDLH for sulfuric acid?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

Mark Question

5. What is the exposure limits (TWA) for hydrogen sulfide (both NIOSH and OSHA)?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

6. After finding out that the spill that you have is sulphuric acid, you have monitored the vapors and the reading is 15 mg/m^3. Convert the reading to ppm?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

7. What is the recommended respiratory selection for Phosphoric Acid?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

8. Your spill is a hazardous material, Mercury. In reviewing the routes of entry, what does Abs mean?

Answer:

Objective: Module 2, Objective #1

Reference: NIOSH Guidebook

Mark	Question	
	9.	What are the synonyms for naphtha?
	Answer:	
	Objective:	Module 2, Objective #1
	Reference:	NIOSH Guidebook
	10.	What is the definition of IDLH?
	Answer:	
	Objective:	Module 2, Objective #1
	Reference:	NIOSH Guidebook

Mark Question

MODULE #3

2000 EMERGENCY RESPONSE GUIDEBOOK ASSIGNMENT

1. Identify the following materials, listed below by their four-digit identification number.

a) #1993

b) #2809

c) #2797

d) #1263

e) #2796

Answer:

Objective: Module 3, Objective #4

Reference: 2000 Emergency Response Guidebook

Mark Question

2. List the four digit identification numbers for the following materials:

a) Gasoline

b) Waste Flammable Liquid n.o.s.

c) Waste Corrosive Liquid n.o.s.

d) Waste Corrosive Solid n.o.s.

e) Sodium Hydroxide

Answer:

Objective: Module 3, Objective #4

Reference: 2000 Emergency Response Guidebook

Mark Question

3. What guide page offers advice on situations involving the below listed commodities?

a) 1999

b) 1334

c) 1856

d) Creosols

e) Mercury

Answer:

Objective: Module 3, Objective #4

Reference: 2000 Emergency Response Guidebook

4. What is the telephone number for CHEMTREC?

Answer:

Objective: Module 3, Objective #4

Reference: 2000 Emergency Response Guidebook

5. List the information you would want to relay to CHEMTREC.

Answer:

Objective: Module 3, Objective #4

Reference: 2000 Emergency Response Guidebook

Mark Question

MODULE #5

INCIDENT COMMAND ASSIGNMENT

1. Name the five major activities around which the ICS is organized.

Answer:

Objective: Module 5, Objective #1

Reference: Module 5; page 2

2. The General Staff consists of:

Answer:

Objective: Module 5, Objective #2

Reference: Module 5, page 5

Mark	Question	

3. Name the three major activities of the Command Staff:

Answer:

Objective: Module 5, Objective #2

Reference: Module 5, page 4

4. The Incident Commander may have one or more deputies from the same agency or from other agencies or jurisdictions.

a) True

b) False

Answer:

Objective: Module 5, Objective #4

Reference: Module 5, page 5

5. Deputies must always be as qualified as the person for whom they work.

a) True

b) False

Answer:

Objective: Module 5, Objective #4

Reference: Module 5, page 5

Mark Question

6. Deputies may be used at which of the following levels of the ICS organization? (Circle all that apply)

a) Unit

b) Section

c) Command Staff

d) Division/Groups

e) Branch

Answer:

Objective: Module 5, Objective #4

Reference: Module 5, page 11

7. For each of the organization elements listed below on the left, designate the letter for the appropriate ICS title.

Answer:	Branch	______	a)	Leader
	Section	______	b)	Officer
	Division	______	c)	Supervisor
	Command Staff	______	d)	Chief
	Group	______	e)	Director
			a)	Manager

Objective: Module 5, Objective #4

Reference: Module 5, page 11

Mark Question

8. Groups and Divisions are at the same organization level.

a) True

b) False

Answer:

Objective: Module 5, Objective #8

Reference: Module 5, page 11

9. List the principal facilities, which may be located at an incident.

Answer:

Objective: Module 5, Objective #9

Reference: Module 5, pages 12, 13

10. a) Groups ______________________________responsibility.

b) Divisions have _________________________responsibility.

Answer:

Objective: Module 5, Objective #8

Reference: Module 5, page 7