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Hazardous Waste Operations and Emergency Response

Initial

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Chapter 1

Introduction and Requirements

This course provides attendees with either 24 or 40 hours of Off-Site Health and Safety Training at the Hazardous Materials Technician (24 hour) non-emergency response level and/or General Site Worker (40 hour) level. It meets both Federal and Alaska State workplace training requirements established by OSHA under 29 Code of Federal Regulation (CFR) 1910.120 Hazardous Waste Operations and Emergency Response, as well as DOT Hazardous Material Transportation Awareness and Safety Training.

Following this course, it is the employer's responsibility under OSHA regulations to provide their employees with 1 (24 Hour) or 3 (40 Hour) days of On-Site Training prior to initial job assignment to familiarize them with:

- Site-specific Health and Safety Plan
- Hazard Communication Program (Global Harmonization System)
- Personal Protection and Respiratory Program
- Medical Surveillance Program
- Any other pertinent training required by the regulation

Chapter Objective

Introduce attendees to the philosophy, methods of instruction, course content and an overview of OSHA and other regulations, and describe the responsibilities and rights employers and employees have under OSHA.

Student Expectations

Attendance of all course hours of instruction is expected. Classroom work, projects and testing on the materials covered will be used to determine satisfactory completion. Attendees will be given a final test; a score of 70% or higher as determined by the instructor is required to obtain a certificate of training. There is a final 50 question test of matching, definitions, fill in the blank and true and false questions; two points per question. So be here when class starts, pay attention and feel free to ask questions. **This class is for you!** At the end of the class, attendants are given an opportunity to evaluate the course and the quality of the instruction. Your honest input is appreciated.

Methods of Instruction

Methods of instruction used during this course include a combination of lecture, overhead and video projection, review of industry publications, class room work projects and discussions, personal protective and respiratory equipment donning and doffing, and hands-on with air monitoring devices. Students in the 40 hour course will participate in a field exercise.

Safety Attitude

Individuals working with hazardous materials or waste have to have a professional, responsible, and informed mature attitude. Your overall goal at the beginning of each work shift should be to take whatever precautions are necessary to make sure that you return to your personal life safe and sound after your work shift. In other words, look around your work place and ask yourself, "**How can I or others be hurt and what can I do to prevent it?**" The alternative is to be an OSHA Recordable (OR) entry or statistic on the OSHA 300 Log of Work – Related Injuries and Illnesses. "It's **Your Choice!"**

Course Introduction

Employee health and safety regulations in place in our country in today's work environment originated from the mining industry. Beginning in 1870, a series of laws were promulgated to address the high mortality rate of mine workers. After World War II, health and safety regulations grew to encompass other industrial trades. However, it was not until 1970, when Congress adopted the Occupational Safety and Health Act (OSHA), that specific regulations were created to protect worker health and safety.

For the mining industry, current mining regulations include Federal Mine Safety and Health Act of 1977 (Public Law 91 – 173) which was amended on June 15, 2006 by the Mine Improvement and New Emergency Response (Miner) Act of 2006 (Public Law 109 – 236) from which we get the Mine Safety and Health Administration (MSHA).

In addition, the Occupational Safety and Health Administration (OSHA), was created with the authority to enforce those health and safety regulations in the workplace and is implemented either through Compliance or Consultation. The employer run, Voluntary Protection Program (VPP), for workplace safety implemented through the Consultation division of OSHA has two levels: Star Program and Safety and Health Achievement Recognition Program (SHARP). This program rewards employers with the Star, Merit or Demonstration level of compliance for large employers with 500 or more employees. The SHARP program is for small businesses with less than 500 employees. OSHA also uses their Compliance program as a way to enforce worker safety regulations.

See the Chronology of Regulations and Incidents in Chapter One.

Course Contents

A summary of Appendix E to 1910.120 – Training Curriculum Guidelines (67 Federal Register 67964, Nov. 7, 2002) of the HAZWOPER regulation suggests that the 24/40 Hour Off-Site Training Programs include the following:

- Regulatory Knowledge – overview of relevant government agencies responsible for hazardous materials oversight, the safety and health regulations that they enforce, and how they interface with other agencies and private industry
- Explanation and Application - core components of 29 CFR 1910.120 and 1910.1200 will be discussed to include contents of Health and Safety programs and plans, medical surveillance programs, required illumination, sanitation, and emergency response plans
- Technical Knowledge – identification of types of potential exposures with explanation of human responses to chemical, biological and physical hazards; principles of toxicology, acute and chronic health effects, and chemical and

physical properties of all classes of hazardous materials and substances, as well as some publications and manuals that provide hazard information

- Comprehensive Review - examples of general safety standards, engineering controls, safe work practices, along with safety guidelines for air, ground and water sampling and monitoring, container handling, spill control, and confined space entry operations
- Technical Skills – understand components and procedures of a respiratory protection program as well as the selection, use, maintenance and limitations of personal protective and respiratory equipment. Attendees will also receive information and experience at donning and doffing of PPE levels A, B, and C, as well as decontamination procedures for personnel and equipment
- Hands - On - exercises using hazardous materials information resource and reference manuals to identify chemical and physical hazards and prepare site specific health and safety plans or work plans incorporating appropriate engineering and administrative controls, safe work practices, and PPE

Department of Labor – Occupational Safety and Health Administration

The Occupational Safety and Health Administration (OSHA), within the Department of Labor (DOL) was created by the Williams - Steiger Occupational Safety and Health (OSH) Act of 1970, to develop safety and health standards and enforce the OSH Act nationwide. OSHA, through regulatory guidelines for employers, consultation and compliance programs, ensures the health and safety of employees in the workplace.

OSHA is charged with:

- Inspecting work places to assure standards are being met
- Issuing citations and fines to companies that do not meet the standards
- Overseeing state plans for safety and health
- Education and the development of training programs
- Investigating workplace accidents

Regulations set by OSHA are published in:

- Code of Federal Regulations (CFR) Title 29 – Department of Labor
- Part 1910 – General Industry
- Part 1915 – Shipyard Employment
- Part 1917 – Marine Terminals
- Part 1918 – Long shoring
- Part 1926 – Construction Industry

In this class we will concentrate on 29 CFR 1910 – General Industry Regulations and 29 CFR 1926 – Construction Industry Regulations.

The **General Industry Regulations** (Part 1910) cover virtually all production industries working out of fixed facilities. Examples of parts of the General Industry Standards include:

1910.20	Employee Access to Exposure and Medical Records
1910.38	Employer Emergency Plans and Fire Prevention Plans
1910.95	Occupational Noise Exposure
1910.120	Hazardous Waste Operations and Emergency Response
1910.134	Respiratory Protection
1910.146	Permit-Required Confined Spaces
1910.147	The Control of Hazardous Energy (Lockout/Tagout)
1910.1000	Permissible Exposure Limits on Airborne Toxic Substances
1910.1200	The Hazard Communications Standard (Right-to-Know)

The **Construction Industry Regulations** (Part 1926) cover activities such as earth-moving and building of structures. Examples of the Construction Industry Standards:

1926.52	Occupational Noise Exposure
1926.55	Permissible Exposure Limits on Airborne Toxic Substances
1926.59	The Hazard Communications Regulation (Right–to-Know)
1926.152	Flammable and Combustible Liquids
1926.202	Barricades
1926.302	Power Operated Hand Tools
1926.1200 - 1213	Confined Spaces in Construction

Employer Responsibilities under the OSH Act

It is the general responsibility of the employer not to expose employees to harmful situations or chemicals. This responsibility is commonly referred to as the "General Duty Clause" of the Act. It says "The employer: 1) shall furnish each of his employees' employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to employees; 2) shall comply with occupational safety and health standards promulgated under this Act.

Employers have the responsibility to provide a safe and healthful workplace, and any necessary personal protective equipment to reduce both physical and chemical hazard exposure to their workers.

Employers must comply with the applicable parts of both the OSHA General Industry Standards (1910) and/or the Construction Industry Standards (1926), including HAZWOPER (1910.120). HAZWOPER applies to hazardous waste operations and emergency response. In the event of conflict between regulations, the most protective regulation is enforced.

Employee Responsibilities under the OSH Act

Employees have the responsibility to their employer, themselves, and their families to know and to follow safety rules set by their employer. These rules include:

- Abide by established policies, procedures and safety rules
- Wear and/or use required safety equipment
- Seek prompt medical treatment when required
- Bring safety and health concerns to the attention of management

It is possible for a worker to file a complaint against the employer as long as they are still employed by that employer. A formal procedure is followed including the completion and submission of the OSHA Complaint form (OSHA – 7 Notice of Alleged Safety or Health Hazards) which is available through the OSHA website at www.OSHA.gov. Once a complaint is received at the OSHA Office, it is assigned to an OSHA compliance officer.

OSHA Inspections

Since not all eight million worksites covered by OSHA can be inspected, the agency has a system of inspection priorities, which may include your HAZWOPER site. There are six inspection priorities and they are categorized by OSHA as follows:

1. **Imminent Danger Situations** – hazards that could cause death or serious physical harm receive top priority. Compliance officers will ask employers to correct these hazards immediately or remove endangered employees.

2. **Severe injuries and illnesses** – employers must report:
   - All work-related fatalities within 8 hours.
   - All work-related inpatient hospitalizations, amputations, or losses of an eye within 24 hours.

   (The above-mentioned injuries must be reported within 8 hours in accordance with Alaska OSH).

3. **Worker Complaints** – allegations of hazards or violations also receive a high priority. Employees may request anonymity when they file complaints.

4. **Referrals** of hazards from other federal, state or local agencies, individuals, organizations or the media receive consideration for inspection.

5. **Targeted inspections** – inspections aimed at specific high-hazard industries or individual workplaces that have experienced high rates of injuries and illnesses also receive priority.

6. **Follow – up inspections** – checks for abatement of violations cited during previous inspections are also conducted by the agency in certain circumstances.

OSHA also conducts Special Emphasis and Monitoring Inspections. These inspections are made as needed, and take priority over Targeted Inspections. A follow – up inspection is made to see if violations cited on an earlier inspection were fixed. A Special Emphasis inspection is for an operation where there is an excessive amount of accidents. Monitoring inspections are made to make sure hazards are being corrected and workers are protected whenever a long period of time is needed for a hazard to be fixed.

OSHA on – Site Inspection Stages

There are five major stages of an OSHA inspection. They are:

1. **Preparation** – Before conducting an inspection, OSHA compliance officers research the inspection history of a worksite using various data sources, review the operations and processes in use and the standards most likely to apply. They gather appropriate personal protective equipment and testing instruments to measure potential hazards.

2. **Presenting of Credentials** – The on-site inspection begins with the presentation of the compliance officers' credentials, which include both a photograph and a serial number.

3. **Opening Conference** – The compliance officer will explain why OSHA selected the workplace for inspection and describe the scope of the inspection, walk around procedures, employee representation and employee interviews. The employer then selects a representative to accompany the compliance officer during the inspection. An authorized representative of the employees, if any, also has the right to accompany the inspector. The compliance officer will consult privately with a reasonable number of employees during the inspection.

4. **Walk around** – Following the opening conference, the compliance officer and the representative will walk through the portions of the workplace covered by the inspection, inspecting for hazards that could lead to employee injury or illness. The compliance officer will also review worksite injury and illness records and the posting of the official OSHA poster.

5. **Closing Conference** – After the walk around, the compliance officer holds a closing conference with the employer and the employee representatives to discuss the findings. The compliance officer discusses possible courses of action an employer may take following an inspection, which could include an informal conference with OSHA or contesting citations and proposed penalties. The compliance officer also discusses consultation services and employee rights.

The above listed OSHA information is under the Federal OSHA program. In the State of Alaska, we have both a Federal OSHA and a State OSHA. Starting in 1995, the State of Alaska adopted all of the Federal OSHA regulations, however, there are some specific regulations listed in the Alaska (OSH 8) Alaska Administrative Code (AAC) 61 Article 11, Sections 1010 – 1190 "Occupational Safety and Health Standards" that go over and above what the Federal Regulations require.

Chapter 2

Regulations

Chapter Objectives

Familiarize students with the relevant government acts and agencies responsible for the safety and health regulations that they enforce, hazardous materials overview, and the interface between these agencies and private industry.

Introduction

Prior to 1970, effective workplace safety and health regulations did not exist on either the state or federal levels. The regulations that did exist were not adequately enforced. Therefore large numbers of employees experienced illness, injury and death as a result of unsafe and unhealthy workplace conditions. In addition to occupational health and safety concerns, our nation was grappling with environmental management of industrial chemical use and their disposal and subsequent pollution.

In 1970, Congress established the Occupational Safety and Health Administration (OSHA) to ensure safe and healthful work environments in the manufacturing and construction industries. At the same time (1970), the Environmental Protection Agency (EPA) was established to consolidate in one agency a variety of federal research, monitoring, standard – setting and enforcement activities to ensure environmental protection. Today, OSHA is the primary guardian of worker's health and safety, possessing the authority to develop and implement workplace health and safety regulations. The EPA protects the public's health along with regulating the cleanliness and safety of our air, water and ground.

Federal Acts and Agencies

Employees need to have a basic understanding of the laws and agencies that help regulate hazardous materials operations. Understanding the laws and rules that stipulate the requirements and restrictions for working in hazardous environments and/or conditions requires familiarity with the changes that have occurred in regulatory oversight and the interface of the federal acts and agencies that contain the laws. In addition to the EPA and OSHA, many other federal, state and local entities play a role in writing and enforcing regulations that effect hazardous material operations such as the National Fire Protection Association (NFPA), Local Emergency Planning Committee (LEPC) and State Emergency Response Commission (SERC).

The following is a listing of federal enforcement agencies that regulate the organizations that are engaged in hazardous materials operations. Under each agency is a chronological list of the acts that created and empowered these agencies with enforcement authority.

Environmental Protection Agency (EPA)

The EPA governs the quality of our environment including air, land, and water. In addition, the EPA administers the regulations that manage hazardous substances and hazardous waste. The EPA played a vital role in spearheading the HAZWOPER regulations that are currently in place for worker health and safety.

EPA Regulation – Title 40 CFR

These are a few of the parts of the EPA regulations noting where some significant environmental acts are incorporated into the regulations.

- 40 CFR 50-99: Clean Air Act
- 40 CFR 100-140 and 400-470: Clean Water Act
- 40 CFR 240-271: RCRA
- 40 CFR 260-299: Hazardous Waste Management System
- 40 CFR 279: Used Oil Management Standards
- 40 CFR 700-799: Toxic Substance Control Act

Clean Water Act of 1948 (CWA)

Major amendments were implemented in 1956, 1972, 1977 and 1987. The CWA, amended and reauthorized in 1987, has the goal of maintaining or regaining the chemical, physical, and biological integrity of our nation's waters. Both the EPA and Army Corps of Engineers have jurisdiction. The CWA regulates discharge of toxic and non-toxic pollutants into surface waters. The interim goal is to make surface waters usable for activities such as fishing and swimming; with the ultimate goal to eliminate all discharges into surface waters. The EPA sets guidelines and individual states issues permits through the National Pollutant Discharge Elimination System (NPDES) specifying the types of control equipment and discharges for each facility.

Clean Air Act of 1970 (CAA)

The Clean Air Act, reauthorized in 1990, amended the Air Quality Act of 1967. The CAA is designed to enhance the quality of air resources by authorizing the EPA to set the criteria for our nation's air pollution control programs. The CAA mandates and enforces toxic emission standards for stationary sources and motor vehicles (Catalytic converters). Air quality standards are required to be achieved and maintained nationwide for six pollutants:

> Ground level ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), particulate pollution or matter called total suspended particulates (TSP), and lead (Pb).

For each of these pollutants, EPA has established an Air Quality Index (AQI) of national air quality standards to protect public health.

Think of the AQI as a yardstick that runs from 0 – 500. The higher the AQI value, the greater the level of air pollution and the greater health concern. For example, an AQI of 50 represents good air quality with little potential to affect public health, while an AQI over 300 represents hazardous air quality. The AQI is divided into six categories:

When AQI is in this range:	air quality conditions are:	color is:
0 – 50	Good	Green
51 – 100	Moderate	Yellow
101 – 150	Unhealthy for sensitive groups	Orange
151 – 200	Unhealthy	Red
201 – 300	Very Unhealthy	Purple
301 – 500	Hazardous	Maroon

Anchorage, Alaska monitors carbon monoxide (CO) and total suspended particulates (TSP) to evaluate our air quality. The CAA established a Pollutant Standard Index (PSI) and requires standardization of monitoring efforts for AQI. An AQI that is:

- 100 is considered unhealthy for sensitive groups
- 200 is very unhealthy
- 300 is considered hazardous

Federal Insecticide, Fungicide, and Rodenticide Act of 1972 (FIFRA)

FIFRA amended in 1988, directs the EPA to regulate the manufacture, distribution, and use of pesticides, as well as conduct research into the effects on human and environmental health as a result of their use. This act provides for some agricultural worker safety standards, pesticide handling licenses, and stringent labeling requirements.

Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA)

The Marine Protection, Research, and Sanctuaries Act permits the EPA to protect the oceans from the indiscriminate dumping of waste.

Safe Drinking Water Act of 1974 (SDWA)

Safe Drinking Water Act, reauthorized in 1996, permits the EPA to regulate the quality of public drinking water systems and the disposal of wastes into injection wells.

Resource Conservation and Recovery Act of 1976 (RCRA)

In the late 1960s and early 1970s, the Congressional Office of Technology Assessment estimated that approximately 250 to 275 million metric tons of hazardous waste were produced each year in the United States. Air and ground water pollution, contamination of surface water, and poisoning of animals and humans via the food chain supported the EPA's belief that only a small percentage of generated waste was being "disposed" of in an environmentally acceptable manner.

Congress had generally addressed the problems of solid waste disposal by enacting the Solid Waste Disposal Act in 1965 and the Resource Recovery Act in 1970. The first comprehensive Federal effort to confront the problems of solid and hazardous waste began in 1976 when RCRA was enacted. RCRA is an amendment that completely revised the Solid Waste Disposal Act of 1965.

RCRA was established to regulate the management and disposal of hazardous materials and wastes. RCRA gave the EPA the jurisdiction and responsibility to create and enforce the regulations governing the proper identification, handling, labeling, storing, treating, and disposal of hazardous waste. RCRA instituted the manifest system of tracking a hazardous waste from generator through transportation, storage, and disposal; referred to as the "cradle to grave" liability tracking system. It also encouraged hazardous waste recycling and minimization. Businesses which generate hazardous waste must have:

- Hazardous Waste Management System
    - Hazardous Waste Identification
    - Generator, Transporter, and Treatment, Storage, and Disposal (TSD) Facility Responsibilities
    - "Cradle to Grave" Tracking of Hazardous Waste
- Hazardous Waste Minimization, Prevention, Reduction, or Elimination
- Conservation of Energy and Natural Resources

RCRA Amendments of 1984

As of 1983, an estimated 40 million metric tons of hazardous waste escaped regulatory control through loopholes in the legislative framework. RCRA was falling short of its intent, thus congress amended it in 1984. These amendments strengthened RCRA to include underground storage tanks (USTs), redefined small-quantity generator (SQG) to include more generators, and restricted liquid and hazardous wastes from landfills.

Toxic Substance Control Act of 1976 (TSCA)

TSCA gave the EPA the authority to regulate the manufacture, distribution and use of chemical substances for which there are not specific standards already established. TSCA required the EPA to evaluate chemicals before they are sold to prevent any unreasonable chemical risk to humans or the environment, as well as create a list of reviewed harmful substances that need precautions and safe work practices when used by the public or industry. Under TSCA, the EPA must:

- Gather Information on Chemicals
- Screen New Chemicals Proven to Present Risks
- Require Testing of Chemicals Identified as Possible Risks
- Control Chemicals Proven to Present Risk

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)

Enacted to fill a void in the RCRA law, CERCLA addresses problems associated with contamination from abandoned facilities, military sites, or releases of hazardous substances into the environment from vessels or facilities that are not subject to RCRA authority. CERCLA, also known as **Superfund**, authorizes government money for clean-up of abandoned hazardous waste sites, clean-up and emergency response for transportation incidents involving chemical releases, and payments to injured or affected citizens. It was amended by Superfund Amendment and Reauthorization Act (SARA) in 1986 and:

- Established National Priority List (NPL)
- Provides for Identification & Cleanup of Hazardous Waste Sites
- Funds to implement come from Oil Tax, Generator Fines, and US Treasury

Superfund Amendment and Reauthorization Act of 1986 (SARA)

SARA was passed to safeguard the safety and health of personnel working in hazardous operations, as well as the community at large. First, SARA reauthorized money to continue site characterization to determine which locations belong on the NPL, as well as continuing abandoned site cleanup.

In addition, SARA mandated that OSHA established worker safety and health standards for hazardous waste and emergency response operations. SARA requires training for both workers and management personnel covering safety and health risks at waste sites, TSD facilities, and emergency response operations. SARA initiated the requirement for local and regional emergency contingency planning.

SARA is made up of three separate sections or 'Titles.' Titles I and III cover hazardous waste operations, emergency response and planning, while Title II targets a fund for hazardous waste clean-up.

Title I

- Requires training for hazardous waste operation site workers and emergency response personnel (HAZWOPER)
- Requires preparation of a written emergency response plan for operations where hazardous materials may be spilled or released
- Requires proper procedures for handling emergency response operations

Title II

- Gives authority for "Superfund" to continue to pay for hazardous waste cleanup through a tax on industry

Title III (Community Right-to-Know)

Established in large part as a result of the widely published 1984 disaster in Bhopal, India, in which massive amount of toxic methyl isocyanate escaped from the Union Carbide plant.

- Develop "Comprehensive Community Emergency Plans" by Local Emergency Planning Committees (LEPCs)
- Report specific chemical inventory and release information to local fire departments, LEPCs, and the State Emergency Response Commission (SERC)
- Facilities storing chemicals provide chemical types, quantity on hand, and locations with inventory lists; fees are assessed based on substances and quantities
- Local fire departments visit facilities to determine hazards and ensure compliance

Pollution Prevention Act of 1990

The key provisions of this act address prevention, recycling, treatment and disposal of hazardous material, substances, and wastes.

DOL – Occupational Safety and Health Administration (OSHA)

Under the Department of Labor, OSHA is the primary federal agency designated to safeguard the safety and health of workers in any hazardous activity. OSHA sets, oversees and enforces health and safety regulations for workplace safety. The two primary regulations OSHA utilizes to protect employees are Hazard Communication and Hazardous Waste Operation and Emergency Response.

Individual states, called “state plan states,” may write and enforce their own OSHA regulations as long as they are at least as stringent as the federal law. In 1995, Alaska DOL rescinded its OSHA regulations, and adopted the federal regulations in their entirety. However, Alaska retained more stringent OSHA requirements for but not limited to: respiratory protection, confined space entry, air contaminants, and hazard communications.

Hazard Communication Regulation enacted in 1980 (Haz Com) (Re-written May, 2012 to comply with the United Nations, Globally Harmonized System of Classification and Labeling of Chemicals (GHS).

This regulation was referred to as the ‘Right-to-Know (RTK)’ law, and now under GHS it is not only your right to know, but your “Right to Understand” chemicals in the workplace and it is found under 29 CFR 1910.1200 in the Federal OSHA regulation.

In the State Hazard Communication requirement, Alaska requires employers to make Physical Agent Data Sheet (PADS) available as part of an employer’s Hazard Communication training program when Federal OSHA only requires Safety Data Sheets (SDS) under the Globally Harmonized System (GHS). Alaska OSH Table Z 1 – A: Limits for Air Contaminants is another example where our state has adopted equal or lower permissible exposure limits.

The Hazard Communication Regulation requires:

- Manufacturers and/or importers of chemicals to evaluate the hazards
- Chemical hazards information be passed on to employers
- Employees know and understand the chemical and physical hazards present in their work environment
- Haz Com addresses these topics and more:

    1. Hazard Determination
    2. Written Hazard Communication Program
    3. Labels and Other Forms of Warning
    4. Safety Data Sheets (SDS) under Global Harmonization System (GHS)
    5. Employee Information and Training
    6. Labeling containers
    7. Transferring contents

Alaska Hazard Communication Standard revised 1995 (Haz Com)

8 AAC 61.1110 – Alaska State adopted in 1984, amended in 1995

- Requires employers to inform employees of "physical agents" present in the workplace
- The physical agents, as delineated by American Conference of Governmental Industrial Hygienists (ACGIH), adopted under this statute and which are in your reference manual include:

1. Cold Stress
2. Heat Stress
3. Noise
4. Hand-Arm Vibrations
5. Lasers
6. Ionizing Radiation
7. Ultraviolet Radiation
8. Radiofrequency (Rf) and Microwave Radiation

  - Requires Physical Agents Data Sheets (PADs) to be available for each physical agent present in the workplace
  - Requires posting of "Right-to-Know" posters in the workplace

As of December, 2013, our country is switching over to the International Standard called the Global Harmonization System, (GHS) which will change some icons and add pictograms that will be used on containers and the manufacturer or importer must have a new Safety Data Sheet (SDS); by June 2015. End users must have new SDS and labels by June 2016 or document that they are not available yet.

Hazardous Waste Operations and Emergency Response Regulation enacted in 1989 (HAZWOPER)

Effective March 6, 1989, 18 days prior to the Exxon Valdez 11,000,000-gallon oil spill into Prince William Sound

29 CFR 1910.120

HAZWOPER requires stringent health and safety programs for hazardous waste and emergency response operations, as well as quantity and content of the training that must be provided to anyone who may be exposed to a hazardous waste or material in the workplace. The full regulation is in your reference manual.

29 CFR 1910.120 – HAZWOPER

Paragraphs (a) – (q) of the HAZWOPER regulation are listed below:

a. Scope, Application and Definitions
b. Safety and Health Program
c. Site Characterization and Analysis
d. Site Control
e. Training
f. Medical Surveillance
g. Engineering Controls, Work Practices and Personal Protective Equipment for Employee Protection
h. Monitoring
i. Informational Programs
j. Handling Drums and Containers
k. Decontamination

l. Emergency Response by Employees at Uncontrolled Hazardous Waste Sites
m. Illumination
n. Sanitation at Temporary Work Places
o. New Technology Programs
p. Certain Operations Conducted Under the Resource Conservations and Recovery Act of 1976 (RCRA)
q. Emergency Response to Hazardous Substance Releases

Permit-Required Confined Spaces of 1998 in General Industry

29 CFR 1910.146

The Confined Space Entry (CSE) regulation addresses the teams, programs, procedures and permits that ensure employees can safely enter and work in confined spaces. See reference manual.

Lockout/Tagout Control of Hazardous Energy Sources of 1976

29 CFR 1910.147

The Lockout/Tagout (LOTO) regulation addresses shutting down sources of energy and verification that all energy sources have been rendered to a zero-energy state. See reference manual, and Chapter 9.

Sources of Guidelines

American Conference of Governmental Industrial Hygienists (ACGIH)

An organization of professional personnel from government agencies and educational institutions devoted to the administrative and technical aspects of occupational and environmental safety and health programs. ACGIH develops and publishes threshold limit values (TLV's) for hundreds of chemical substances and physical agents and biological exposure indices (BEI's).

National Institute for Occupational Safety and Health (NIOSH)

An agency of the Department of Health and Human Service (DHHS) with the Centers for Disease Control (CDC) and Prevention that investigates incidents, researches occupational safety issues and establishes recommended exposure limits (RELs) and recommends them to OSHA for hazardous chemicals. They also test and certify Air Purifying Respirators (APR) and respiratory and air sampling devices (except specific mining devices), as well as recommend assigned protection factors (APF) for respirators. NIOSH does not act in a regulatory capacity.

Department of Transportation (DOT)

49 CFR 107 – 180: Hazardous Material Transportation Standards

The DOT oversees the transport of hazardous materials through interstate and intrastate commerce. The Hazardous Materials Transportation Act (1975) granted the DOT authority to establish criteria for packaging, labeling, placarding, marking and shipping papers necessary to transport hazardous material; as well as the training of personnel responsible for hazardous material transportation. This act was reauthorized in 1990, becoming the Hazardous Materials Transportation Uniform Safety ACT (HMTUSA).

Hazardous Materials Transportation Uniform Safety Act 1990 (HMTUSA)

The federal transportation act that applies to any person or company that ships hazardous materials and/or hazardous waste in commerce by air, water, rail, or highway. The shipping requirements include preparation of shipping papers, a bill of lading or a uniform hazardous waste manifest, packing the material in specific packages, segregation of hazardous materials, placing hazard labels on the packages and placards on shipping containers.

Pipeline and Hazardous Materials Safety Act of 2004

PHMSA is a U.S. Department of Transportation agency that develops and enforces regulations for the safe, reliable, and environmentally sound operation of the nation's 2.6 million mile pipeline transportation system and the nearly 1 million daily shipments of hazardous materials by land, sea, and air. PHMSA comprises two safety offices, the Office of Pipeline Safety and the Office of Hazardous Materials.

PHMSA's mission is to protect people and the environment from the risks inherent in transportation of hazardous materials - by pipeline and other modes of transportation.

United States Coast Guard (USCG)

- 33 CFR

The USCG is a branch of the United States Armed Forces and one of the country’s seven uniformed services. The Coast Guard is a maritime, military, multi-mission service unique among the U. S. Military branches for having a maritime law enforcement mission and a federal regulatory agency mission as part of its mission set. It operates under the U. S. Department of Homeland Security during peacetime, and can be transferred to the u. S. Department of the Navy by the U. S. president at any time, or by the U. S. Congress during times of war. They are responsible for the preservation of navigable water ways, as well as response to hazardous material releases that threaten those waterways of the United States. As a federal agency, they are responsible for enforcing regulations governing the safe carriage of hazardous material in maritime.

Oil Pollution Act of 1990 (OPA 90)

This legislation was passed in response to the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska. OPA 90 regulations are intended to ensure the safe transportation of petroleum products, particularly in marine environments. OPA 90 requires industry to develop Spill Prevention Control and Countermeasures (SPCC) plans, as well as demonstrate their spill response capabilities to both incidents “most likely to occur” and “worst case scenarios.”

Alaska State Agencies

Alaska Department of Environmental Conservation (ADEC)

The Federal EPA has delegated enforcement of its regulation to this state agency. ADEC functions are similar to the EPA, with enforcement

powers to oversee protection of the environment on both state and private lands. Alaska regulates substances called “special wastes.” These include waste oils, asbestos abatement waste and petroleum-contaminated soil in addition to EPA hazardous wastes. ADEC works with other state agencies to ensure compliance with state laws while overseeing the development of lands and resources.

Alaska Department of Labor (ADOL)

The Alaska Department of Labor is responsible for developing and administering an occupational safety and health program for the State of Alaska. To carry out this responsibility, the Division of Labor Standards and Safety was established. The division is charged with the responsibility and has the authority to:

- Investigate disabling or fatal occupational injuries and illnesses
- Inspect workplaces to determine if conditions are safe and healthful
- Enforce all laws and lawful orders requiring work and workplaces to be safe and healthful
- Develop occupational safety and health standards which, after adoption, have the effect of law
- Establish special orders or rules and regulations to cover a specific place of employment or process of work

In 1995, Alaska rescinded its OSHA regulations and adopted the federal standards.

Alaska Division of Occupational Safety and Health (AKOSH)

AKOSH is an agency within ADOL that develops and enforces safety and health standards for the workplace.

Labor Standards and Safety

Alaska section under ADOL that deals with work health and safety issues.

CHRONOLOGY OF REGULATIONS AND INCIDENTS

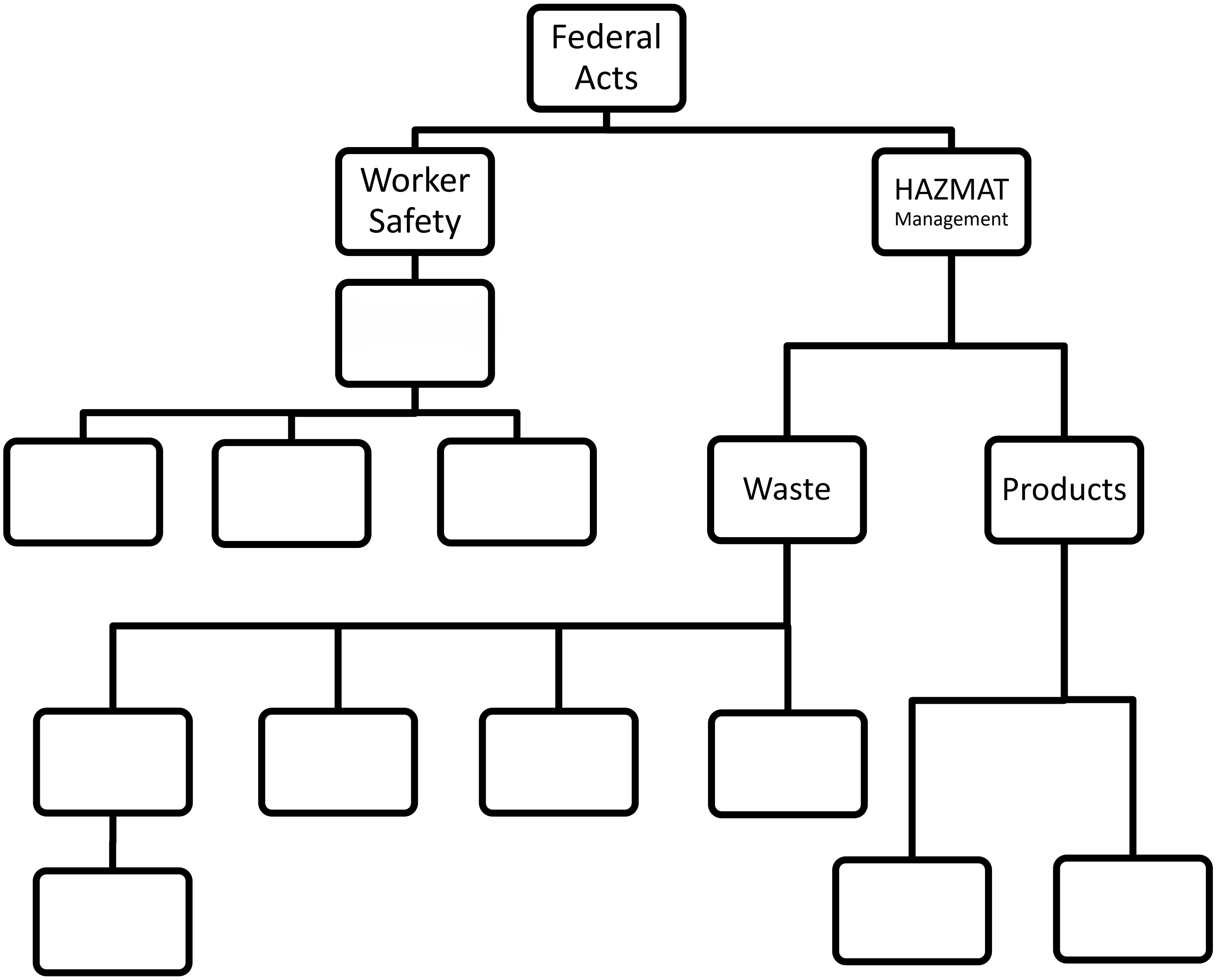
As a result of the publication of these incidents, workplace hazards have received a great deal of public attention. The media regularly announces that another physical or health hazard associated with chemicals or waste has been revealed. Both government and industry begin the task of regulating the situation in a manner that provides protection for personnel.

- 1870 Pennsylvania becomes the first State to institute compulsory inspection of mines by enacting a safety law for the anthracite coal field
- 1910 Organic Act of 1910 created U.S. Bureau of Mines – 1910-1940 – Safety role of the Bureau of Mines consists of advice, research and teaching safety and first aid courses
- 1941 Bureau of Mines is granted inspection and investigation authority, but no enforcement powers

  During WWII, 1941-1945, approximately 1300 coal miners die each year
- 1946 Federal Mine Safety Code – advisory only
- 1948 Clean Water Act (CWA)
- 1952 Federal Coal Mine Safety Act – Mandatory safety provisions for large mines, amended in the 1960s to include small mines
- 1965 Solid Waste Disposal Act
- 1969 National Environmental Policy Act (NEPA)
- 1970 Occupational Safety and Health Act (OSH Act); Clean Air Act (CAA)
- 1973 Mining Enforcement and Safety Administration (MESA)

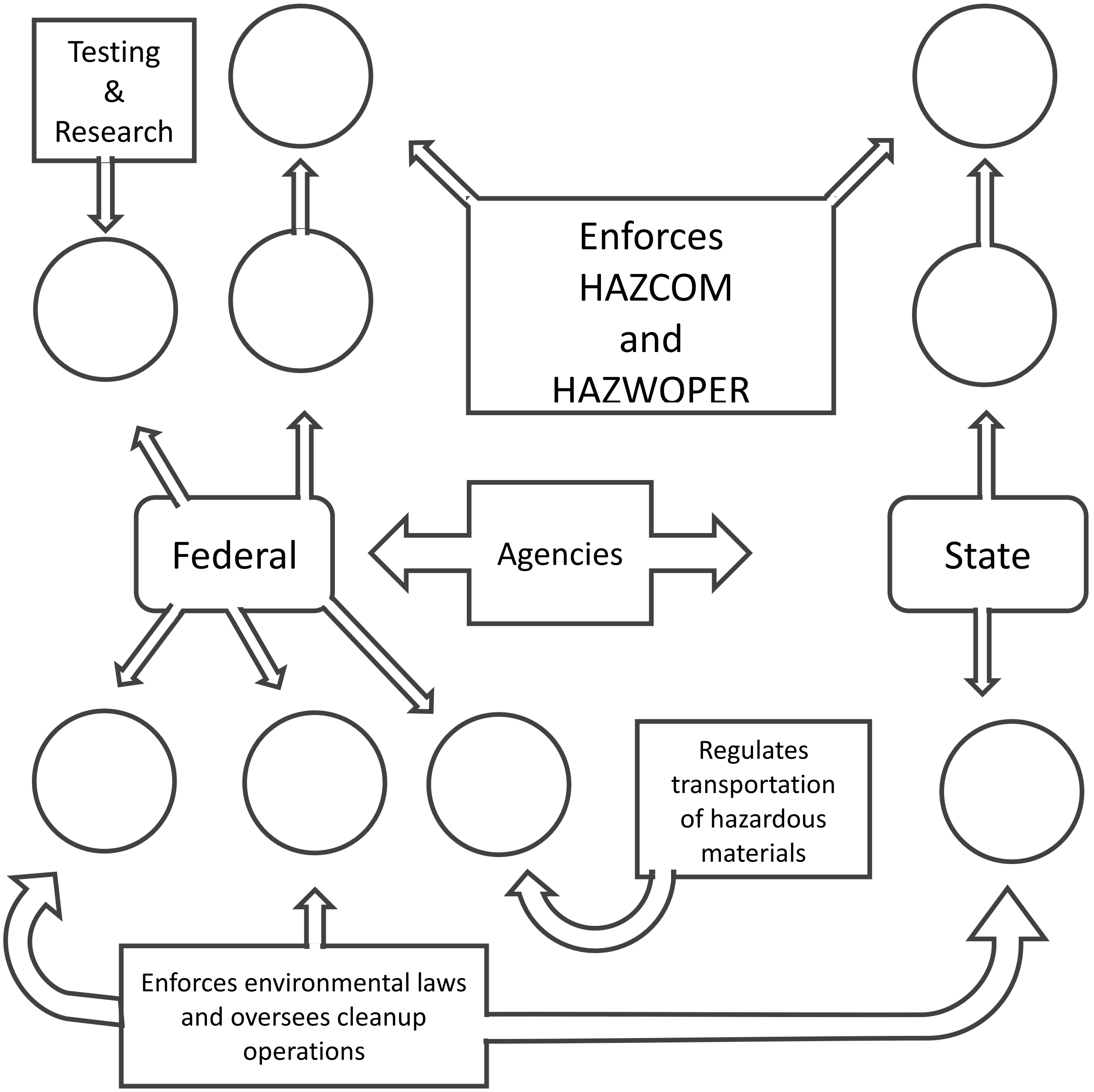
  By the mid-1970s the number of coal miners killed each year dropped to about 115
- 1975 Hazardous Materials Transportation Safety Act (HMTUSA)
- 1976 Resource Conservation and Recovery Act (RCRA); Toxic Substance Control Act (TSCA)
- 1980 Comprehensive Environmental Response, Compensation and Liability ACT (CERCLA), “Superfund”
- 1980 Hazard Communication (Haz Com)
- 1984 Bhopal, India – Escaping methyl isocyanate gas leaking from a factory kills 2,500 people within hours; 3,000 die from illnesses presumed to be linked to their exposures. As of 1994, 15,000 had died. Mexico City – Liquefied Natural Gas tank explosion kills 452
- 1986 Chernobyl, Ukraine – Explosion and fire in nuclear plant forces evacuation of 100,000
- 1986 Superfund Amendments and Reauthorization Act (SARA) – amendment to CERCLA
- 1989 Hazardous Waste Operations and Emergency Response (HAZWOPER)
- 1990 Pollution Prevention Act
- 1990 Oil Pollution Act of 1990 (OPA-90)

  Federal regulations were passed in response to the Exxon Valdez oil spill in Alaska
- 1990 Reauthorization of the Hazardous Materials Transportation Safety Act of 1975 (HMTUSA)
- 1992 First year mining industry death in the U.S. dropped below 100
- 1992 450 industrial fatalities related to confined space operations
- 1993 Permit-Required Confined Space Entry Regulations



1. HAZWOPER
2. MPRSA
3. OSHA
4. PRCS
5. RCRA
6. CERCLA
7. Clean Air Act
8. Clean Water Act
9. FIFRA
10. HAZCOM
11. SARA

Which Federal and State agencies perform the duties
that are described in the rectangles below?
Fill in the missing agencies in the blank circles below.



NIOSH
OSHA
DOL

AKOSH
EPA
USCG

DOT
ADEC
ADOL

Chapter 3

Hazards and Toxicology

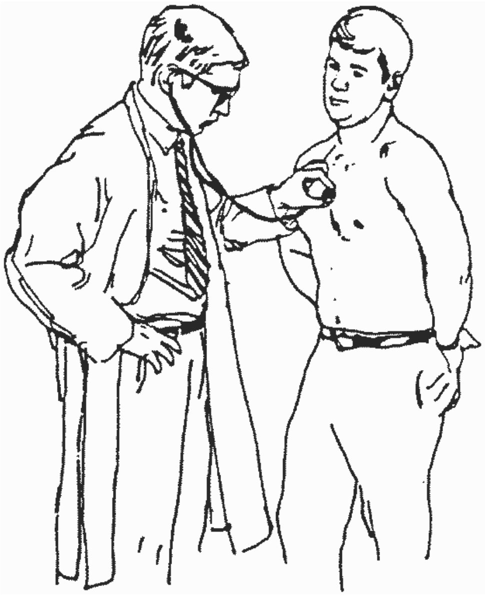
Chapter Objectives

Enable participates to:

- Recognize hazards, how exposures occur, the signs and symptoms of overexposure, and how humans react
- Understand chemical characteristics and physical hazards
- Understand toxicology, exposure limits and health effects
- List routes of entry and target organs affected by chemical substances and physical agents
- Know how to use Safety Data Sheets – SDS under Global Harmonization System (GHS) Physical Agent Data Sheets (PADs), the NIOSH Pocket Guide to Chemical Hazards, and the DOT Emergency Response Guidebook (ERG)
- Interpret hazard information from placards, labels, and marking systems

This unit is divided into four areas of hazard recognition and identification, and the effects to human beings exposed to them.

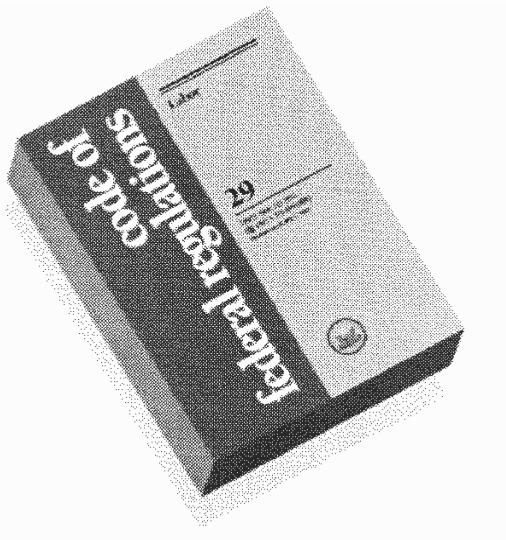
- Types of Hazards
- Chemical Health Hazards
- Chemical Physical Hazards
- Physical Agents and Other Physical Hazards



Types of Hazards

Agency Definitions

Various agencies that govern hazardous materials operations were reviewed in Chapter 2. The terms 'Hazard' and 'Hazardous' can have different definitions depending on the agency and the aspect of a particular environmental or employee health and safety issue. In general, Hazardous means; Toxic, Corrosive, Flammable, or Reactive. Several examples are listed below.



Hazardous Chemical – DOL OSHA/EPA

Chemicals which are a physical hazard or a health hazard during transportation, that are hazardous to people in the workplace or to the air, water, or ground in the community if released.

Hazardous Material – DOT

Materials capable of posing unreasonable risks to health and safety when transported in commerce, and are capable of doing harm to people, property, or the environment.

Hazardous Substance – EPA Reportable Quantity (RQ)

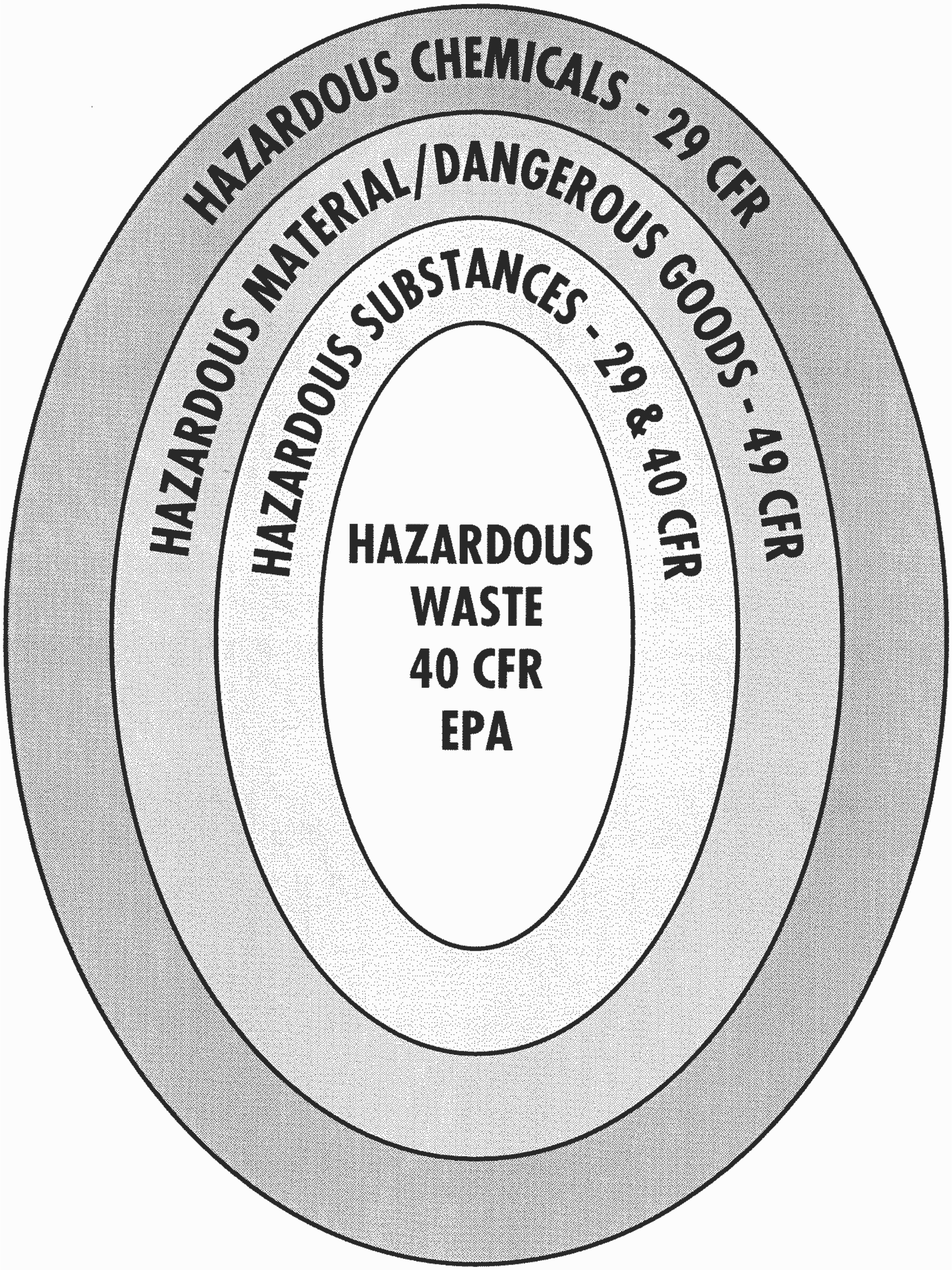
Any substance designated or listed below, which exposure to results, or may result, in adverse effects to the health or safety of individuals or the environment.

- Any biological agent and other disease-causing agent, which when released into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions, including malfunctions in reproduction or physical deformations in persons or their offspring.
- Any substance defined under section 101 (14) of CERCLA
- Any substance listed by the DOT as hazardous materials under 49 CFR 172.101 (DOT Hazardous Materials Table) and appendices and must be reported when spilled in that quantity
- Any hazardous waste as herein defined

Hazardous Waste – EPA

Those substances and materials that no longer have a commercial value. They cannot be rejuvenated, reclaimed, or recycled. As defined in 40 CFR 261 (Identification and listing of hazardous waste), a Solid Waste or combination of Wastes, Characteristic Wastes, or Listed Wastes, and/or Materials defined as Hazardous Wastes in 49 CFR 171.8 (Hazardous materials definitions and abbreviations).

Life of a Product



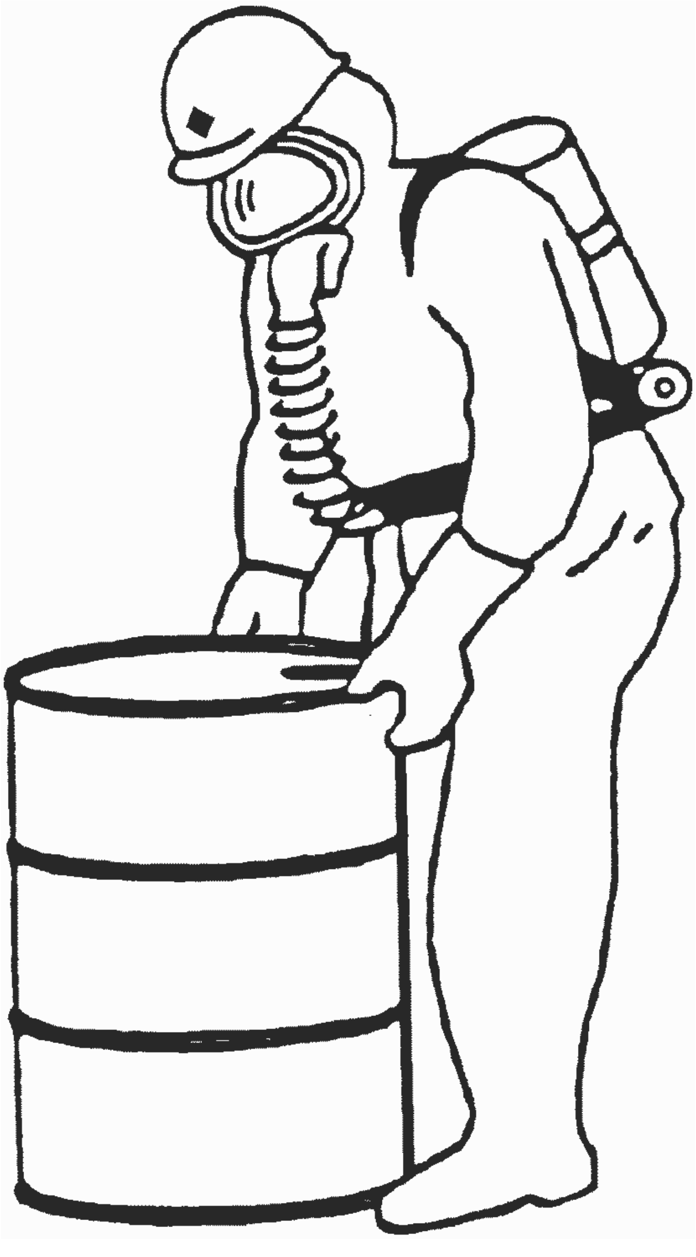
Types of Hazards Continued

Workers involved in hazardous waste operations may encounter a wide variety of hazards. Employees need to know how to recognize hazards and signs and symptoms of exposure in order to protect themselves, others, property and the environment. If workers understand hazards, how exposures occur and how the body reacts, they are better able to take appropriate actions to minimize their risk of exposure.

A hazard is anything that can cause injury, illness, adverse reaction or death to humans, property damage or contamination of property, and/or damage to the environment such as air, water, or ground.

There are four main categories of hazards found in the workplace:

- Chemical
- Physical
- Biological
- Radiological



Chemical Health and Chemical Physical Hazards

Chemical hazards are divided into two categories. They are **chemical health hazards or "health hazards"** and **chemical physical hazards or "physical hazards."** The term "health hazard" generally refers to chemicals that will affect workers from inside the body, while the term "physical hazard" generally refers to chemicals that will affect workers from outside the body. Some substances may present both health and physical hazards to an individual.

Chemical Health Hazard or Health Hazard

A chemical for which there is statistically significant evidence that acute (Rapid onset of symptoms) or chronic (Delayed onset of symptoms) health effects may occur in exposed employees. Health hazards include those substances which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, and nephrotoxins, agents which act on the blood or hematopoietic system, and agents which damage the lungs, skin, eyes, or mucous membranes.

Under the Global Harmonization System (GHS) any chemical that has a Health Hazard will have the new pictogram on the placard and label showing:

- Carcinogen (Cat 1A, 1B, & 2)
- Mutagenicity (Cat 1A,1B, & 2)
- Reproductive Toxicity (Cat 1A, 1B, & 2)
- Respiratory Sensitizer (Cat 1)
- Target Organ Toxicity (Cat 1 & 2)
- Aspiration Toxicity (Cat 1 & 2)

Separate from chemical physical hazards are **physical agents.**

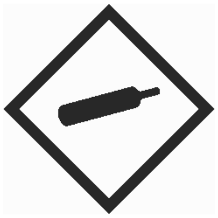
Physical Agents

A term for those agents of a non-chemical nature of an acoustic, electromagnetic, ergonomic, mechanical, and thermal nature as determined by the ACGIH to have harmful effects on workers above specific levels of exposure. Eight of the most common and those adopted by the State of Alaska Occupational Safety and Health (AKOSH) for enforcement in the workplace are: Heat Stress, Cold Stress, Noise, Hand-Arm Vibration, Lasers, Ionizing Radiation, Ultraviolet Radiation, Radio-frequency (Rf), and Microwave Radiation. The State of Alaska Department of Labor and Workforce Development, Labor Standards and Safety Division web site has the eight Physical Agent Data Sheets (PADS) available at: http://labor.alaska.gov/lss/pads/pads.htm. We have included them in the classroom HAZWOPER Reference materials also.

Biological Hazards

Some organisms are potential sources of health hazards which may arise from contact with them. Included are insects, invertebrates, mold, fungi, bacteria, viruses, parasites, some reptiles, amphibians, birds, mammals, and some plants. Alaskan examples include bear, moose and foxes which may carry the rabies virus and giardia or "beaver fever."

GHS Pictograms and their Corresponding Chemical Hazards

Name	Hazard	Name	Hazard
 **Exploding Bomb**	Explosive (Unstable, Divisions 1.1, 1.2, 1.3 and 1.4), Self-Reactive (Type A and B), Organic Peroxide (Type A and B)	 **Corrosive**	Corrosive (Skin Corrosion Categories 1A, 1B and 1C, Eye Corrosion Category 1), Corrosive to metal
 **Flame**	Flammable (Solids Categories 1 and 2, Liquids Categories 1, 2 and 3, Gases Category 1, Flammable Aerosols Categories 1 and 2), Self-Reactive (Type B, C, D, E and F) Pyrophoric, Self-heating, Emits Flammable Gas, Organic Peroxide (Type B, C, D and F)	 **Skull**	Acute toxicity (Categories 1, 2, and 3)
 **Flame over Circle**	Oxidizer	 **Exclamation Mark**	Irritant (Skin Irritation category 2 and eye Irritation Category 2A), Dermal Sensitizer (Category1), Acute Toxicity (Category 4, harmful), Target Organ Toxicity/STOT Category 3 = narcotic effects, respiratory irritation
 **Gas Cylinder**	Gas under pressure	 **Chronic Health Hazard**	Carcinogen (Categories 1A, 1B, and 2), Respiratory Sensitizer (Category 1), Reproductive Toxicity (Categories 1A, 1B, and 2), Target Organ Toxicity/STOT (Categories 1 and 2), Mutagenicity (Categories 1A, 1B and 2), Aspiration Toxicity (Categories 1 and 2)

Additional Pictograms

OSHA does not have jurisdiction over environmental hazards, and the following GHS pictogram will not be covered by OSHA. It may be covered by other agencies once those decisions have been made, and is provided for informational purposes.

 **Environmental Hazard**	Acute Aquatic Toxicity (Category 1), Chronic Aquatic Toxicity (Categories 1 and 2)

This is how Chemicals are Classified under the GHS and the Hazard Communication Standard (29 CFR 1910.1200(d))

There are 10 health hazard classes, each of which is divided in categories at 29 CFR 1910.1200 Appendix A-Health Hazard Criteria, which include:

1. Acute Toxicity, Categories 1-4 (with 1 being the most dangerous, 4 the least dangerous
2. Skin Corrosion/Irritation, Categories 1A, 1B, 1C, and 2
3. Serious Eye Damage/Eye Irritation, Categories 1, 2A, and 2 B
4. Respiratory or Skin Sensitization, Category 1A and 1B
5. Germ Cell Mutagenicity, Categories 1A, 1B, and 2
6. Carcinogenicity, Categories 1A, 1B, and 2
7. Reproductive Toxicity, Categories 1A, 1B, 2, and additional category for effects on or via lactation
8. Specific Target Organ Toxicity – Single Exposure (STOT-SE), Categories 1 – 3
9. Specific Target Organ Toxicity – Repeated or Prolonged Exposure (STOT-RE), Categories 1 and 2
10. Aspiration Hazard, Category 1

The 16 physical hazard classes and their associated hazard categories are defined at 29 CFR 1910.1200, Appendix B – Physical Hazard Criteria, and include:

1. Explosives, Divisions 1.1 – 1.6 (with 1.1 being the most hazardous, 1.6 the least hazardous)
2. Flammable Gases, Categories 1 and 2
3. Flammable Aerosols, Categories 1 and 2
4. Oxidizing Gases, Category 1
5. Gases under Pressure, 4 Groups including: Compressed gas, Liquefied gas, Dissolved gas, and Refrigerated liquefied gas

6. Flammable Liquids, Categories 1 – 4
7. Flammable Solids, Categories 1 and 2
8. Self-Reactive Chemicals, Types A – G
9. Pyrophoric Liquids, Category 1
10. Pyrophoric Solids, Category 1
11. Self-Heating Chemicals, Categories 1 and 2
12. Chemicals Which, in Contact with Water, Emit Flammable gases, Categories 1 - 3
13. Oxidizing Liquids, Categories 1 – 3
14. Oxidizing Solids, Categories 1 – 3
15. Organic Peroxides, Types A – G
16. Corrosive to Metals, Category 1

Radiological Hazards

Radiological hazards include: ionizing radiation from naturally occurring radioactive materials (NORM), Alpha and Beta Particles, Gamma Rays, X-rays and non-ionizing radiation from infrared, ultraviolet or microwave sources which include solar energy, welding, microwave dish, and electromagnetic field.

In order to understand how these chemicals interact with humans and the environment, a review of chemistry is needed.

Basic Chemistry

Chemistry is a science that deals with the study of the composition, structure, and properties of substances and of the transformations that occur when different substances are mixed, heated and/or exposed to extreme pressure or temperature.

Chemicals are made out of molecules, tiny particles way too small to even see without a microscope. There are many different kinds of molecules. Each kind is made out of a particular combination of atoms. An atom is the smallest particle of an element and there are more than 100 different kinds of elements that occur naturally on earth. When you talk about a chemical, you usually think of a pure substance made out of just one kind of molecule. One chemical compound you see in almost pure form every day is ordinary table salt. Each one of its molecules is made out of one atom of sodium and one atom of chloride. So, its name is sodium chloride.

Each element is described in its simplest form – the atom. Elements have abbreviations or symbols, as shown below in parenthesis, used to identify them. About three-fourths of elements are classified as metals.

Some examples are:

Aluminum (Al)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Gold (Au)
Iron (Fe)
Lead (Pb)
Manganese (Mn)
Mercury (Hg)
Nickel (Ni)
Platinum (Pt)
Potassium (K)
Sodium (Na)
Tin (Sn)
Uranium (U)
Zinc (Zn)

About one-fourth of the elements combine with metals. Some examples are:

Hydrogen (H)
Oxygen (O)
Chlorine (Cl)
Iodine (I)
Nitrogen (N)
Fluorine (F)
Bromine (Br)
Sulfur (S)

Elements (atoms) are the building blocks of chemical compounds. A combination of two or more elements is called a chemical compound. Compounds are grouped as either organic or inorganic compounds.

Organic Chemical Compounds

Any compound that contains carbon (C) is an organic compound. Many solvents (degreasing agents) are organic. Petroleum, coal, oils, vegetation, and animals are made of organic chemical compounds. Some examples of organic compounds are:

Benzene (C_6H_6)	Methyl alcohol (CH_3OH)
Carbon Monoxide (CO)	Carbon Tetrachloride (CCl_4)

Inorganic Chemical Compounds

Chemical compounds that do not contain a carbon (C) atom are inorganic. Examples include:

Water (H_2O)	Hydrochloric acid (HCl)
Ammonia (NH_3)	Asbestos (Hydrated mineral silicates)
Sulfuric Acid (H_2SO_4)	Sodium Chloride – Table Salt (NaCl)

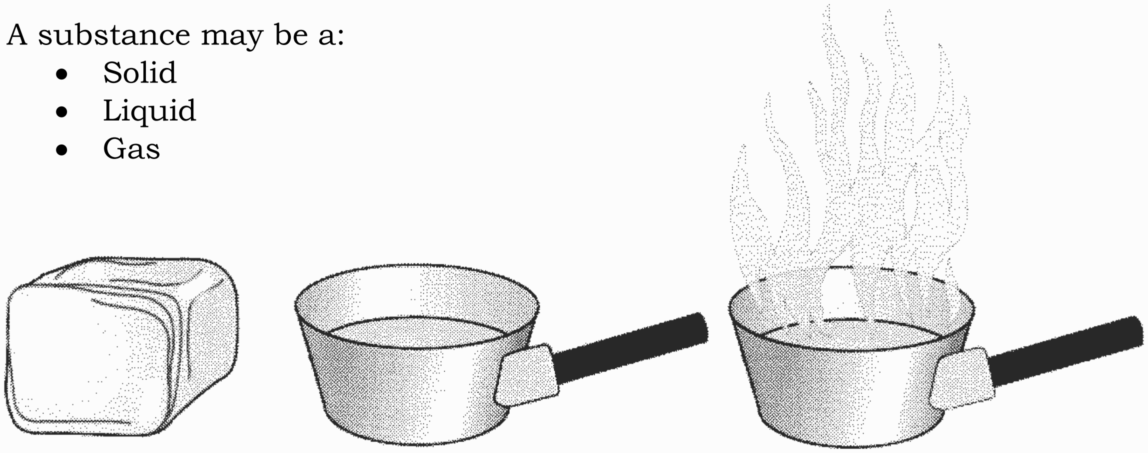
Chemical products (compounds) are generally identified by a trade name (manufacturers' name) rather than a chemical name and formula. Trade names can be found in a chemical dictionary, on Safety Data Sheets (SDS) and in the NIOSH Pocket Guide to Chemical Hazards.

Physical Form

The degree or intensity of the hazard associated with a material may change depending on its physical form. The same compound may be a solid, liquid or gas/vapor (molecules in the air). The amount entering the body will depend upon the form the substance is in and the route of entry.

A substance may be a:

- Solid
- Liquid
- Gas



Solid

The physical state of matter where the substance is in its most highly concentrated form having a specific size and shape.

Liquid

The physical state of a substance that is between a solid and a gas. A liquid is similar to a gas in that its molecules are relatively free to move about in its container with respect to other molecules. It is similar to a solid in that the volume of a given mass in its container remains nearly constant in spite of changes in pressure. Most liquids assume the shape of the container in which they are put and seek the lowest level.

Gas

The state of matter of a substance distinguished from the solid and liquid states by very low density and viscosity. The molecules are practically unrestricted by cohesive forces; forces that cause matter to stick together. Gases can expand and contract greatly in response to changes in temperature and pressure. They occupy the shape and volume of their container.

The term 'gas' is applied to those airborne molecules of a substance that will only be found in the liquid or solid state at very low temperatures, increased pressures or both. Gases in the solid or liquid state are cryogenic (Super cold) in nature regardless of their toxicity. Gasses occur at Standard Temperature and Pressure (STP), 60 ˚F, at normal atmospheric pressure of 14.5 psi. Oxygen, nitrogen and carbon dioxide are examples.

Vapors may be formed from a gas by increasing the temperature or pressure, but the terms are used interchangeably.

- **Vapor**

Describes the gas phase of a substance that is usually in the solid or liquid state at standard temperature and pressure. Often used interchangeably, but incorrectly, with the term 'gas'. Benzene, xylene and gasoline are examples of substances that give off vapors.

How Physical Form Effects Entry into the Body

An organic solvent such as acetone is liquid when a full container is stored at room temperature. Liquid acetone may be absorbed through the skin, especially if the individual has unprotected cuts or sores. If the container is opened, some will evaporate into the air. This vapor can then be inhaled. Vapor inhaled with air is quickly absorbed by the body.

Dry ice is frozen carbon dioxide. Solid carbon dioxide can cause severe skin damage from a cold burn. At room temperature carbon dioxide enters the air as a gas. High concentrations of the gas displace oxygen and could result in asphyxiation.

Terms Relating to Change of Physical Form

Boiling Point (BP)

The temperature at which a liquid changes into a vapor or gas.

Examples: Water 212° F (100° C)
Acetone 133° F
Chlorine -29° F

Freezing Point (FRZ)

Temperature at which a liquid or gas becomes a solid.

Example: Water changes to ice

Melting Point (MLT)

Temperature at which a solid becomes a liquid or gas.

Example: Ice left at room temperature changes to a liquid (water)

Sublime

Process where a substance passes directly from the solid to the gaseous state.

Example: Dry ice (CO_2) at room temperature changes to gas very rapidly

Chemical Health Hazards

Toxicology

Toxicology is the study of the effects of poisonous substances on humans, other organisms and/or the environment in general. Almost any substance can be toxic.

A toxin is simply a poisonous substance that is a specific product of the metabolic activities of a living organism and is usually very unstable, notably TOXIC when introduced into the tissues, and typically capable of inducing antibody formation. A poison or toxin is a substance which causes an adverse health effect in organisms.

The severity of the effect depends on several variables including:

- Individual susceptibility
    - Age
    - Gender
    - Heredity
    - Physical condition
    - Previous exposures
- Time or length of exposure
- Amount or concentration of toxin
- Route of entry
- Ambient conditions

    - Temperature
    - Humidity
    - Wind

Toxic Response

What is a **toxic response?** Below are some examples of toxic responses and how some bodies react to an exposure.

- Have you ever inhaled cigarette smoke? What reaction did you have?
    - Eye, throat and airway irritation; nausea; dizziness; coughing
- Do you, or someone you know, have an allergic reaction during 'ragweed' season?
    - A runny nose and red, watery eyes, sneezing, or congestion
- Have you ever drunk too much alcohol? What did you experience?
    - Slurred speech, dizziness or lack of coordination, happiness, sadness, nausea, "passing out," a hangover or headache?

Types of Exposure and Responses

Toxic chemicals can adversely affect the body in different ways depending upon the exposure. Exposures and responses fall into two categories: acute or chronic, based on concentration of the substance, exposure time and how quickly symptoms appear.

Acute Exposure

An acute exposure is generally a high concentration of a substance over a short period of time that usually causes an immediate response. An **acute response** is characterized by rapid onset of symptoms, frequently within 24 hours. After recovery, a person may not have any evidence of damage. Examples of an acute response include:

nausea
dizziness
coughing or breathing difficulty
irritation to the skin, eyes or lungs

If the chemical has good **warning properties** such as pungent odor or taste below the permissible exposure limit (PEL), an individual can recognize the possibility of an acute exposure and remove themselves from the area. The following are examples of both acute exposures and acute responses.

- Exposure to high levels of ammonia, which has good warning properties, would generally motivate an individual to leave the area, activate a ventilation system, or put on a respirator.
- On the other hand, hydrogen sulfide gas (H_2S) also has an excellent warning property. Below 1 ppm the sulfurous odor of rotten eggs can be detected significantly below the PEL. The problem arises as H_2S concentration increases. The gas 'deadens' ones sense of smell above a certain level, leading one to believe the gas has disappeared; potentially resulting in immediate unconsciousness or death as levels increase, because the gas paralyzes the respiratory system.

Chronic Exposure

A chronic exposure is generally long-term, low concentration, repeated exposures to a substance which may take days, months or years to produce a response. A **chronic response** is characterized by a delay from onset to exposure or by a low level, long-term exposure.

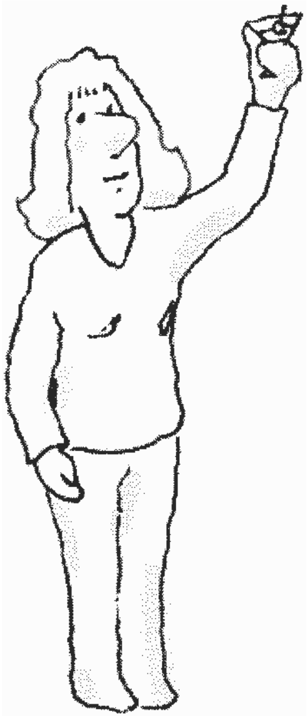
Chronic exposures may not seem to be having a negative effect, but may be causing injury at levels not detectable to the victim. An example of chronic exposure and response is the development of severe anemia after several years of exposure to low levels of benzene. Other examples include:

Chronic Exposure	Chronic Response
asbestos	asbestosis, lung cancer
benzene	central nervous system effects, leukemia, anemia
solvents	liver cirrhosis, kidney damage, skin damage, central nervous system effects
phosgene	emphysema

Historically, acute exposures were thought to produce acute effects and chronic exposures, chronic effects. This is not always the case. Asbestos-associated cancers can develop 20-40 years after either limited or high-level exposure. **Exposure limits** are set to help prevent both acute effects and chronic disease.

Dose-Response Relationship

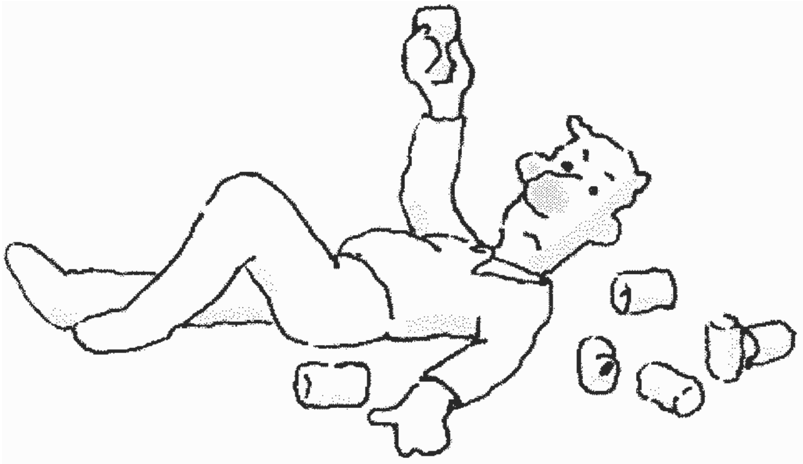
The relationship between 'dose' and biological response is one of the basic principles of toxicology. Many of the compounds in our daily lives are relatively harmless, but can become very toxic if exposure levels or exposure conditions change. Substances such as zinc, copper, potassium, selenium, and manganese are essential for good health. They are included in small quantities in a balanced diet, but these same substances can be highly toxic at high concentrations.



The higher the <u>dose</u>, the greater the <u>response.</u>

The toxic effect of a substance is determined either when variable amounts of the material are administered to test animals to achieve response results, or when effects of a toxic material are observed and measured on humans. The resulting test data is used to prepare a dose-response curve.

- If 30 people were each given 12 alcoholic drinks, when 15 people ‘passed out,’ there could be somebody who would not appear to be drunk. Each person has his/her own **dose response** to chemicals. Individual factors affect an individual’s response to a toxic chemical.
    - Age
    - Gender
    - Heredity
    - Body weight
    - Personal habits
    - Physical condition
    - Ability to assimilate



Dose-Response Graph:

T Passing Out ________________________________

I Nausea ________________________________

M Dizziness ________________________________

E Slurred Speech ________________________________

____

2 4 6 8 10 12

(Drinks)

LD_{50} and LC_{50}

LD stands for "Lethal Dose". LD50 is the amount of a material, given all at once, which causes the death of 50% (one half) of a group of test animals. The LD50 is one way to measure the short-term poisoning potential (acute toxicity) of a material.

Toxicologists can use many kinds of animals but most often testing is done with rats and mice. It is usually expressed as the amount of chemical administered (e.g., milligrams) per 100 grams (for smaller animals) or per kilogram (for bigger test subjects) of the body weight of the test animal. The LD50 can be found for any route of entry or administration but dermal (applied to the skin) and oral (given by mouth) administration methods are the most common.

LD_{50} and LC_{50} are the units used to report the toxicity of a substance. They provide safety professional and employees with an idea of the level of toxicity so that appropriate protective measures can be taken.

To establish the **lethal dose (LD)** of a substance, a material is administered **orally** or **dermally** to test animals. It is increased or decreased until the range of response is found. At the lower dose, all the animals will survive and at the upper concentrations, all the animals will die. At intermittent doses, some, but not all of the test animals will die. The dose at which 50% of the test animals die is called the LD_{50}. Doses are expressed in terms of quantity of test substance per unit of body weight of the test animal such as milligrams per kilogram (mg/kg) or parts by volume of contaminants per million parts of air (ppm).

LC stands for "Lethal Concentration". LC values usually refer to the concentration of a chemical in air but in environmental studies it can also mean the concentration of a chemical in water.

For inhalation experiments, the concentration of the chemical in air that kills 50% of the test animals in a given time (usually four hours) is the LC50 value.

Doses are expressed in milligrams of contaminants per cubic meter of air (mg/m3), or (in the case of asbestos) number of fibers per cubic centimeter of air (fibers/cc).

Measurements of Concentration

Concentration is the amount of a substance contained in a certain volume of relative material. Concentration of gases and vapors is usually measured in parts per million (ppm). Concentration of particulates, dusts and mists are usually measured in fibers per cubic centimeter (f/cc).

- 10,000 ppm is 1 % atmospheric concentration
- One ppm is equal to 1 teaspoon in 1,300 gallons
- A cc is about the size of a sugar cube

Routes of Entry

The way a harmful substance enters the body is called the “route of entry.” There are four routes of entry. In the Exposure Routes (ER) section of the NIOSH Pocket Guide to Chemical Hazards chemical tables; they refer to CON meaning Skin and/or eye contact, but it is referred to as absorption in most other documents.

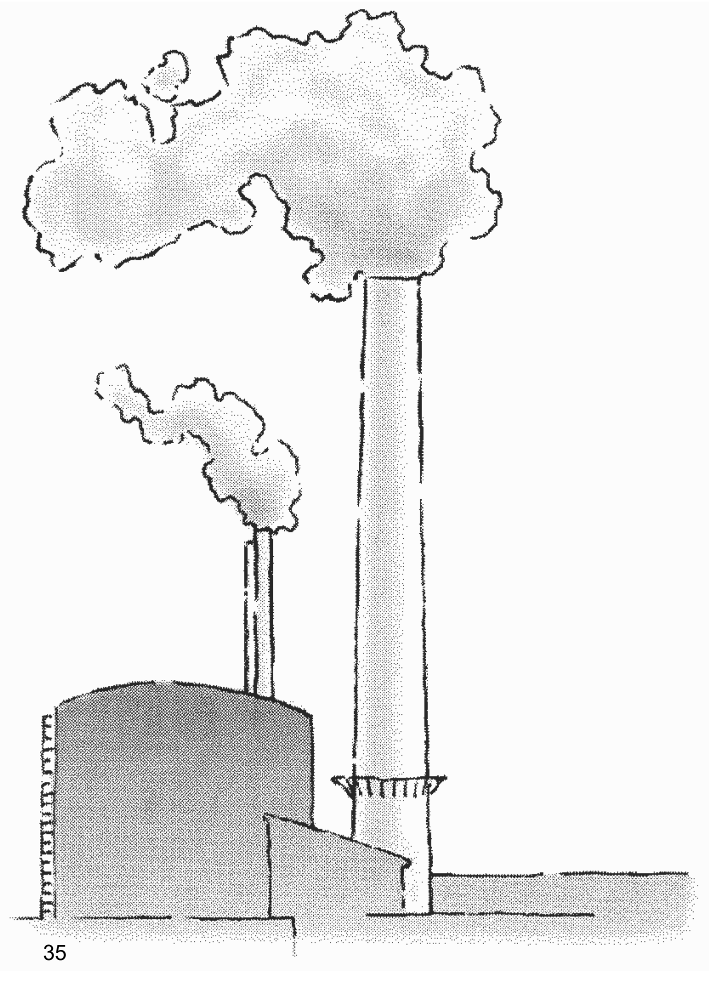
- Inhalation
- Absorption
    - CON – NIOSH
- Ingestion

NIOSH does not use the term:

- Injection

Inhalation

Inhalation is the most common route of entry. **Inhalation is generally viewed as the primary route of acute exposure.**



As we breathe, we take into our bodies what is in the surrounding air.

The respiratory system is an air pump that has a basic function to supply the body's cells with a continuous supply of oxygen, as well as rid the body of the metabolic byproduct, carbon dioxide. At rest, an average-sized person breathes approximately 8 liters of air per minute. This amount increases as muscular activity increases. Therefore, in a single day, one inhales an enormous amount of air.

The basic structure of the lungs is fairly simple, consisting of two structures; bronchial tubes, and air sacs or alveoli. The alveolar tissue in the lungs is estimated to have between 750-1100 square feet of surface area. This tissue is extremely thin (2 cells thick) to allow for efficient gas exchange. This delicate tissue is the only barrier between inhaled toxic vapors and gases and the circulatory system.

The basic function of the lungs is relatively simple. Oxygen from the air is distributed through the bronchial tube system to each of the millions of alveoli. Oxygen and other airborne molecules diffuse along pressure gradients from the alveoli through extremely thin capillary walls, where oxygen molecules combine with hemoglobin in red blood cells. Carbon dioxide molecules move along pressure gradients in an opposite direction: that is, from capillary blood into the alveolar gas, which is then exhaled out of the lung, and gas exchange occurs. Virtually any gas or vapor can enter the unprotected body through the respiratory system.

Gaseous Contaminants

Types of gaseous contaminants are:

Gas

A substance characterized by very low density and viscosity compared with liquids and solids. The molecules are practically unrestricted by cohesive forces. Gases can expand and contract greatly in response to changes in temperature and pressure. They occupy the shape and volume of their container. The term 'gas' is applied to those airborne molecules of a substance that will only be found in the liquid or solid state at very low temperatures, increased pressures or both.

Vapor

Describes gaseous substances formed from a substance which is usually in the solid or liquid state at standard temperature and pressure. Often used interchangeably, but incorrectly, with the term 'gas'.

Particulate Contaminants

Types of particulates are:

Dust

Airborne solid particles, ranging in size from 0.1 to 25 microns, generated by physical processes such as handling, crushing or grinding of solids.

Fiber

Fibers are solid particulates that are three times longer than wide.

Fumes

Minute airborne solid particles created by heating a solid body to the point of vaporization and then cooling. Fumes are often produced by heated metal operations, such as welding, soldering, melting or smelting.

Mist

A suspension of very fine liquid droplets in air.

Smoke and Exhaust

A mixture of gases, vapors, fumes, and small solid particles of carbon or soot resulting from combustion or material. Composition is based on substance(s) being burned, combustion and temperature.

Biological Airborne Organisms

When harmful substances are inhaled, they may either be deposited in the lungs or cross into the bloodstream along with oxygen. Inhaled dusts and fibers are caught in the nose and airways and are normally moved out of the nose and airways on an 'up escalator' made of hair-like cilia and mucus, and then swallowed. If the 'escalator' becomes damaged, workers will keep more of the particles in their lungs.

Examples of inhalations hazards and their associated diseases:

Dust/Fumes	Associated Disease
Silica (sand)	Silicosis
Asbestos Fibers	Asbestosis, Mesothelioma & Cancers
Arsenic	Lung Cancer

Absorption (Contact)

Skin is also a major route of exposure. The skin is the body's largest organ, with an area of about 3,000 square inches for an average size person. Since skin is the largest and most exposed part of the body, it often receives the most contact with contaminated environments. Skin is composed of several layers of cells and protective fats and oils. Skin generally offers an effective barrier, but some substances can pass through skin into the bloodstream. Additionally, breaks in the skin from cuts or abrasions may permit direct entry into the body.

Skin absorption is generally more common than ingestion of the same toxic material. An ingested toxic material may move from the digestive tract to the liver where it is then detoxified; however, if the same material is absorbed directly through the skin, it may go directly into the bloodstream, bypassing the liver, and may cause damage to susceptible cells.

Skin absorption is a major route of entry for many hydrocarbons, halogenated hydrocarbons, and organic amines. Substances such as solvents and insecticides can be absorbed through the intact skin directly into the body. These compounds include many common solvents and pesticides used in industry.

Examples of materials that present skin absorption hazards

Hydrocarbons	Halogenated Hydrocarbons	Organic Amines	Non-Organics
Benzene	Aldrin	Acetonitrile	Calcium Arsenate
Cresol	Carbon Tetrachloride	Acrylonitrile	Hydrofluoric Acid
Toluene	1,1,2-Trichloroethane	Cyanides	Mercury
Xylene	PCBs	Parathion	Selenium Compounds

An agricultural worker in California received a fatal dose of the pesticide parathion. He had proper respiratory protective equipment and protective clothing, but allowed the wristlets of his gloves to become contaminated. This limited but prolonged contact resulted in a lethal dose of the pesticide being absorbed through the skin.

Human skin in different areas of the body absorbs chemicals at different rates. Skin thickness ranges from approximately 0.5 mm on the eyelid up to 4 mm on the palm of the hand and sole of the foot. Below is a comparison between the rate of absorption of chemicals through the skin in different parts of the body to the rate of absorption through the skin of the foot.

Area of the Body	Times Greater Than Absorption Through the Foot
Foot	1
Hands	5-10
Arms	10-15
Scalp and forehead	34-36
Scrotal Skin	300

NIOSH Pocket Guide to Chemical Hazards

The NIOSH Pocket Guide to Chemical Hazards is useful for identifying chemical and physical properties, protective equipment and known health hazards for workers.

The Roman numeral pages in the front of the guide explain how to use the information. Substances are listed in the Chemical Listing section in alphabetical order along the far-left margin. Several columns in the Chemical Listing use tables of codes and abbreviations to cross reference, clarify or expand information shown in the column. Tables of codes and abbreviations are defined in the Roman numeral pages as well.

NIOSH Example Exercise: Students to use a job related chemical or use:

Find the chemical: **Ethyl Ether**______________________________

Chemical Name____

Structural Formula_____________________________________

CAS____

RTECS____

ID Number____

ERG Guide____

Contact (NIOSH)

NIOSH indicates skin and eye contact as ‘Contact (CON)’. Some types of chemicals can produce toxic effects with skin or eye contact alone and never actually enter the body. Chemicals which attack the skin directly are broadly defined as irritants or corrosives. Severity of injury may range from mild dermatitis to blindness from eye exposure to acids or bases.

Ingestion

Ingestion is a less common but important route of entry. Chemicals can be ingested through the mouth and swallowed when eating, drinking or smoking. Materials that are eaten or drunk enter the stomach and are absorbed into the bloodstream mainly in the small intestine. Ingestion may also occur as a result of breathing in contaminants which then travel to the throat during coughing. Toxic particles are cleared from the nose and lung in mucus. The mucus is swallowed and moves through the stomach and intestines.

Industrial exposure to harmful substances through ingestion usually occurs when workers eat, drink, smoke, or take medication in a contaminated work area. Workers in smelters and battery plants have received significant lead exposures from storing and consuming food in lead contaminated atmospheres. Don’t eat, drink, smoke, or apply cosmetics in a contaminated area. Never carry cigarettes or cosmetics into contaminated areas.

Injection

Injection occurs when an individual has a cut or abrasion through the skin that may provide a direct entry of the substance into the body. A chemical can be accidentally injected into the body by a worker who gets injured by a tool, a ruptured hydraulic or compressed air/gas line, a fall or a sharp object.

Exposure Limits

An exposure limit is the maximum amount of chemical substance or physical agent to which workers may be exposed without developing adverse health effects. Most individuals can be exposed to this limit for their entire working lifetime.

Enforceable exposure limits are set by OSHA and are known as Permissible Exposure Limits (PEL’s). Organizations such as National Institute of Occupational Safety and Health (NIOSH) has Recommended Exposure Limits (REL’s) and American Conference of Governmental Industrial Hygienist (ACGIH) has Threshold Limit Value’s (TLV’S) and have established **published exposure limits** which are used as guidelines and recommendations. OSHA has also used Threshold Limit Values (TLV’s) from ACGIH for enforcement of the General Duty Clause, for known chemical hazards where no OSHA PEL exists. In other words, published exposure limits may become legally enforceable in the absence of OSHA limits.

Permissible Exposure Limits (PELs) – OSHA

Permissible exposure limits (PELs) are specified by OSHA in 29 CFR 1910.1000, Table Z-1. AK OSH PELs are itemized in Title 8, Alaska Administrative Code, Chapter 61 in Table Z-1-A. Many state PELs are more stringent then the PELs found in the federal OSHA code.

Recommended Exposure Limits (RELs) – NIOSH

Recommended exposure limits (RELs) are set by NIOSH. RELs are NIOSH's designation of the highest concentration that 95% of workers could be exposed to and not show signs or symptoms of overexposure. An REL is a TWA concentration based on a 10-hour workday during a 40-hour workweek. If OSHA does not publish a PEL, then the NIOSH REL is used and enforced if there is one.

Threshold Limit Values (TLVs) – ACGIH

These are recommended exposure levels documented and published annually by ACGIH for approximately 800 chemical substances and physical agents. TLVs are used worldwide for controlling workplace hazards. If a TLV is exceeded, a potential hazard is presumed to exist. If neither OSHA nor NIOSH publish a PEL or REL, then ACGIH's TLV is used and enforced.

Because of individual susceptibility and wide variations in responses, a small percentage of workers may experience discomfort from such substances and concentrations at or below the threshold limit. An even smaller percentage of individuals may be affected more seriously by aggravation of a preexisting condition or by development of an occupational illness.

Exposure limits are averaged over a specified period of time, and usually presented as a time-weighted average (TWA).

Time-Weighted Average (TWA)

This is the concentration of a material to which a person may be exposed, averaged over the total exposure time. PELs, RELs and TLVs may be presented as time-weighted average (TWA). The TWA concentration is based on an 8-hour workday for OSHA and ACGIH, and a 10-hour workday for NIOSH, but a 40-hour week for all three averages. Some PELs, TLVs and TWAs have a 'skin' description, which means that the material is readily absorbed through the skin.

In addition to the 8-hour TWA, two other exposure limits are used by OSHA, NIOSH and ACGIH. They are short term exposure limit (STEL) and ceiling (C) concentration.

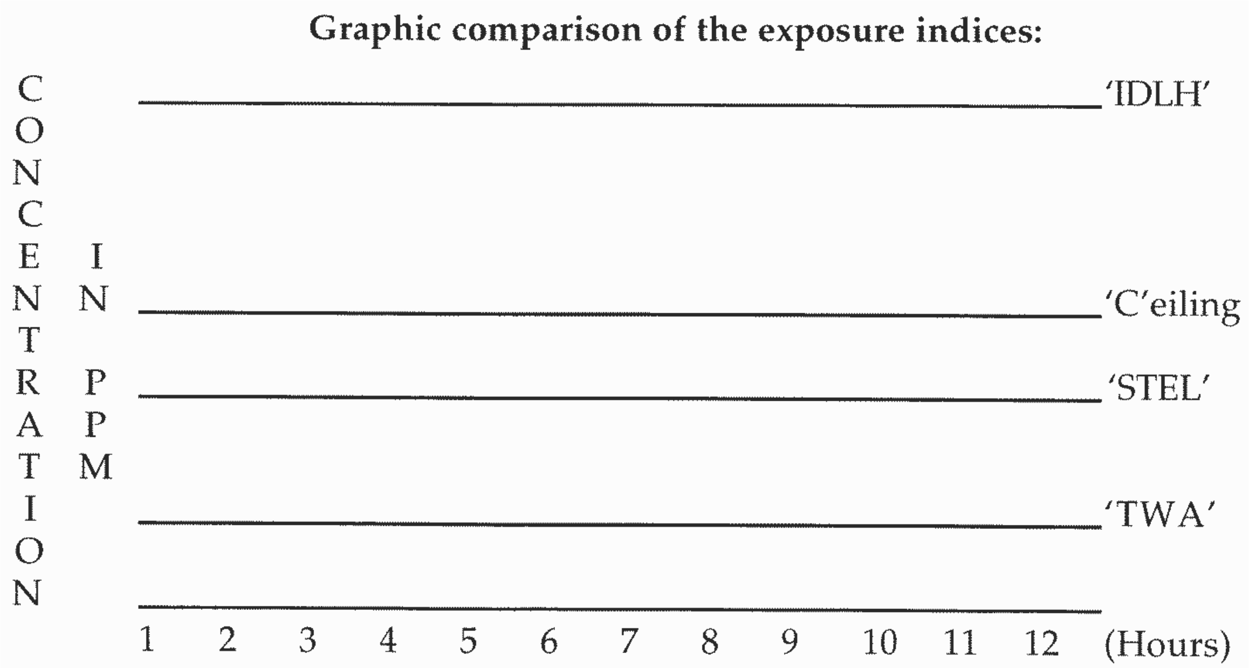
Short Term Exposure Limit (STEL or ST)

A STEL is a 15-minute TWA maximum concentration exposure which should not be exceeded at any time during a work day, even if the 8-hour TWA is below the threshold limit value. Exposures at the STEL should not exceed 15 minutes, and should not be repeated more than four (4) times per day unless otherwise noted. There should be at least sixty (60) minutes of zero concentration of substance between successive exposures at the STEL to give the body time to eliminate the concentration of the substance.

Most workers will not suffer from irritation, chronic or irreversible tissue change or narcosis of sufficient degree to impair self-rescue or reduce work efficiency; provided that the daily TWA is not exceeded. It is not a separate independent exposure limit, rather it supplements the OSHA, NIOSH, or ACGIH limit where there are recognized acute effects from a substance whose toxic effects are primarily of a chronic nature. STELs are recommended only where toxic effects have been reported from high, short-term exposures in either humans or animals.

Ceiling Limits (C)

Ceiling is the maximum concentration of a substance that should not ever be exceeded, even instantaneously, or signs and symptoms of over-exposure may become evident.



Graphic comparison of the exposure indices:

Immediately Dangerous to Life or Health (IDLH)

One final exposure index used by OSHA and NIOSH is the Immediately Dangerous to Life or Health (IDLH) level (NIOSH Pocket Guide page ix – x). This concentration represents a maximum level from which one could escape within thirty (30) minutes without any escape-impairing symptoms or any irreversible health effects. It is listed in either ppm for vapors or mg/m^3 for suspended solids.

IDLH concentrations are set to help avoid severe acute effects. An acute exposure can cause death. Check the NIOSH Pocket Guide to Chemical Hazards for IDLH levels and acute side effects for chemicals of concern. Many Permissible Exposure Limits (PELs) and Threshold Limit Values (TLVs) have been set to prevent other acute effects, such as eye or skin irritations.

Acute Exposure	IDLH	Acute Response
benzene	500 ppm	central nervous system effects dizziness, drowsiness
formaldehyde	20 ppm	airway spasms; irritation of eyes, nose and throat
phosgene	2 ppm	pulmonary edema (water in lungs)

(carbonyl chloride)	2-4 hours after exposure, death

Health Effects

A toxin takes one or more of a combination of four actions once it enters the body:

Distribution

Once a chemical enters the body, the extent of distribution depends on the chemical itself and its physical properties, especially if it is water soluble. Chemicals that are not water soluble can easily penetrate the lipid (fat) based cell membranes and enter the **target organs**.

Storage

Many chemicals that are not water soluble accumulate in body tissues and may stay there a long time (e.g., lead, which is stored in bone).

Metabolism

A chemical may be transformed into products that may be more or less toxic than the original substance through biochemical reactions in the body.

Excretion

Chemicals that are either water soluble or metabolized to water-soluble products are easily excreted.

Local and Systemic Effects

Local Effect

A local effect occurs at the point of contact with the skin, eyes, nose, throat, and airways. The effect occurs in the tissue where the contact occurred.

- Lye or Acid burns skin or eyes, and Chlorine or Ammonia irritates nose and/lungs, as well as causing eyes to water.

Systemic Effect

Systemic effects occur when a substance enters the body through one system, is distributed throughout the body and produces a response in another organ or system.

- The route of entry of a solvent such as xylene may be through the skin or lungs, but the substance affects another organ. A toxic gas such as hydrogen cyanide is inhaled, but the exposure affects the use of oxygen in the muscles and organs. If the heart or brain can't use or receive oxygen, one dies in minutes. The part of the body which is affected by the exposure is called the **target organ.**

Synergistic Effects

Chemical and physical agents sometimes interact to produce a greater toxic effect than the effect of the sum of the part combined. 1 + 1 = 6.

- Exposure to asbestos and cigarette smoke together increased the frequency of cancer developing by **more than 100 times** than exposure to either asbestos or cigarette smoke alone

Target Organs

Chemical and physical agents usually exert their harmful effects on specific organs of the body such as the lungs, liver, kidneys, central nervous system, reproductive system or skin. The mechanism and characteristics of the chemical's toxicity determine which organ it targets. In addition, various organ systems of the body respond to chemical exposure in different ways.

For example, many toxic substances travel through the blood but damage other body parts – the nervous system, liver or kidneys. Lead usually enters the body through the lungs, and can damage almost every part of the body.

Skin

The skin is the largest organ of the body by weight. It is composed of three layers, the upper, or epidermis where skin cells are made, the middle, or dermis where there are lots of blood vessels and the lower or subcutaneous which is a fatty tissue and barrier between skin and muscles and other tissue. It takes approximately five minutes for water to be absorbed through each layer of skin, so most first aid measures on the SDS for chemical skin exposure are to flush with water for at least 15 minutes.

Skin has approximately 20 square feet of surface area for potential contact with foreign substances in the environment. The skin is a sensory organ and cover protecting the body from external elements and helping to regulate body temperature.

Defense Mechanism

The structure of skin is protective because of its thickness, resiliency and its capacity to inhibit entrance of water and water soluble chemicals. Its thickness and elasticity protect underlying muscles, nerves and blood vessels. In addition, its color and thickness protect the body from sunlight and other forms of physical energy. Terms used in conjunction with chemicals that cause skin injury are:

- Corrosives
- Irritants

Corrosives

Corrosives produce visible destruction or irreversible alterations in living tissue at the site of contact.

Irritants

Irritants, that are not corrosives, produce inflammation in living tissue. Irritants are subdivided into three groups based on their mode of action.

- Primary
- Secondary
- Sensitizers

Primary irritants produce adverse reactions at the site of contact. They exert little or no systemic effects.

Secondary irritants do not produce irritation at the initial site of contact, but produce systemic effects from absorption.

Sensitizers produce little or no response from initial contact, but on subsequent exposures can produce serious reactions. Even minute exposures can generate extreme reactions. The body's immune system becomes "sensitized" much the same as an individual who has an allergic reaction to a bee sting. The original bee sting may not cause a reaction; however, future bee stings can be fatal.

Sensitizers, such as epoxy resin hardeners, may produce dermatitis. Others, such as Methylene Bisphenyl Isocyanate (MDI), can produce a severe respiratory sensitivity.

Absorption of Materials

Absorption through skin can occur in different manners, such as when its continuity is disrupted by an abrasion, laceration or a puncture. Absorption of fat-soluble chemicals or solvents can occur via hair follicles. Some substances such as organophosphates are absorbed directly through the skin.

Dermatitis

Dermatitis is inflammation of skin. An understanding of how dermatitis can occur will enable employees to understand how to protect their skin. Additionally, early recognition of a problem may help to assure that it does not become disabling.

Causes of Dermatitis

The direct causes of occupational dermatitis are: chemicals, mechanical trauma, physical agents, and biological agents.

- **Chemicals** act as primary irritants, allergic sensitizers, or photo sensitizers. A primary irritant is a substance, which if permitted to contact skin in sufficient concentration for a long enough period, will produce an effect. Nitric acid is an example of a chemical irritant.
    - Fats and oil solvents such as organic solvents can dissolve the fatty layer of skin so it can no longer maintain its water holding capacity
    - Oils and greases stimulate skin and can act as a primary irritant. This can result in a rash or, if prolonged and frequent contact occurs, unusual growth patterns
- **Mechanical Trauma** such as repeated friction or pressure can result in abrasions or calluses and then in debilitating injuries.
- **Physical Agents** such as heat, cold, sunlight, or ionizing radiation can also result in skin damage such as burns or frostbite. Sunlight exposures may also result in skin cancer or melanoma.

Prevention

The primary methods for preventing skin disease include knowledge and application of appropriate engineering controls, well designed work practices, personal hygiene, protective clothing, and barrier creams.

- **Engineering controls** are designed into the workplace to minimize skin contact with offending agents.
- **Work practices** establish routines that minimize contact by avoiding spills, clothing contamination and contamination of work surfaces.
- **Personal hygiene** is as simple as frequently washing. Use of clean, uncontaminated clothing helps reduce exposure.
- **Clothing and barrier creams** create an effective barrier between the irritating agent and skin.

Eyes

It is obvious that direct injury to the eye is a potential hazard. However, in addition to splashing chemicals onto the eye's surface, several blood-borne toxic agents can have a selectively harmful effect on some component of the visual system. The visual system is complex with various structural elements involved.

Cornea

The outermost layer of the eye, in direct contact with the environment, is the most vulnerable to contact injury.

Lens

Exposure to naphthalene can cause cataracts (opacity of the lens). Some metals such as copper, silver and mercury can mildly discolor the lens.

Retina

Retinal hemorrhage can be caused by exposure to lead compounds (especially the volatile lead alkalis found in gasoline), arsine and benzene.

Optic Nerve

Damage here may be expressed as a narrowing of the visual field or loss of acuity in the central visual area. Methanol (methyl alcohol), a widely used industrial solvent, can cause blindness by damaging this nerve bundle. Exposure to certain chemicals may also lead to intraocular pressure increase (glaucoma, which ammonia can cause) and diplopia (double vision) involving dysfunction of muscles regulating eye movement sometimes caused by lead, ethanol (ethyl alcohol), carbon monoxide, carbon disulfide, methyl chloride, and methyl bromide.

Nervous System – Neurotoxin

The nervous system is made up of cells called neurons that die quickly when sufficiently deprived of oxygen. Thus, inadequate oxygen provided to the brain kills brain cells within minutes. Some cells may die before oxygen stops completely. Because of their need for oxygen, nerve cells are readily affected. Some agents like parathion and Malathion™, actually affect nerve impulses which control heartbeat and breathing. Other agents, like carbon disulfide and formaldehyde are nervous system depressants. These chemicals slow down, but do not block, transmission of nerve impulses. The odorless, colorless, tasteless gas carbon monoxide produces early symptoms such as headaches, nausea and dizziness. Continued exposure causes muscle weakness, unconsciousness and death. Because carbon monoxide acts quickly to rob the body of oxygen by attaching to hemoglobin in red blood cells before oxygen can, immediate diagnosis and first aid are vital.

Some compounds damage neurons or inhibit their function through specific action on parts of the cell. The major symptoms from such damage may include dullness, restlessness, muscle tremor, convulsions, or loss of memory. Common examples of substances causing these effects are lead, carbon disulfide, n-hexane, and methyl butyl ketone. Agents preventing nerves from producing proper muscle contraction potentially resulting in death include dichlorodiphenyltrichloroethane (DDT is a pesticide banned in 1972) and lead.

Liver – Hepatotoxin

The liver performs an enormously important job of changing toxins into chemical forms that can be eliminated by the body. When a foreign substance enters the body, the liver may change that toxic substance into a more toxic substance in its attempt to break the chemical into usable substances. Liver injury depends on the chemical and duration of exposure. In the early stages, liver damage can be easily detected with blood tests. Later, however, more severe symptoms of damage can be liver enlargement and jaundice.

Liver injury caused by chemicals has been recognized as a toxicological problem for hundreds of years. Examples of liver toxins include carbon tetrachloride, chloroform and arsenic. Some compounds don't necessarily kill liver cells immediately, but instead, cause the liver to be more susceptible to disease. These substances include carbon tetrachloride, alcohol, vinyl chloride, arsenic, and lead.

Kidneys – Nephrotoxins

The primary function of kidneys is removing wastes from the body. If this function is damaged, there will be a buildup of waste products in the blood. These wastes can eventually cause death. Kidneys constitute one percent of the body's weight, but receive 20 to 25 percent of the blood flow (during rest). Thus, large amounts of circulating toxicants reach kidneys quickly. Like the brain, kidneys have high oxygen and nutrient requirements because of their work load. While a number of materials which are toxic to kidneys cause acute and chronic kidney and urinary bladder diseases, it is difficult to detect ongoing symptoms of kidney damage. However, medical tests for urinary protein levels can detect problems. Chronic diseases happen gradually, leading to scarring and irreversible loss of kidney function. Heavy metals produce cell toxicity. Heavy metals (including mercury, chromium, arsenic, gold, cadmium, lead, and silver), and high levels of aspirin are readily concentrated in the kidneys, making this organ particularly sensitive.

As kidneys filter compounds that contain chlorine, fluorine, bromine, or iodine out of the blood and attempt to break them down, toxic metabolites are generated (similar to the function performed by the liver). Other toxicants to the kidneys include carbon tetrachloride, chloroform, carbon disulfide and ethylene glycol.

Blood – Hemotoxic or Hematopoietic Toxin

The blood system is damaged by agents that affect blood cells or their production. It is susceptible to cancer-causing agents as blood cells multiply and regenerate.

Examples of agents that affect blood cell production include benzene, which decreases production of red or white blood cells and may lead to Leukemia. Cyanide, carbon monoxide and hydrogen sulfide, effects the nervous system, thus preventing the lungs from working, ultimately eliminating blood's ability to supply oxygen to tissues.

Lungs – Pulmonary or Respiratory Toxin

Lung function and respiratory toxicity are explained in detail under 'Routes of Entry – Inhalation,' of this section. Some substances disrupt lung function causing asphyxiation, or cause insufficient oxygen in an atmosphere. Complications such as pulmonary edema (an abnormal infiltration and excess accumulation of fluid in the lungs) can occur as the body responds to irritation in the lungs.

Asphyxiants

Asphyxiants are gases that cause tissue hypoxia. They are materials which express their toxic action on the body by depriving the tissue of oxygen. Asphyxiants are classified as either simple or chemical.

Simple asphyxiants are physiologically inert gases which simply displace available oxygen. A simple asphyxiant is a substance which causes suffocation by reducing the amount of oxygen available in the atmosphere for gas transfer in the lungs. These gases do not exhibit toxic properties themselves, but at high concentrations, can exclude available oxygen causing death through asphyxia. Simple asphyxiants include:

- Carbon Dioxide (CO_2)
- Nitrogen (N_2)
- Helium (H_e)
- Methane
- Ethane
- Argon

Chemical asphyxiants

Chemical asphyxiants interfere with oxygen transport system and cellular respiration and thereby cause tissue hypoxia. They are substances that interfere with biological processes needed to transfer oxygen to the tissues. Chemical asphyxiants exert their toxic effects at exposure levels far below those of simple asphyxiants.

- Carbon monoxide and cyanide compounds are examples of two historically significant chemical asphyxiants. Carbon monoxide (CO) binds with the blood's oxygen carrying hemoglobin so that normal oxygen transport is not possible. Exposure to CO results in a blue discoloration of the body called cyanosis.
- Cyanide interferes with the enzyme system necessary for the transfer of oxygen from the blood to the body's tissues. Exposure to cyanide results in a flushing or cherry red coloration.
- Other chemical asphyxiants include: aniline, nitrobenzene and hydrogen sulfide.

Oxygen Content

Dry Air is composed of approximately 20.95% oxygen and 78.08% nitrogen, along with 0.93% argon and 0.04% other. Oxygen content can be either deficient or enriched.

- Oxygen deficient atmosphere <19.5% oxygen in an environment
- Oxygen enriched atmosphere >23.5% oxygen in an environment

Oxygen Deficient Atmosphere

Oxygen deficiency can occur if:

- Oxygen is “used up” during oxidation, as it combines with other elements as fire burns, iron rusts, as organic materials decompose or during bacterial actions such as fermentation.
- Oxygen is “pushed out” by another gas. When an area with normal oxygen content fills up with a gas, such as argon. An oxygen deficient atmosphere may be maintained purposely. For instance, inerting a tank by filling it with argon, to prevent combustion during welding.

Oxygen-deficient atmospheres may cause a person to feel lethargic and potentially lose consciousness. Typical symptoms include dizziness and euphoria, like being slightly drunk. Lack of oxygen affects the brain very quickly. A person might not be aware what is wrong until they are too confused to escape. Oxygen starvation can cause serious injury to the brain. The values shown in the table below are approximate and vary according to an individual’s state of health and/or physical activities.

Potential Life-Threatening Effect of Oxygen Deficient Atmospheres

Oxygen Content (% by Volume)	Effects and Symptoms (At Atmospheric Pressure
19.5%	Minimum permissible oxygen level
15 – 19%	Decreased ability to work strenuously. May impair coordination and induce early symptoms in persons with coronary, pulmonary or circulatory problems
12 -14%	Respiration increases in exertion, pulse up, impaired coordination, perception, judgment
10 – 12%	Respiration further increased in rate and depth, poor judgment, lips blue (cyanotic)
8 -10%	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea and vomiting
6 -8%	8 minutes, 100% fatal; 6 minutes, 50% fatal; 4-5 minutes, recovery with treatment (100% oxygen)
4-6%	Coma in 40 second, convulsions, respiration ceases, death

Reproductive System

Chemicals can affect the reproductive system (including both parent and fetus) and may extend into several generations. Chemicals may adversely affect the gonads, fertility, viability, and general reproductive performance. Examples of chemicals that can harm this system are:

- Female: DDT, ethanol, methyl mercury, PCBs
- Male: Lead, boron, methyl mercury, PCBs, dioxin, toluene, xylene, benzene, ethanol

Mutagen

Chemical substances or physical agents that alter or damage the blueprint, DNA – genetic code, are known as mutagens. Symptoms of exposure may include changes in sperm or egg cells, sterility and birth defects. Damage to egg or sperm cells can result in generational changes. Examples include ethanol, PCBs, ozone, ultraviolet light, benzene, and vinyl chloride.

Teratogen

Chemicals that harm unborn fetuses are known as teratogens. Examples of teratogens producing birth defects include ammonium chloride, magnesium sulfate, nicotine, and thalidomide.

Fetal Alcohol Syndrome resulting from the mother's consumption of alcohol during pregnancy can result in devastatingly negative impacts on the developing fetus.

Cancer Caused by Chemicals or Physical Agents

Chemicals and physical agents can cause cancer when exposure is repeated over a long period of time. The higher the concentration and more regular the exposure, the shorter the time for cancer to develop.

Carcinogen

A chemical or physical agent that causes cancer. Characteristics of cancer include uncontrolled cell division and invasion into other tissue, and dispersion to other tissues and organs (metastasis). Examples include ultraviolet light which can cause skin cancer, benzene which can cause bone marrow cancer, and vinyl chloride that can cause liver cancer.

When cells are exposed to a mutagen and DNA is damaged, it tries to repair the damage before it divides. Repeated exposures overcome the target organ's ability to repair the damaged DNA, and cancer may develop.

Key Terms – Toxicology and Health Effects (See Glossary or Manual)

Acute exposure

Asphyxiant

Ceiling (C)

Carcinogen (Ca)

Chronic exposure

IDLH

PEL

REL

Routes of Entry

STEL

Systemic Effect

Target organ

TLV

TWA

Warning Properties

Chemical Physical Hazards

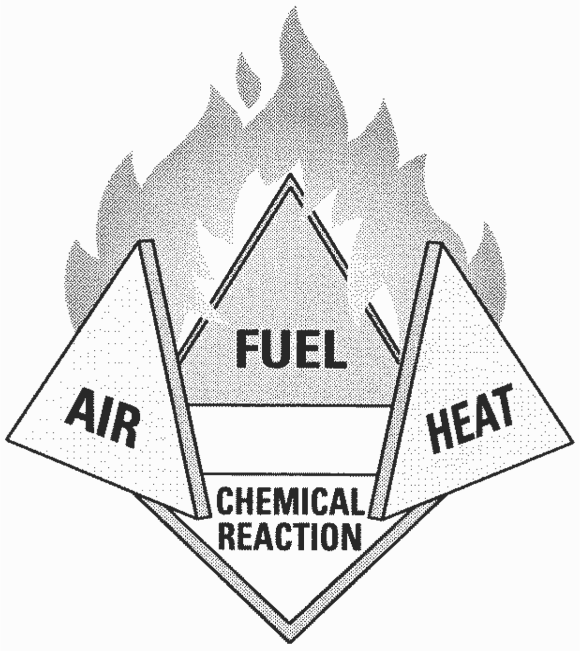
Chemical and Physical Properties

If chemicals or wastes are accidentally spilled, released or combined, it is important to anticipate how they will react. Understanding the way substances behave may help an employee predict the hazards spilling, releasing or mixing may create.

The way chemicals react depends upon their chemical and physical properties. Terms used to describe chemical and physical properties of substances are described below.

Fire Tetrahedron: Fuel, Oxygen, Heat and a Chemical Reaction

Three components must be present for a fire to burn: fuel, oxygen from the air or another source and heat. These three items make up the **fire triangle.**



For example, fuel may be a flammable vapor or gas. Heat can come from an open flame, a spark of static electricity, or a hot engine.

A fire is a chemical reaction that occurs between the components of the fire. A fourth leg is added to the fire triangle to account for the chemical reaction, so we now have a fire tetrahedron.

To put out a fire, either one of the components of the fire triangle must be removed or the chemical reaction must be stopped. Using a dry chemical extinguisher disrupts the chemical reaction, thereby putting out the fire.

Terminology

Ignitable

Capable of burning or being set on fire.

National Institute of Occupational Health (NIOSH)/National Fire Protection Association (NFPA) Fire Classes:

Class I A-flash point <73° F/boiling < 100° F
Class I B-flash point <73° F/boiling ≥ 100° F
Class I C-flash point ≥73° F < 100° F
Class II -flash point ≥100° F < 140° F
Class III A-flash point ≥140° F < 200° F
Class III B-flash point ≥200° F

Flammable
A term used by OSHA and DOT to classify certain liquids that will burn on the basis of flash point temperatures.

- DOT – A flammable liquid is a liquid with a flash point less than or equal to 60.5˚C, or <140°F (transport), or any material in a liquid phase with a flash point at or above 37.8˚C (100˚F) that is intentionally heated and offered for transportation or transported at or above its flash point in a bulk packaging
- OSHA – (Fixed Facility) *Flammable liquid* means any liquid having a flashpoint at or below 199.4 °F (93 °C). Flammable liquids are divided into four categories as follows:

Category 1 shall include liquids having flashpoints below 73.4 °F (23 °C) and having a boiling point at or below 95 °F (35 °C).

Category 2 shall include liquids having flashpoints below 73.4 °F (23 °C) and having a boiling point above 95 °F (35 °C).

Category 3 shall include liquids having flashpoints at or above 73.4 °F (23 °C) and at or below 140 °F (60 °C). When a Category 3 liquid with a flashpoint at or above 100 °F (37.8 °C) is heated for use to within 30 °F (16.7 °C) of its flashpoint, it shall be handled in accordance with the requirements for a Category 3 liquid with a flashpoint below 100 °F (37.8 °C).

Category 4 shall include liquids having flashpoints above 140 °F (60.5 °C) and at or below 199.4 °F (93 °C). When a Category 4 flammable liquid is heated for use to within 30 °F (16.7 °C) of its flashpoint, it shall be handled in accordance with the requirements for a Category 3 liquid with a flashpoint at or above 100 °F (37.8 °C).

Combustible
A term used by DOT to classify certain liquids that will burn on the basis of flash point temperatures.

- DOT – A liquid with a flash point ≥ 140°F and < 200°F (transport)

These definitions and classifications were initially agreed to by NFPA, the U. S. Department of Transportation (DOT), and the U. S. Occupational Safety and Health Administration (OSHA) in an attempt to remove inconsistencies in the definitions used at the time. Since then, DOT has changed its definition of "flammable liquid" by raising the upper limit to 140°F (60.5°C). This was done because the United States is a partner to a world-wide set of hazardous materials regulations sponsored by the United Nations and must use the UN definitions, at least for international transportation. Note, however, that DOT regulations include a so-called "domestic exemption" that allows a shipper to re-designate as a combustible liquid any liquid whose flash point is in the NFPA Class II range and which does not meet any other hazardous material definition. OSHA changed its definitions in 2012.

Flash Points (Fl. P.)
The lowest temperature at which a liquid will give off enough vapor to flash or explode if there is a source of ignition, but there is usually not enough vapor (fuel) to sustain ignition.

There are two types of flash point test methods, open cup and closed cup; therefore, flash points may vary for the same material depending on the test method used. The test method is usually indicated on the SDS for the substance.

Examples:	Gasoline	-45°F	Benzene	12°F
	Acetone	0°F	Turpentine	95°F

Boiling Point (BP)
The temperature at which a liquid changes into a vapor or gas, and an actual boil begins on the surface of the liquid.

Examples: Water 212°F (100°C) Acetone 133°F Chlorine -29°F

Autoignition Temperature
The lowest temperature at which a flammable gas or vapor air mixture will ignite from its own heat source or a contacted heat surface without the presence of a spark or flame.

Examples:	Acetone	1000 F° (537° C)	Benzene	1044 F° (562° C)
	Toluene	997 F° (536° C)	Methane	1000 F° (537° C)

Explosive Limits/Flammable Range
The explosive limit indicates the explosive range of a vapor or gas expressed in percentage by volume of gas or vapor in air. The flammable range is usually expressed as the **lower explosive limit** (LEL) and **upper explosive limit** (UEL). **Lower flammable limit** (LFL) and **upper flammable limit** (UFL) are other terms used interchangeably.

Lower Explosive Limit (LEL)
The minimum percent concentration of a substance, when mixed with air, which will explode or produce a flash or fire when an ignition source is present. At a concentration lower than the LEL, the mixture is too “lean” to burn.

Upper Explosive Limit (UEL)
The maximum percent concentration of a vapor or gas in air that will explode or produce a flash or fire when an ignition source is present. At concentrations above the UEL, the mixture is too rich to burn and due to insufficient oxygen present, the concentration of a gas in air becomes too great to allow an explosion upon ignition.

In an automobile engine, fuel (gasoline), oxygen (in air) and heat (spark plug) combine to form a rapid series of explosions which push cylinders to power the vehicle. These explosions occur because gasoline vapor (fuel) concentration is between its LEL and UEL, and sparks from the plugs produce an explosion.

Compare explosive limits to the operation of a carburetor. When the mixture is too lean (not enough fuel), the vapor mixture is below the LEL so the engine will not fire. If the engine floods (too much fuel), the UEL has been exceeded so once again the engine will not fire. When the mixture is right and the spark plugs are working, the fuel/air mixture burns and the engine fires.

Potential Hydrogen (pH)

A scale from 0 to 14 which measures the acidity or alkalinity of a solution in terms of the relative concentration of hydrogen ions in solution. The scale is logarithmic so that pH 3 is ten times more acidic than pH 4.

- pH values from 0 – 7.0 indicate acidity (decreasingly acidic)
- pH 7 is regarded as neutral (hydrogen ion concentration in pure water)
- pH values from 7.0 – 14 indicate alkalinity (increasingly alkaline/basic)

Substances with a pH between 0 and 2.0 or 12.5 and 14 are regulated as hazardous waste by the EPA under the corrosivity characteristic. DOT regulates both extremes of the scale as corrosive.

Corrosive

Substances cause deterioration, destruction or alterations at the site of contact; corrosives may burn body tissue on contact or erode through inert materials such as steel. Both strong acids (low pH) and bases (high pH) are corrosive.

Examples:	Acids	Bases
	Nitric acid	Lye
	Sulfuric acid	Lime
	Hydrochloric acid	Caustic soda
	Hydrofluoric acid	Sodium hydroxide

Very Low or Very High pH = Tissue Damage on Contact

Acids							Neutral (Water)							Bases
0							7							14
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14

- 1.0 - Gastric Juices
- 2.0 - Lemon Juice
- 3.0 - Soda
- 4.0 - Tomato Juice
- 6.5 - Saliva
- 7.3 - Human Blood/Tears
- 8.0 - Sea Water/Egg White
- 9.0 - Baking Soda
- 12.0 - Household Ammonia
- 13.0 – Clorox bleach

Oxidizer

A substance, not necessarily containing oxygen, which promotes combustion in other materials, causing fire either by itself or through the release of oxygen or other gases.

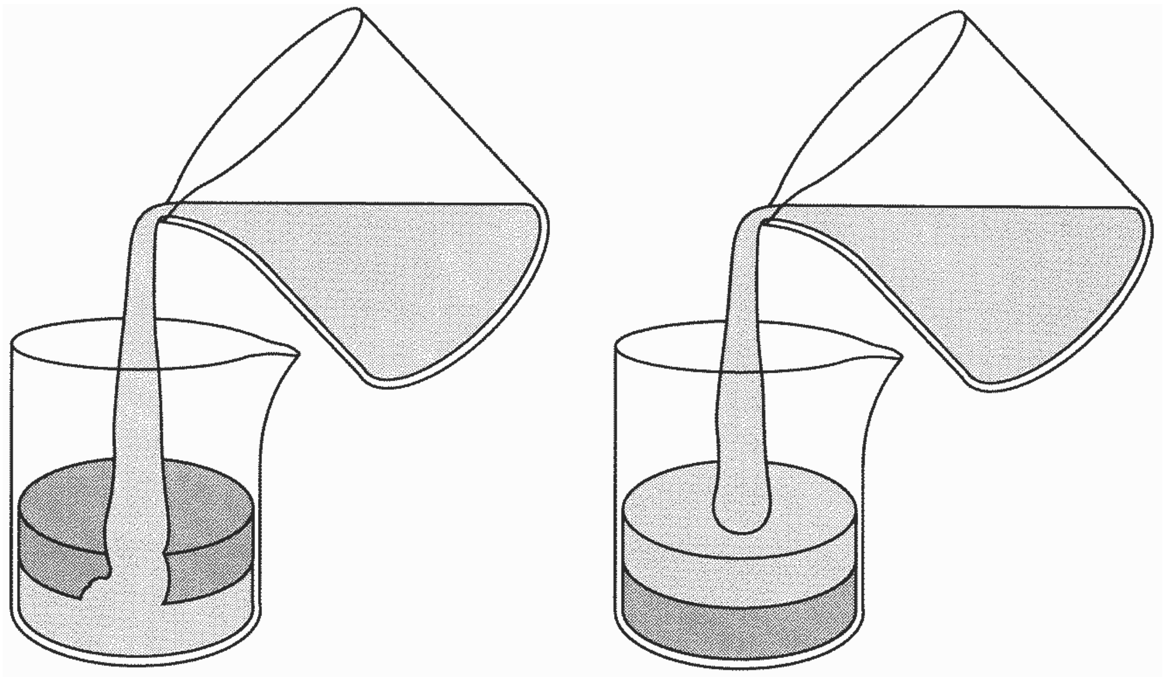
Examples:
Ozone
Peroxides
Household bleach
Perchloric acid
Benzoyl peroxide
Hydrogen peroxide

Chemical Behavior

Specific Gravity (Sp Gr)

A measurement used to quantify the weight of a substance by comparing its weight to the weight of water. Water is given the value of 1. Material with a specific gravity of < 1 is lighter than water, therefore will float if it does not dissolve. Material with a specific gravity > 1 is heavier than water, therefore will sink if it does not dissolve.

Methylene chloride	1.33	Kerosene	0.81



Solubility in Water (Sol)

A term expressing the percent of a material (by weight) that will dissolve in water at ambient temperature. Solubility information is useful in determining cleanup methods for spills and fire extinguishing methods for material.

Solubility may be expressed as:

- negligible, less than 0.1%
- slight, 0.1 to 1.0%
- moderate, 1 to 10%
- appreciable, more than 10%
- complete, soluble in all proportions

Examples:	Glucose	100%	Methylene chloride	2%
	Kerosene	Insoluble	Hydrogen chloride	67%

Soluble liquid released into water, dissolves and mixes with it. If a compound is not soluble, it will either float or sink based upon its specific gravity.

Miscibility is the property of liquids to mix in all proportions, forming a homogeneous solution. In principle, the term applies also to other phases (solids and gases), but the main focus is usually on the solubility of one liquid in another. Water and ethanol, for example, are miscible since they mix in all proportions.

By contrast, substances are said to be **immiscible** if in some proportion, they do not form a solution. For example, diethyl ether is fairly soluble in water, but these two solvents are not miscible since they are not soluble in all proportions.

Viscosity

Viscosity of a liquid refers to its thickness or its inability to flow. Viscosity can change with the temperature; a high-viscosity substance may become runny when exposed to heat, thus lowering its viscosity. As the temperature increases, the viscosity of a liquid decreases. This may result in the substance spreading faster.

Examples: Water has a low viscosity. Molasses has a high viscosity

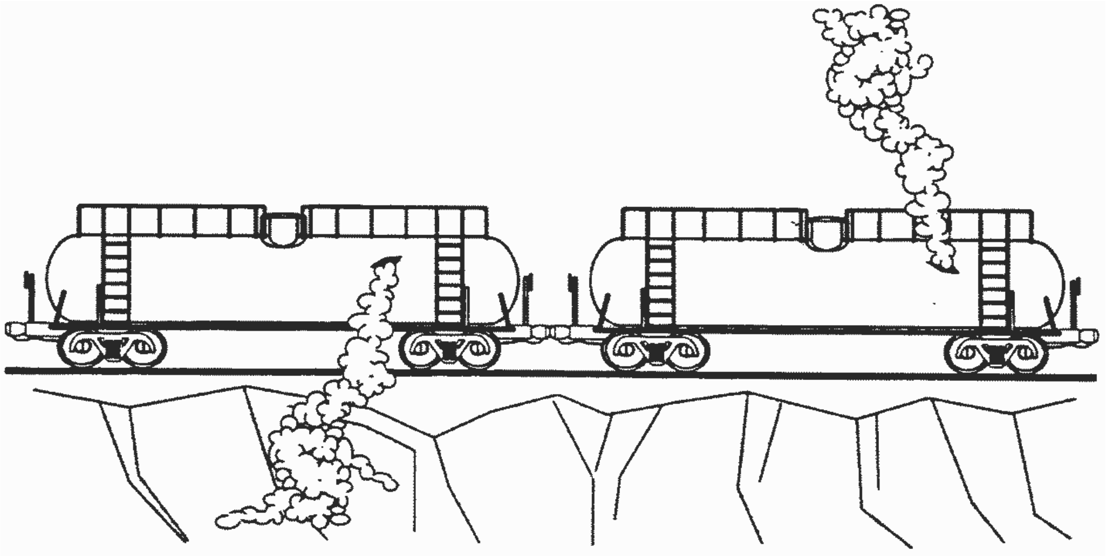
Relative Gas Density (RGasD)

A NIOSH term for which the relative density of gases is referenced to air which is given the value of 1. Substances with RGasD values < 1 are lighter than air and will rise and disperse, while substances with RGasD values >1 are heavier than air and will settle and collect in low lying areas.

Examples:	Ammonia	0.59	Chlorine	2.47
	Ethylene	0.97	Gasoline	4.40

Vapor Density (VD)

A term identical to Relative Gas Density. The weight of a vapor of gas compared to the weight of an equal volume of air; an expression of the density of the vapor or gas. Materials lighter than air have vapor densities less than 1.0. Materials heavier than air have vapor densities greater than 1.0. All vapors and gases will mix with air, but lighter materials will tend to rise and mix (unless confined).



Heavier vapors and gases are likely to concentrate in low places (along or under floors, in sumps, sewers, manholes, trenches, and ditches) where they can create fire or health hazards.

Vapor Pressure (VP)

Vapor Pressure is the pressure exerted on walls of a closed container of liquid by vapor formed above its surface most commonly measured by a J tube with liquid mercury inside a graduated cylinder. As the liquid evaporates in a closed cup, it exerts pressure on the mercury driving it up the graduated cylinder and giving a measurement in millimeters of Mercury (mmHg).

This is a measure of how readily a material will evaporate, and indicates how volatile it is. The lower the vapor pressure, the slower it evaporates and the longer it takes to build up toxic or explosive concentrations.

Boiling point (BP)

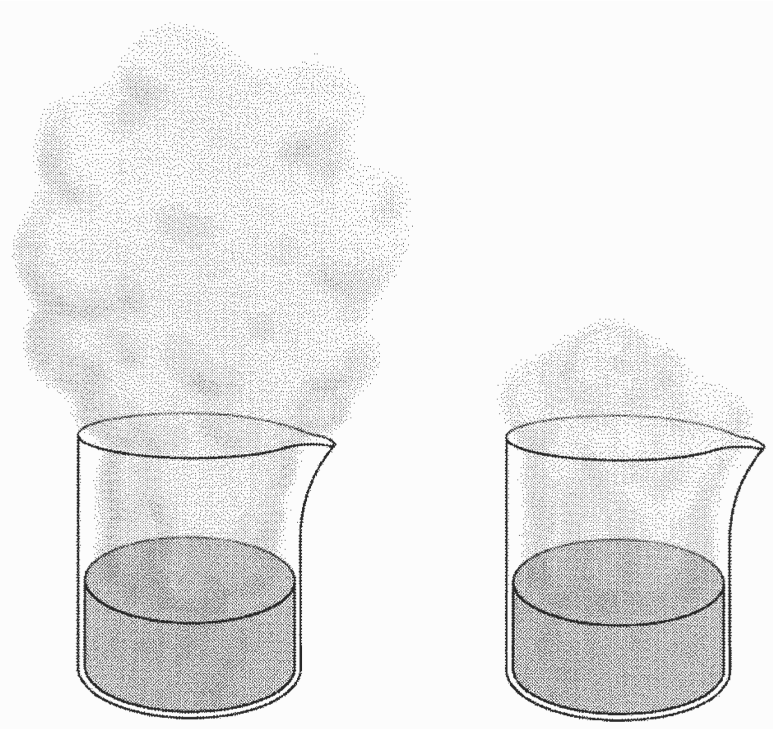
This measurement is inversely related to vapor pressure (VP), in other words the lower the boiling point the higher the vapor pressure.

Examples:

	BP	VP (mm/Hg)
Chlorine	-29°F	>atmosphere
Methylene Chloride	104°F	350
Acetone	133°F	180
Benzene	176°F	75
Trichloroethylene	189°F	58
Toluene	232°F	21
Xylene	269°F	9

Materials with high vapor pressures will enter air quickly (evaporate). Also, the higher the vapor pressure of a sealed chemical container, the more likely it is to explode as the temperature rises due to increased pressure.

For example, when you 'smell' gasoline, you are definitely inhaling benzene because its vapor pressure is greater than xylene and tolulene, the other two 'light-end' substances in gasoline.



Cryogenic
A liquefied or solidified gas or other substance existing at very low temperatures that can freeze body tissues on contact.

Examples: Liquid Oxygen and Dry Ice

Subliming or Sublimation
The process of a solid 'vaporizing;' passing directly to the gaseous state bypassing the liquid state. That is the reason ice cubes may become smaller if left in the freezer for a long period of time.

Example: Dry Ice evaporating into the atmosphere

Incompatible Chemicals

Incompatible chemicals are ones which react violently when they come in contact with other chemicals, or react due to an atmospheric change such as a temperature increase or decrease.

Reactions of incompatible materials may result in:

- Fire
- Explosion
- Toxic gas release

When strong acids and alkalines (bases) are mixed, heat and splattering occur and can damage unprotected eyes and skin. Acids added to cyanides produce hydrogen cyanide gas, which can cause death. Acids added to sulfides produce hydrogen sulfide gas, which can cause death.

Incompatible chemicals must be stored separate from each other and protected from coming into contact with each other. Under DOT this is called segregation. If the containers leak or rupture and get in contact with the other incompatible chemical, a negative reaction might occur.

Some chemicals react when exposed to water or air, thus creating heat, splattering, and toxic gases.

Keep These…	**Away From These**	**Or You GET**
Acids	Bases	Heat, Violent Reaction
Acids, Bases Solvents	Reactive Metals Metal Hydrides	Fire, Explosion Hydrogen Gas
Water or Alcohols	Acids, Bases Calcium, Lithium Potassium	Heat, Fire, Explosion Flammable and Toxic Gases
Strong Oxidizers	Acids, Reactive Solvents Flammable Liquids	Fire, Explosion
Cyanide or, Sulfide Solution	Acids	Hydrogen Cyanide or Hydrogen Sulfide Gas

Key Terms – Chemical Physical Hazards (See Glossary or Manual)

Boiling point

Corrosive

Fire triangle/Tetrahedron

Flammable, Combustible, and Ignitable

Flash point

Freezing point

Incompatible Chemicals

LEL/LFL

Oxidizer

pH

Relative Gas Density/Vapor Density

Specific Gravity

Toxicity

Vapor Pressure

Viscosity

Physical Agents and Other Physical Hazards

Physical Agents

Alaska's Haz Com regulations require employers to inform employees whenever any of the eight physical agents are present in the workplace. In addition, employers are required to make Physical Agents Data Sheets (PADSs) available to employees for each physical agent present in the workplace.

Physical Agents are hazards, other than chemical, determined by the ACGIH to cause injury or harm to the body if specific limits are exceeded. Categories of physical hazards include acoustic, electromagnetic, ergonomic, mechanical, and thermal.

Physical Agent Data Sheets (PADSs) are to physical agents what Safety Data Sheets (SDSs) are to chemicals. They are adopted from ACGIH by the Alaska Department of Labor for eight physical agents identified by the state as workplace hazards. PADs are included in the reference documents manual.

Physical Agents Data Sheets are available for the following hazards:

1. Cold Stress
2. Heat Stress
3. Noise
4. Hand-Arm Vibration
5. Lasers
6. Ionizing Radiation
7. Ultraviolet Radiation
8. Radiofrequency (rf) and Microwave Radiation

Cold Stress

If the body is overexposed to cold, it can result in two types of injuries.

- Hypothermia
- Frostbite

Hypothermia

Hypothermia occurs when cold exposure causes the body's internal temperature to lose heat more rapidly than it is being produced. Un-controllable shivering occurs when body temperature drops to 95°F.

Hypothermia impairs judgment

Drowsiness	Vague, slow, slurred speech
Inability to use hands	Frequent stumbling
Forgetfulness, memory lapses	Exhaustion, collapse
Unconsciousness	Death

Hypothermia Prevention – BE PREPARED

- Stay Dry
- Drink plenty of water
- Avoid Exposure
- Terminate Exposure

Hypothermia Treatment

- Get victim out of wet and windy weather
- Remove all wet clothing
- If the person is only **mildly** affected
  - give warm liquids
  - put into dry clothing and a warm sleeping bag

Severe characteristics are clumsiness, confusion, inability to shiver.

Safest method of rewarming is warmth from skin to skin contact.

- Treat very gently
- Place the victim naked into a warm sleeping bag
- Place a warm naked rescuer into the same sleeping bag
- If a double bag is available, place the victim between two rescuers
- Wrap warm objects in towels or clothing and place them on back of neck, in arm pits, sides or groin
  - rocks, hot water bottles, heat packs, and warm, wet towels
- Arrange for evacuation
- **Do not** give warm drinks until the victim has a clear level of consciousness, ability to swallow, and is already starting to warm up.

Frostbite

Frostbite is caused by direct contact with temperatures and/or winds below freezing or freezing objects. Fingers, toes, and the face are the most vulnerable parts of the body, particularly the nose and ears.

Frostbite Recognition

- Numbness of hands, feet, or face (fingers, toes, ears and nose)
- Initial pain in hands and feet
- Loss of the sensation of touch, pressure and pain
- Skin becomes less elastic and white
- Headache (Brain freeze)

Frostbite Prevention

- Protection from Cold
- Drink plenty of water
    - survival gear
    - shelter from elements/waterproof/windproof protective clothing
- Essential Clothing
    - parka (Down)
    - thermal underwear
    - quilted or ski pants
    - double mittens
    - insulated footwear
- Special Warnings
    - contact with super cooled liquids may cause immediate frostbite
    - avoid bare skin contact with metal below freezing – wet skin will freeze to metal and tear away if one attempts to withdraw it too rapidly. If necessary, thaw gently with heat, warm water or urine.

Frostbite Treatment – Proper Rewarming

Rewarming is an acutely painful process. Give pain medication. As rewarming occurs, move afflicted part gently and voluntarily.

- Avoid thawing and refreezing
    - keep body part frozen until permanent shelter is available and rewarming can be done satisfactorily- **this means staying thawed**
- Gently warm frostbitten tissue, stop exposure to further cold
    - rewarm in stirred water between 100-105°F
    - never try to thaw using cold water or snow
    - if feeling is lost, never use fires, stoves, exhaust pipes to thaw tissues, as it can go from frozen to charred without the victim feeling it.
- When a major part of a limb is frozen
    - body temperature will fall as cooled blood flows throughout the body
    - give warm liquids by mouth
- **Requires Medical Attention**
    - **upon thawing, a dull purple color, swelling or blisters may appear**
    - **means for circulation must be administered by medical personnel**

Heat Stress

Heat Stress occurs when the body temperature builds up above normal without a way to release heat. When our internal body temperature increases, vessels dilate and blood flows to the skin to release heat. Sweating also helps maintain stable internal temperatures; as sweat evaporates, cooling results.

Four environmental factors affect heat stress:

Temperature
Air Velocity
Humidity
Radiant Heat (such as from the sun or a furnace)

Heat Stress results in three levels of dangers:

- Heat Cramps
- Heat Exhaustion
- Heat Stroke

Heat Cramps

Painful spasms of the bone muscles – one may be drinking large quantities of water, but failing to replace the body's salt loss

Treatment

- Taking salted liquids by mouth
- If medically required, intravenous saline solutions provide faster relief

Heat Exhaustion

Loss of fluid through sweating – failure to drink enough fluids or take in enough salt or both. Signs include:

Giddiness
Nausea
Complexion pale or flushed
Body temperature normal or slightly higher
Headache
Extreme weakness or fatigue
Clammy and moist skin

Treatment

- Rest in a cool place and drink salted liquids
- Salt tablets are not recommended

Heat Stroke

The body can no longer rid itself of excess heat. Signs include:

Mental confusion or Delirium
Loss of consciousness
Convulsions or coma
Hot, dry skin
Skin red, mottled or bluish
Body temperature of 105°F or higher

Treatment: Victims of heat stroke will die unless treated promptly

- Remove to a cool area immediately
- Soak clothing with cool water
- Fan vigorously to increase cooling through evaporation

Fainting

A person can faint from not being acclimatized to a hot environment – working in the heat; standing still in the heat

Treatment

- Briefly lie down
- Move around

Heat Rash

Sweat is not removed from the surface of skin by evaporation

Treatment

- Shower
- Rest in a cool place
- Allow skin to dry

Heat Stress Prevention

Acclimatization

Use administrative controls to give the body 5 to 7 days to adjust to working in the heat by gradually increasing exposures over successive days

Limit Stressful Conditions

- Perform light or intermittent work
- Automate work procedures
- Provide air conditioned or heat shielded environment

Limit Exposure

Use administrative controls to:

- Incorporate work-rest cycles
- Postpone nonessential tasks
- Provide additional workers

Thermal Conditions

Use engineering controls to minimize exposure to heat

- Improve insulation on furnace walls
- Install exhaust hoods over sources
- Simplest, least expensive methods:
  - open windows
  - use fans, or
  - create airflow – exhaust ventilation or air blowers

Rest Areas

Provide rest areas near 76°F if possible

Drinking Water

Provide 5-7 oz. of water for workers to drink every 15 to 20 min.

Protective Clothing

Wear clothing that allows heat elimination, or provides cooling

Noise = Unwanted Sound

Terminology

Sound

Created when a vibrating source (like a bell, motor or a stereo speaker) sends sound waves through the air to your ear.

Loudness

Measured in units called decibels (dB). A conversational voice is about 65 dB. A shout is 90 dB or greater.

Frequency

Measured in units called Hertz (Hz). The frequency of a locomotive horn is about 250 Hz. The frequency of a table saw is about 4,000 Hz.

Common Sound Levels Table

Bedroom	10 decibels
Business Office	50 – 65 decibels
Siren/Jack Hammer	90 decibels
Traffic/Chain Saw	100 decibels
Rock and Roll Concert	125 decibels
Jet Airplane	150 decibels

Health Effects

- Fatigue
- Sleeplessness
- Nervousness
- Abnormal Hormone Secretions
- Tensing of Muscles
- Narrowed Blood Vessels
- Quickened Pulse
- Increased Blood Pressure

Loss of Hearing

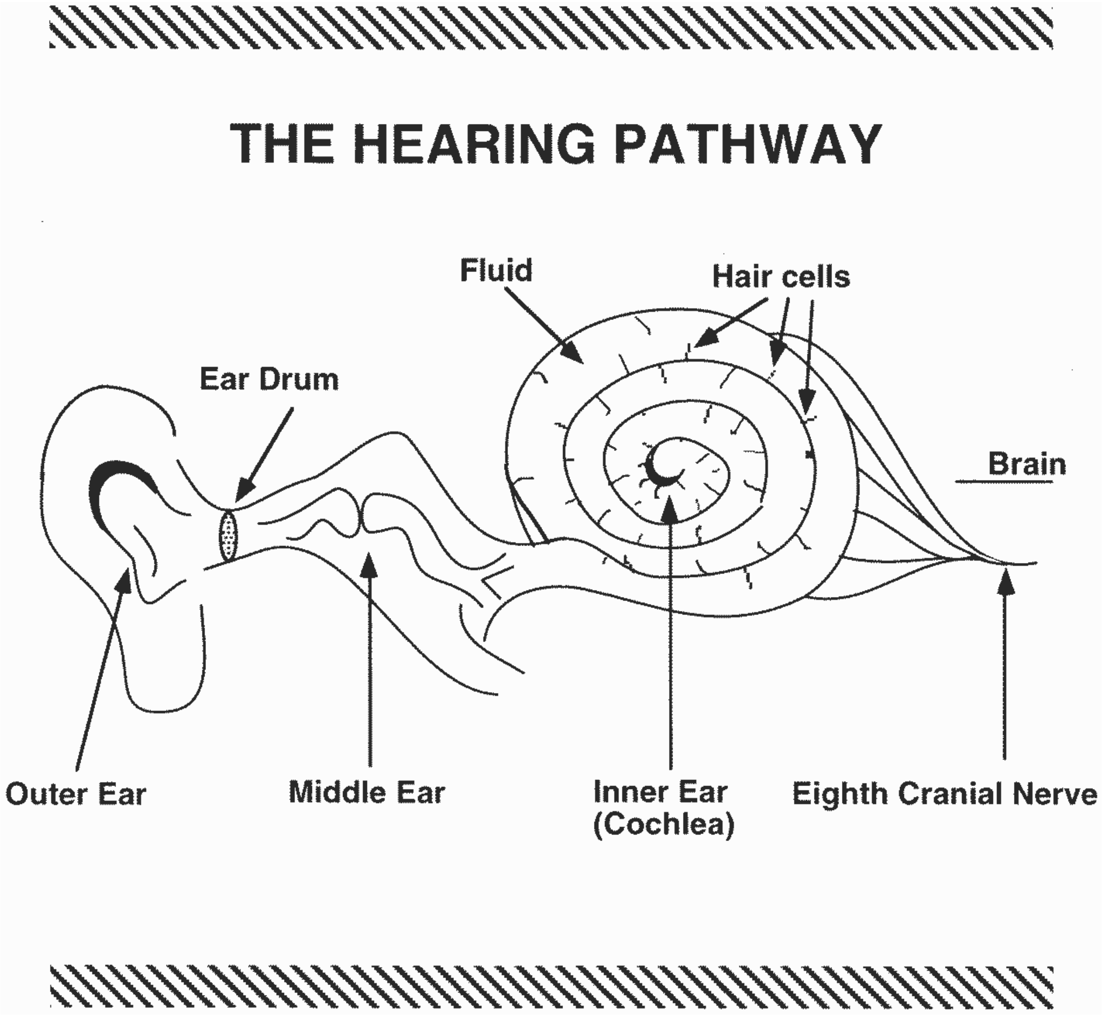
Excessive noise destroys the ability to hear. Hearing loss may result from damage to various parts of the ear, some of which are presently impossible to repair, so prevention is the only way to avoid noise induced hearing loss.

Permissible Exposure Limit

- Action Level – A TWA noise level of 85 dB for an 8-hour day
    - a Hearing Conservation Program must be established

    - employees must be provided with hearing protection
    - employees must be trained

- PEL – A TWA of 90 dB for an 8-hour day
    - engineering or administrative controls must be installed or used
    - if controls **do not reduce noise exposures below** 90 dB, then hearing protection must be worn or rotation of employees must occur.



How Noise Affects Hearing

To understand how noise affects us, we must understand the structures of the **hearing pathway** and how sound travels from outside the ear to the brain.

Outer Ear
The outer ear directs sound waves into the ear canal, vibrates the ear drum and these vibrations then enter the middle ear.

Middle Ear
The middle ear consists of a series of three tiny bones attached at one end to the ear drum and the other to the inner ear. The ear drum and the bones (ossicles) vibrate in sequence and send these vibrations to the inner ear.

Inner Ear
The inner ear, or cochlea, is filled with fluid. When vibrations from the middle ear bones reach the cochlea, the fluid vibrates. Movement of fluid causes tiny hair cells, which line the inside of the cochlea, to move. This movement of cells stimulates nerves cells to send impulses to the eighth cranial nerve (auditory nerve) and then to the brain where

impulses are translated into recognizable sounds. It is the inner ear where sound waves (mechanical energy) are changed into nerve impulses (electrical energy).

Types of Hearing Loss

Conductive Hearing Loss

Conductive hearing loss occurs when sound is not conducted efficiently through the outer ear canal to the eardrum and the tiny bones (ossicles) of the middle ear. Conductive hearing loss usually involves a reduction in sound level or the ability to hear faint sounds. This type of hearing loss can often be corrected medically or surgically.

Some possible causes of conductive hearing loss:

- Fluid in the middle ear from colds
- Ear infection (otitis media)
- Allergies (serous otitis media)
- Poor Eustachian tube function
- Perforated eardrum
- Benign tumors
- Impacted earwax (cerumen)
- Infection in the ear canal (external otitis)
- Swimmer's Ear (otitis externa)
- Presence of a foreign body
- Absence or malformation of the outer ear, ear canal, or middle ear

Sensorineural or Noise-Induced Hearing Loss

Sensorineural hearing loss (SNHL) occurs when there is damage to the tiny hair cells (Cilia) in the inner ear (Cochlea), or to the audiometric nerve pathways from the inner ear to the brain. Most of the time, SNHL cannot be medically or surgically corrected. This is the most common type of permanent hearing loss.

SNHL reduces the ability to hear faint sounds. Even when speech is loud enough to hear, it may still be unclear or sound muffled.

Some possible causes of SNHL:

- Illnesses
- Drugs that are toxic to hearing
- Hearing loss that runs in the family (genetic or hereditary)

- Aging
- Head trauma
- Malformation of the inner ear
- Exposure to loud noise

Noise and Hearing Loss

Noise can cause hearing loss, depending on the dosage (amount of noise exposure over a period of time). Dosage equals intensity, or loudness, multiplied by duration, or length of time exposed. Hair cells are less traumatized when the noise is less intense and of shorter duration.

Hearing Thresholds

A hearing threshold is determined by a hearing exam which tests for an individual's 'best' hearing. Excessive exposure to noise above 85 dB is dangerous because, over time, it will destroy the tiny hair cells in the inner ear. When that occurs, the hearing threshold "shifts."

Temporary Threshold Shift (TTS)

A TTS can occur after exposure to high noise levels in as short a time as 2 hours. Hair cells mat down. If the ear is not subjected to high noise levels for a period of time, usually 12 to 14 hours, hair cells 'bounce back,' and normal hearing is restored.

Permanent Threshold Shift (PTS)

Repeated exposure to hazardous noise can cause a PTS where hair cells have been permanently damaged.

Standard Threshold Shift (STS)

A STS can be a permanent shift in hearing. It occurs when the audiogram shows a loss of 10 dB or more in either ear at 2000, 3000 or 4000 Hertz. Under OSHA regulations, persons experiencing a STS are required to wear hearing protection and be retrained in the use of hearing protection.

Sound Measurements

A **dosimeter** performs two functions. Its microphone and instrument are placed on a person being monitored. The microphone monitors the 'hearing zone' while the remainder of the instrument automatically computes the desired noise measures.

Three weighting networks are provided on standard sound level meters in an attempt to duplicate the response of the human ear to various sounds. These weighting networks cause the sensitivity of the meter to vary with frequency and intensity of sound like the sensitivity of the human ear.

There are "A", "B" and "C" weightings for various frequency filters that cover the frequency range of human hearing. The "A" weighted filter attempts to make the dosimeter respond more closely to the way the human ear hears. "A" weighting is the most commonly used filter in industrial noise application.

Protective Measures

Engineering Controls

Engineering controls should be evaluated as the first choice in the hierarchy of controls to eliminate the noise. Baffles, sound proofing, ducting, or alternative processes should be considered.

Administrative Controls

If engineering controls won't work or does not eliminate excess noise, administrative controls are the next choice under the hierarchy of controls. Barricading the area off, rotating employees or limiting exposure time are examples. If these controls won't work, then PPE is necessary.

When noise levels equal or exceed a TWA or 85 dB for an 8-hour day:

- Hearing protection – ear plugs or muffs must be made available to employees at no cost

When noise levels exceed a TWA of 90 dB for an 8-hour day:

- Employees are required to wear provided hearing protection
- Annual hearing tests and audiometric exams must be conducted
- Engineering and/or administrative controls must be used to reduce noise, if feasible

Employees should receive training that explains the effects of noise on hearing, hearing tests, and proper fitting and care of ear plugs or muffs.

Hearing Protection

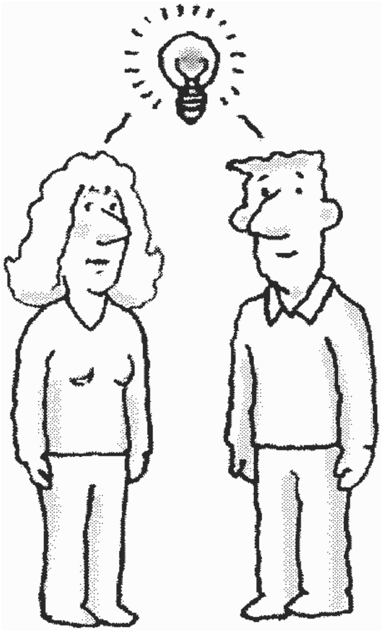
A proper fit of plugs and muffs is important for protection from hazardous noise. There are a couple of types of hearing protection that can be used independently or in combination with each other:

- Ear Plugs
  - molded
  - expandable foam
- Muffs

Proper Fit of Ear Plugs and Muffs

Molded ear plugs

- Reach over your head, grasp the opposite ear by the top and pull upward
- Grasp the plug by its tab and insert into the ear with a twisting motion
- The plug should be well seated in the ear canal
- Repeat for other ear
- Some peoples' anatomy requires pulling down on the ear lobe instead of pulling up



Expandable foam or disposable plugs

- Make sure hands are clean, free of dirt and/or chemical residue
- Roll foam plug between thumb and forefinger until it has a small point
- Reach over your head, grasp the opposite ear by the top and pull upward
- Insert plug into the ear and hold it until it swells in your ear canal
- Repeat for other ear
- Discard plugs after each shift

Ear Muffs

Ear muffs should be inspected before and after each use for defects. Anything that would reduce the ability of muffs to provide appropriate protection should be replaced. If the replacement of the defective part is not feasible, muffs should be replaced.

- Lengthen or shorten the head strap to fit muffs over both ears
- The cup of the muff should fit securely around the outer ear
- Earrings, glasses and hair should not interfere with the seal of the muff
- Inspect the seal periodically and discard if damaged

Noise Reduction Rating (NRR)

Each hearing protection device has a NRR associated with it. Due to improper fit, poor insertion, or not enough time to expand, this NRR should have seven subtracted from it, then divided by two to get a more realistic idea of the actual dB level it is good for. For example: If the NRR = 27. (27 – 7)/2 = 10 dB of actual protection.

Double Hearing Protection

If you wear ear muffs over your ear plugs, you only add about 3-5 dB of protection. If you will still be over the TWA, you must implement administrative controls such as rotating workers to keep them below the PEL.

Hand-Arm Vibration

Hand-Arm Vibration is caused by the use of vibrating hand-held tools, such as pneumatic jack hammers, drills, gas powered chain saws, and electrical tools such as grinders. The nature of these tools involves vibration (a rapid back and forth type of motion) which is transmitted from the tool to the hands and arms of the person holding the tool.

Health Hazards

The major health hazards related to the use of vibrating tools are:

- Vibration Syndrome
- Vibration-Induced White Finger (VWF)
- Raynaud's (Disease/Phenomenon) Syndrome of Occupational Origin

Another health problem that is linked to smaller hand-held vibrating tools is:

- Carpal Tunnel Syndrome

Vibration Syndrome

Vibration Syndrome is a group of symptoms related to the use of vibrating tools. It includes some or all of the following:

Muscle weakness or fatigue
Arms and shoulder pain
Vibration-induced white finger
Irritability
Headaches
Forgetfulness
Sleeping problems
Depression

Vibration-Induced White Finger (VWF)

Also known as "Dead Finger" or "Dead Hand" is the result of impaired circulation (poor blood supply in the fingers) caused by prolonged use of vibrating tools. VWF may appear after only several months on the job, or may not appear until twenty to forty years on the job.

An indicator of VWF is tingling and numbness in the fingers lasting more than an hour after finishing work. For 'Stages of Vibration White Finger' see Table 1 in the Hand Arm Vibration PADS in the Reference Documents book.

Raynaud's Disease

Raynaud's disease is a rare disorder of the blood vessels, usually in the fingers and toes. It causes the blood vessels to narrow when you are cold or feeling stressed. When this happens, blood can't get to the surface of the skin and the affected areas turn white and blue. When the blood flow returns, the skin turns red and throbs or tingles. In severe cases, loss of blood flow can cause sores or tissue death.

Carpal Tunnel Syndrome (CTS)

A group of symptoms in the hand which arise from increased pressure on the median nerve and tendons passing through the Carpal Tunnel on the palm side of the wrist.

- Early symptoms are similar to the early symptoms of VWF and consist of tingling in the fingers. For the most part only the thumb, index and middle fingers are affected in CTS.

- Later, symptoms can progress to numbness. Pain in the wrist and fingers may also develop.
- The symptoms of CTS are frequently worse at night and a person may be awakened from sleep by pain or the feeling of pins and needles in the fingers, hand or wrist.

Preventing Hand-Arm Vibration Diseases

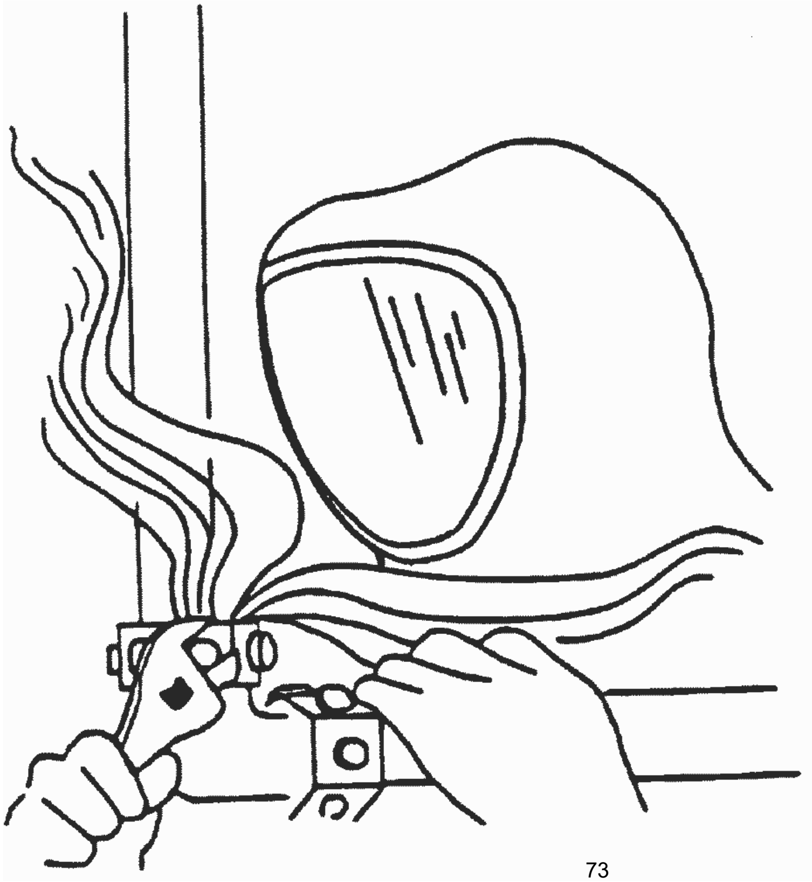
- Redesign job(s) to minimize use of hand-held vibrating tools
- Look for ways to reduce tool vibration
- Substitute a manual tool when practical
- Replace with low vibration tools designed to absorb vibration
- Introduce breaks – 10-minute break for each hour of using the tool

Work Practices

Employees who use or will be using vibrating hand-held tools should receive training about the hazards of vibration and they should be taught how to minimize the ill effects of vibration.

- Operate tool only when necessary
- Operate tool at the appropriate speed for the job
- Grasp tool as lightly as possible
- Rest tool on a support or on the work piece
- Maintain tools to keep vibration to a minimum
- Wear multiple layers of warm and/or anti-vibration gloves
- Warm hands before staring a job

This is even more important when it is cold, as it improves blood circulation.



Radiological Hazards

Radioactive material sends atomic particles or electromagnetic waves (rays) as energy through air. All forms of radiation are serious health hazards. Radiation is also listed as one of the major types of hazards at the beginning of Chapter 3. It is also identified in Alaska's Haz Com Standard under Physical Agents.

The four kinds of radioactivity that we are concerned with here are Alpha and Beta particles, Gamma rays, and X-Rays. They can cause reproductive and developmental problems or cancer. The degree of damage caused depends on the particular type of radioactivity, as well as the dosage.

Ionizing Radiation and Non-ionizing Radiation

Ion

An ion is an atom whose electron numbers and proton numbers do not balance on a one to one ratio, thus creating an atom which is either positively charged (more protons) or negatively charged (more electrons).

Ionizing Radiation

Ionizing radiation is a burst of energy such as X-rays or gamma rays (electromagnetic waves) or particles of atomic disintegration such as alpha or beta particles, which when interacting with adjacent atoms, have enough energy to knock an electron out of its orbit, creating an ion.

Because it cannot be seen, heard, felt, tasted, and gives no advanced warnings of the damage it is causing; this form of radiation is extremely dangerous. In fact, overexposure may take days, weeks, months, or even years to be detected, and then symptoms can be very hard to attribute to an overdose of ionizing radiation.

Once limited to the medical field, ionizing radiation is being used in industry at an ever-increasing rate. This includes X-rays, gamma-rays, alpha-particles, and beta-particles. Non-destructive testing of pipelines, wells and casings is commonly done with electromagnetic radiation.

Like all problems in occupational health, the length and strengths of the exposure determines the level of damage done and the time required for symptoms to manifest themselves. When harmful levels of ionizing radiation are in use, employees shall have received training required to operate that equipment in a safe manner. Additionally, for their own protection, employees should ensure that all equipment is tested and maintained to manufacturer's specifications and they conduct periodic inspections.

Naturally Occurring Radioactive Materials (NORM)

Many people are unaware that we are constantly bombarded with radiation from naturally occurring radioactive materials (NORM) that are all around you. We are surrounded by "background" radiation from NORM present in the soil and rocks of our planet and from the sun's cosmic radiation. Research indicates that this radiation only becomes dangerous when we are exposed to doses far greater than this "background" level.

NORM is an issue in some oil fields in Alaska because radioactivity has been discovered in some oil field piping and production vessels. The source of this radioactivity is a scale or sludge that can build up inside these systems. This scale or sludge can contain NORM which is gradually leached from the earth by the water produced with oil and carried to the surface. Small amounts of these materials may be deposited in pipes and other parts of the production system that carries the mixture to processing centers.

The primary sources of NORM radiation in oil field scale and sludge are trace amounts of radioactive elements such as radium 226 and radium 228, which are naturally present throughout the earth, including rock which contains oil. These materials become dissolved in the produced water, and can precipitate from the water along with barium sulfate and, rarely, calcium carbonate, to form the scale.

Alpha Radiation
Alpha particles are large and only travel about 3 inches in air. They are composed of two protons and two neutrons. They originate from radon, uranium, and polonium among others. Alpha radiation can damage internal body parts if ingested or inhaled; therefore, working where exposure is possible requires the use of respiratory protection such as a High Efficiency Particulate Air (HEPA) particulate filter. Alpha radiation can be stopped or diverted by material as thin as a sheet of paper or ones outer most layer of skin.

Beta Radiation
Beta particles are small, being composed of single electrons, and can travel about 20 feet in air. They can originate from radioactive phosphorous and radioactive carbon among others. Beta radiation can damage the body if inhaled, ingested or allowed to penetrate the skin. It can penetrate more deeply than alpha radiation; therefore, can result in skin burns or even skin cancer. Beta particles will travel through clothes, but are somewhat reflected by plastic. A HEPA filter is needed for respiratory protection and proper protective clothing is also needed.

Gamma Radiation
Gamma radiation consists of electromagnetic waves that can pass through the body just like X-rays. Since gamma radiation can completely penetrate the body, it can result in cancer, burns or, with massive exposure, death. A thick lead or concrete shield or distance is required to stop penetration of gamma rays.

Non-Ionizing (Electromagnetic Radiation)

Non-ionizing radiation in the form of infrared, ultraviolet, microwave, and laser emissions can cause harm in ways different from ionizing radiation. Non-ionizing radiation can burn skin, underlying structures and may cause deep internal damage. Sources of non-ionizing radiation employees need to be aware of are:

- Solar radiation
- Transmitting microwave dishes emanating electromagnetic waves

Infrared Radiation (IR)

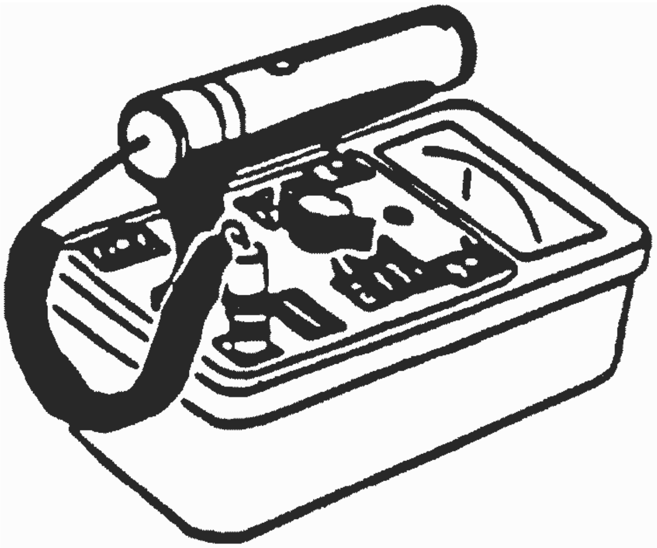
Infrared radiation is used in industry to dry paints, heat metal parts for shrink fitting and warming food. Radiant heat raises the temperature of surfaces it strikes, not the air it travels through. Because of this characteristic, ventilation and air movement do not affect it. Radiant heat shields, reflective clothing, and protective eye wear (with infrared lenses) are common methods of control.

Ultraviolet Radiation (UV)

Sunlight is a common source of ultraviolet radiation. Industrial sources of UV include arc welding and lights used for inspection purposes and/or sterilization. Welding flash or "flash burn" is a complaint of welders and helpers who inadvertently look directly at the intensified UV light of a welding arc without proper shaded eye protection resulting in a sensation of sand in the eyes. The use of proper clothing, eye protection, welders' helmets, and hard hats will stop UV rays from reaching the skin and minimize burns (sunburn) caused by welding.

Microwave Radiation

Microwave radiation is used for cooking, industrial drying and medical applications. It is increasingly finding its way into communication systems, computing, telemetering, and other data transport activities. Although both industry and homes use microwaves to do their intended job, the level used for industrial application is of a lower intensity and frequency. Industrial applications do not impose the same dangers as cooking waves. Microwaves in the higher intensity and frequency category produce heat from inside of material and present a serious health hazard to humans. Excessive exposure to high levels of microwaves can cause cataracts and may damage reproductive organs. Control of hazards associated with microwaves is achieved by proper shielding, minimizing exposure, good safety practices, good maintenance and leak detection surveys.



Laser (Light Amplification by Stimulated Emission of Radiation)

Lasers are composed of parallel light waves traveling in the same direction. In recent years, lasers have found application in areas of communication, welding, surveying, and mechanical measuring, and beams for sighting in some firearms. Lasers are now being used on instrument pigs going through the Alyeska Pipeline to detect irregularities in the pipe. The intensity of laser waves may be such that serious injury can occur if they are not properly handled. Reflections from lasers are also hazardous. The eye is the most vulnerable part of the body because the lens focuses the laser beam to a tiny spot on the retina, causing serious injury and even blindness. Safe exposure limits have not been clearly defined, so exposure should be avoided if at all possible. In any case, one should wear eye protection specifically designed and rated for laser exposure.

Protection from Radiation

- **Time** Minimize length of time exposure
- **Distance** Maintain distance from the source
- **Shielding** Use protective barriers specifically designed to protect against the type of radiation encountered

Other Physical Hazards

Physical hazards are those which primarily cause damage from outside the body. In addition to the physical components of chemical hazards, injury can occur as a result of encounters with physical objects that comprise our surroundings.

The working environment must continually be evaluated for physical hazards that may also be present. Accidents and injuries can be prevented by:

- Hazard recognition
- A safety attitude
- Using safe work practices
- Attention to the details of the task at hand

Other Physical Hazards

- Biological Hazards
- Mechanical Hazards
- Atmospheric Hazards

Biological Agents

Biological hazards result from close contact with some organisms such as bacteria, viruses, fungi, insects, protozoa, plants, mammals, birds, reptiles, amphibians, and fish. Hay fever, giardia (beaver fever) and poison ivy sufferers are just as incapacitated as the person who suffers chemical exposure.

Methods to control biological hazards include good personal hygiene, insect control, personal protective equipment, standard operating procedures, good housekeeping, as well as an awareness of surroundings. (This is Binky. See YouTube video: “Polar Bear Attack” in Anchorage in 1994).

Learning about potential biological hazards in a work area is just as important as understanding the chemical and physical hazards one may encounter. Often, we concentrate on infectious agents, bacteria and viruses, only to forget about protozoa, insects, plants, mammals, and reptiles.

Slips, Trips, and Falls

Slips, trips, and falls comprise major physical hazards to all employees no matter what their job; especially for those working outdoors or in unfamiliar environments. Prevention is the key to avoid serious injuries. Don't put yourself in situations that could result in injury. In most work areas, control measures taken to eliminate the risks that employees face include:

- Building adequate access-ways
- Familiarizing employees with hazards
- Installing anti-slip surfaces and handrails
- Keeping work areas free from slipping and tripping hazards
- Ensuring employees have appropriate soles on their shoes or boots

Slips

Loss of traction is a leading cause of workplace slips. They can be the result of slick surfaces, spills, or weather hazards such as ice and snow. Improper footwear for the job being performed may also cause slips. Footwear with appropriate soles for the work environment that fit properly or the use of traction devices is important.

Trips

Trip hazards can be prevented by:

- Well-lit work areas that enable you to see where you are going
- Don't block your line of vision by carrying more than you can see past
- Clean work areas without cluttered aisles, stairs or footpath areas
- Equipment arranged so that it doesn't interfere with footpath areas
- Keeping power cords anchored and out of walking paths

Falls

Fall hazards can be prevented by:

- Wearing appropriate shoes with nonskid soles
- Not storing items on stairs or in aisles
- Repairing or replacing stairs or handrails that are loose or broken
- Not jumping between levels, docks or work areas
- Remaining off equipment not designed as a ladder
- Wearing fall restraint equipment where required

Strains

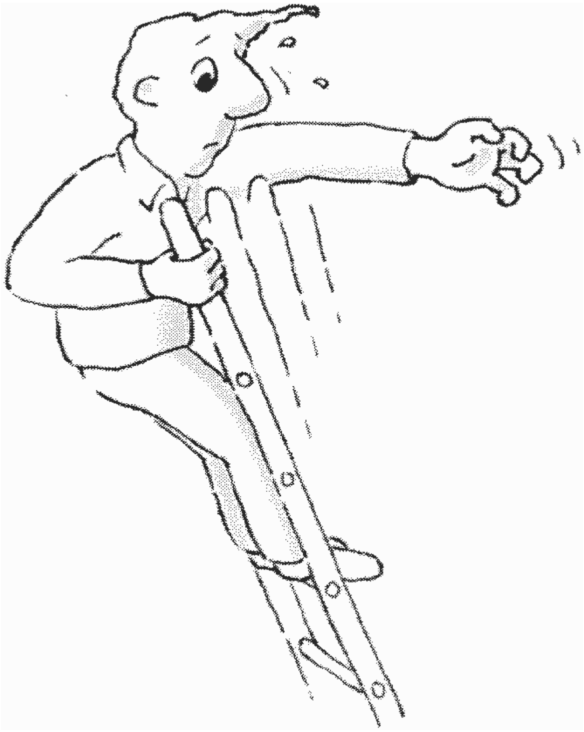
Any pulling or pushing using arms, legs or back may result in a strain if overexertion occurs. Back strain is most common, although any muscle group can be affected. Measures to eliminate strains include:

- Not lifting too much/seeking assistance
- Using mechanized lift equipment if available
- Keeping your back straight and lifting with your legs
- Using your legs, not your back, for power when pulling or pushing
- Not twisting while lifting

- Not carrying as much on a wet, slick or uneven surface as you carry on a flat, dry, even surface.

Ladders

Improper use of step or extension ladders contributes significantly to falls at work sites. The following practices are suggested to prevent accidents when using ladders:



- Inspect all ladders for defects before use
- Use a ladder tall enough for the job
- An extension ladder must be a minimum of 3 feet above the level to be reached
- Do not stand on the top two steps of a step ladder unless it is designed for that.
- Brace knees between the rails to work hands free and maintain at least three points of contact
- Climb or descend using the rungs, not the rails maintaining three points of contact.
- Don't lean out to the side of a ladder past your navel or belt buckle
- Hoist tools or materials in bag or bucket up to you after reaching the top of the ladder
- Slant extension ladder equal to one-fourth of the used length or until the rungs are parallel to the ground
- Tie off top of extension ladder to prevent slips
- Spreader bars on a step ladder must be in the open and locked position. No leaning of step ladders
- Don't use a step ladder as an extension ladder unless it is designed for that
- Ladders must be Heavy Duty or Extra Heavy Duty (250 lbs. or 300 lbs.) on Construction sites
- Fixed ladders installed on or after 11/19/18 must have a Ladder Safety System, or Personal Fall Arrest System (PFAS). Existing fixed ladders will be required to have a PFAS or Ladder Safety System on or after 11/18/2036.

Uneven Surfaces and Terrain

Typical work environments are not flat, and neither are the areas that we live and work in. A rock, rise or depression in the ground or carpet runner can cause trips and falls. Pay close attention to the terrain you are working in.

Mechanical Hazards

Struck-By Hazard

Equipment and tools may be moving in the workplace leaving opportunities for "collisions." These can be anything from being hit on the head with a falling object, to smashing fingers and toes with drums. They also include having substances splashed in one's eyes and walking into materials left in a footpath. To avoid 'struck-bys':

- Watch where you are walking
- Stay alert to activities around you
- Pay attention to the task you are performing
- Wear safety equipment
    - hard hat
    - safety glasses
    - gloves
    - safety shoes or boots

Vehicle Safety

- Operators must use safety belts, both lap and shoulder harnesses
- Do not leave any unattended unit running
- Ensure back-up signals are in working order
- Pay attention to back-up signals and moving vehicles in work areas
- Exhaust in closed areas could cause a carbon monoxide hazard
- Set brakes and chock wheels when loading and unloading
- Eliminate cell phone use while driving or operating equipment

Control of Energy Hazards

A brief mention of energy hazards is mentioned here. It is covered in more detail in Chapter 9, Safe Work Practices.

Electricity

Electrocution can occur as a result of contact with or failure of energized equipment. Never use electrical equipment in wet areas. Other precautions to prevent electrocution include the use of:

- Double insulated tools
- Pneumatic equipment
- Ground fault circuit interrupters (GFCIs)
- Cords and equipment in good repair, with ground prong
- Insulated or non-conductive PPE

Fluids, Pressure and Steam

Pipes in work areas can contain 'hidden' hazards. Pipes contain liquids that may be under pressure, heated or both. Pressure released suddenly can sever appendages or cut skin. Steam from ruptured lines can cause severe burns. Vapors that appear to be steam may actually be a chemical giving off a toxic cloud which appears steam-like. Steam or heat may also react with other materials to compound problems.

Waterways – Streams, Lakes and Ponds

Alaska is an environment with lots of surface water. Streams, lakes, ponds, or oceans can either be part of the terrain at a work site, or may be used for holding or treating hazardous materials. Hazards associated with waterways include hypothermia, drowning or becoming stuck in mud or silt. Mud flats in coastal Alaska can be especially hazardous. Unstable silt allows sinking due to suction which may be impossible for self-rescue.

Precautions one should use when working in and around water include:

- Buddy System
- Cold Stress Management
- Personal Flotation Devices (PFD)
- Knowing tide schedules in coastal areas
- Using extreme caution when working around silt and/or mud flats
- Avoiding traveling and/or working in waterways that are:
    - excessively rough
    - at or above flood stage

Atmospheric Hazards

Flammable/Explosive Atmospheres

These hazards are covered under Chemical Physical Hazards of this Chapter.

Confined Spaces

A brief mention of Confined Space and its associated hazards is made here. It is covered in greater detail in Chapter 9, Safe Work Practices under Permit-Required Confined Space Entry.

Examples of confined spaces include process and storage tanks or holds, tank trucks or rail cars, hoppers, vaults, or pits.

Confined Space Characteristics

- Large enough to allow entry for work
- Limited or restricted entry or exit
- Not intended for continuously occupancy

Confined Spaces become Permit Required when they have:

- Potential hazardous atmosphere
- Potential to engulf or entrap an employee
- Configuration that could result in entrapment or asphyxiation
- Any other serious recognized hazard
    - falls

  - electrical
  - mechanical
  - biological

Characteristics of Hazardous Atmospheres:

- Oxygen Deficient or Oxygen Enriched
- Flammable/Combustible gases or vapors above 10% of LEL
- Flammable/Combustible dust at or above LFL
- Toxins above PELs
- IDLH Atmosphere

Oxygen Content

Oxygen Deficient Atmosphere:
Atmospheres where the percentage of oxygen-by-volume is < 19.5%.

Oxygen Enriched Atmosphere:
Atmospheres where the percentage of oxygen-by-volume is > 23.5%.

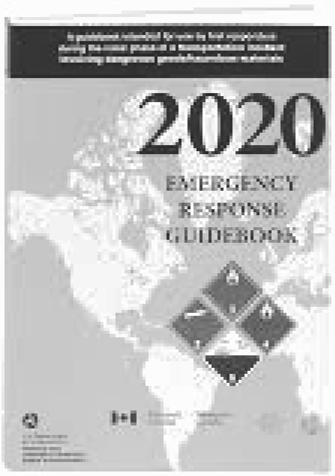
Chapter 4

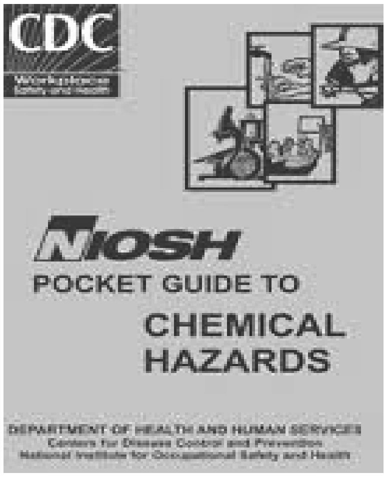
Publications and Source Documents

Introduction

Hundreds of publications and reference documents containing information delineating the characteristics of hazardous substances are available from a wide variety of sources. During this course we will be using reference guides and documents most commonly found in the workplace. It is important to know the types of information each resource contains and where they are found in the workplace.

Publications used during this course are the 2007/2010 NIOSH Pocket Guide to Chemical Hazards, (Download free online) and the 2020 Emergency Response Guidebook (ERG), (Download free online). In addition, several Safety Data Sheets (SDS) and Physical Agent Data Sheets (PADSs), National Fire Protection Association (NFPA) 704 Diamond, as well as DOT shipping papers, hazardous waste manifests forms, and labeling and placarding systems will be examined and used during the hands-on portions of the class.





Safety Data Sheets (SDS) under Globally Harmonized System (GHS)

Where Did SDS Come From?

The workplaces of the world are loaded with chemicals that have properties that can cause illness, injury and even death to people who are exposed to them. In an attempt to protect employees who are exposed to these chemicals in the workplace, the United States Government created the Hazard Communication standard, which requires that all firms manufacturing and/or distributing chemicals for use in the United States prepare SDS for those chemicals and distribute them to their customers.

The law further requires that employers provide their employees with comprehensive listing of chemicals and the corresponding SDS for every hazardous chemical that is present in their workplace. Employers must also provide employees with the information and training necessary to read and understand SDS so that those employees can do what is necessary to protect themselves from the hazards associated with exposure to these chemicals, and provide the risk assessment and personal protective equipment necessary to do the job safely.

What Is An SDS?

The Safety Data Sheet (SDS) is one of those rare items that is elegantly functional. **It can save your life.**

The objective of the SDS is to concisely inform you about the hazards of the materials you work with so that you can protect yourself and respond to emergency situations. The law states that you must have access to SDS and be taught to read and understand them.

The information on the SDS is the summarization of facts from many sources. Training, knowledge and understanding of the technical data on an SDS will provide you with the skills, wisdom and good judgment to safely deal with your occupational exposure to hazards. It will take some study to learn what an SDS says. The real challenge, however, is to learn what an SDS means.

The purpose of an SDS is to tell you:

- Material physical properties or fast-acting health effects that make it dangerous to handle
- Level of protective gear you need
- First aid treatment to be provided when you are exposed to a hazard
- Preplanning needed for safely handling spills, fires and day-to-day operations
- How to respond to accidents

The SDS Format

SDS were initially written for health and safety professionals and trained workers in the chemical industry. The information was usually very technical, and the type of information and formats varied from supplier to supplier. As Federal and state Right-to-Know regulations expanded, a wider audience with diverse backgrounds needed SDS. Reading and understanding the various SDS became a difficult task for many. A few years ago, the Chemical Manufacturers Association (CMA) began working on a standard to develop consistent and understandable SDS that would be easily recognized in the U.S., Canada and Europe. This standard, also accepted by the American National Standards Institute (ANSI), does not fulfill every country's legal requirements, but it does provide consistent and useful information to a variety of audiences, from the worker on the shop floor to the physician treating an exposure victim. Specific legal requirements for an SDS in the U.S. are addressed in OSHA's Hazard Communication standard, and are covered in the 16 total sections of a Globally Harmonized System (GHS) compliant Safety Data Sheet.

OSHA has adopted the United Nations (UN) Standard called Globally Harmonized System (GHS) which is the first change to its Hazard Communication Standard (HCS) in many years.

As of March 25th, 2012, according to OSHA's Hazard Communication standard, SDS must include (See 29 CFR 1910.1200(g):

Section 1, Identification. If the hazardous chemical is a single substance, its chemical and common name. For example:

Brand name: Clorox ™
Chemical name: Sodium Hypochlorite
Common name: Bleach
Section 2, Hazard(s) identification;
Section 3, Composition/information on ingredients;
Section 4, First-aid measures;
Section 5, Fire-fighting measures;
Section 6, Accidental release measures;
Section 7, Handling and storage;
Section 8, Exposure controls/personal protection;
Section 9, Physical and chemical properties;
Section 10, Stability and reactivity;
Section 11, Toxicological information;
Section 12, Ecological information;
Section 13, Disposal considerations;
Section 14, Transport information;
Section 15, Regulatory information and;
Section 16, Other information, including date of preparation or last revision.

Note: OSHA will not be enforcing information requirements in sections 12 – 15, as these areas are not under its jurisdiction.

The GHS standard requires consistent placing of the information within the 16 sections. In some cases, information may be contained in more than one section. For example, exposure guidelines, such as OSHA PELs or ACGIH TLVs, may be placed in Section 3 – Composition and Information on Ingredients, or in Section 8 – Exposure Controls/Personal Protection.

An understanding of how to interpret the data on the SDS is your best defense against accidents and injuries. Knowing what data an SDS should include, as well as where it's included, will help you find it more quickly. The law states very clearly that the manufacturer/supplier must include complete data on the SDS. If you feel that an SDS is incomplete, or you don't fully understand it, call it to the attention of your supervisor before you work with that particular material. The sheet may be returned to the manufacturer or supplier with a request for a better sheet. If you encounter a material you're unfamiliar with, immediately read it's SDS for precautions, and then scan the sheet for health and physical hazards, but remember to be completely informed about the material. You must read and understand the whole sheet.

The SDS is the cornerstone of the law. It is the basic tool that organizations and their employees have available to use as a guide to safe practices and emergency response. It's up to employers to provide the SDSs and it's up to you to read and follow the instructions of the SDS.

Hazard Communication Labels and other forms of warning (See 29 CFR 1910.1200(f) & Appendix C) under GHS compliant revised OSHA standard

The Hazard Communication standard requires the chemical manufacturer, importer, or distributor to ensure that each container of hazardous chemicals leaving the workplace is labeled, tagged, or marked. Hazards not otherwise classified do not have to be addressed on the container. Where the chemical manufacturer or importer is required to label, tag, or mark the following information must be provided:

- Product identifier;
- Signal word;
- Hazard statement(s);
- Pictogram(s);
- Precautionary statement(s); and,
- Name, address and telephone number of the chemical manufacturer, importer, or other responsible party.

Employers must ensure that each container of hazardous chemicals in the workplace is labeled, tagged, or marked with either:

- The information specified above; or,
- Product identifier and words, pictures, symbols, or combination thereof, which provide at least general information regarding the hazards of the chemicals, and which, in conjunction with the other information immediately available to employees under the hazard communication program, will provide employees with the specific information regarding the physical and health hazards of the hazardous chemical.

The employer may use signs, placards, process sheets, batch tickets, operating procedures, or other such written materials in lieu of affixing labels to individual stationary process containers, as long as the alternative method identifies the containers to which it is applicable and conveys the information required as above to be on the label. The employer must ensure the written materials are readily accessible to the employees in their work area throughout each work shift.

The employer must not remove or deface existing labels on incoming containers of hazardous chemicals, unless the container is immediately marked with the required information.

The employer must ensure that the workplace labels or other forms of warning are legible, in English, and prominently displayed on the container, or readily available to the work area throughout each shift. Employers having employees who speak other languages may add the information in their language to the material presented, as long as the information is presented in English as well.

Exception

The employer is not required to label portable containers into which hazardous chemicals are transferred from labeled containers, and which are intended for immediate use of the employee who performs the transfer.

GHS labels

There is a new label format for GHS labels as well. See sample label:

SAMPLE LABEL

PRODUCT IDENTIFIER

CODE ________________

Product Name __________

SUPPLIER IDENTIFICATION

Company Name _____________

Street Address _______________

City _________________State __________

Postal Code __________Country_________

Emergency Phone Number
____

PRECAUTIONARY STATEMENTS

Keep container tightly closed. Store in cool, well ventilated place that is locked.
Keep away from heat/sparks/open flame. No smoking.
Only use non-sparking tools.
Use explosion-proof electrical equipment.
Take precautionary measure against static discharge.
Ground and bond container and receiving equipment.
Do not breathe vapors.
Wear Protective gloves.
Do not eat, drink or smoke when using this product.
Wash hands thoroughly after handling.
Dispose of in accordance with local, regional, national, international regulations as specified.

In Case of Fire: use dry chemical (BC) or Carbon Dioxide (CO_2) fire extinguisher to extinguish.

First Aid
If exposed call Poison Center.
If on skin (on hair): Take off immediately any contaminated clothing. Rinse skin with water.

HAZARD PICTOGRAMS

SIGNAL WORD

Danger

HAZARD STATEMENT

Highly flammable liquid and vapor.
May cause liver and kidney damage.

SUPPLEMENTAL INFORMATION

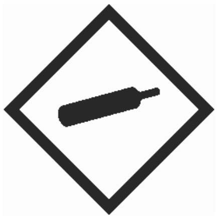
Directions for use:
____
____
____

Fill weight: ___________ Lot Number: _________

Gross weight:_________ Fill Date:
____
Expiration Date: _______

GHS Pictograms and their Corresponding Chemical Hazards

Name	**Hazard**	**Name**	**Hazard**
 **Exploding Bomb**	Explosive (Unstable, Divisions 1.1, 1.2, 1.3 and 1.4), Self-Reactive (Type A and B), Organic Peroxide (Type A and B)	 **Corrosive**	Corrosive (Skin Corrosion Categories 1A, 1B and 1C, Eye Corrosion Category 1), Corrosive to metal
 **Flame**	Flammable (Solids Categories 1 and 2, Liquids Categories 1, 2 and 3, Gases Category 1, Flammable Aerosols Categories 1 and 2), Self-Reactive (Type B, C, D, E and F) Pyrophoric, Self-heating, Emits Flammable Gas, Organic Peroxide (Type B, C, D and F)	 **Skull**	Acute toxicity (Categories 1, 2, and 3)
 **Flame over Circle**	Oxidizer	 **Exclamation Mark**	Irritant (Skin Irritation category 2 and eye Irritation Category 2A), Dermal Sensitizer (Category1), Acute Toxicity (Category 4, harmful), Target Organ Toxicity/STOT Category 3 = narcotic effects, respiratory irritation

 **Gas Cylinder**	Gas under pressure	 **Chronic Health Hazard**	Carcinogen (Categories 1A, 1B, and 2), Respiratory Sensitizer (Category 1), Reproductive Toxicity (Categories 1A, 1B, and 2), Target Organ Toxicity/STOT (Categories 1 and 2), Mutagenicity (Categories 1A, 1B and 2), Aspiration Toxicity (Categories 1 and 2)

Additional Pictograms

OSHA does not have jurisdiction over environmental hazards, and the following GHS pictogram will not be covered by OSHA. It may be covered by other agencies once those decisions have been made, and is provided for informational purposes.

 **Environmental Hazard**	Acute Aquatic Toxicity (Category 1), Chronic Aquatic Toxicity (Categories 1 and 2)

Other Labels in the Workplace

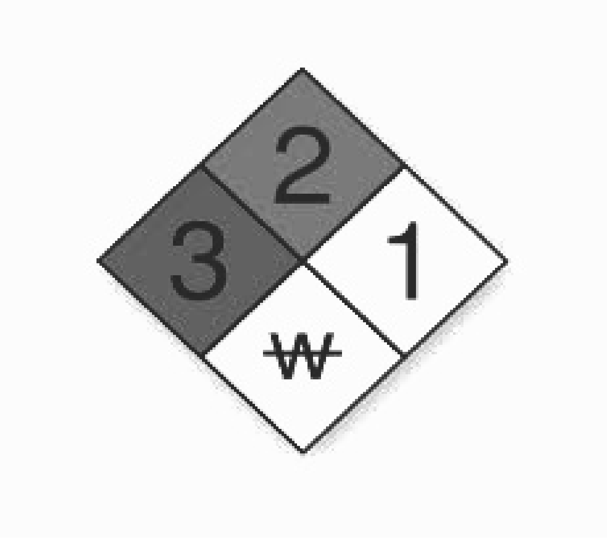
There are three more labeling systems commonly used for identifying hazards in the workplace. They are:

1. National Fire Protection Association (NFPA) Labeling System
2. Hazardous Material Information System (HMIS) Labeling System
3. Department of Transportation (DOT) Labeling System

There may also be a Hazardous Waste label required under the Environmental Protection Agency regulations for waste.

NFPA Labeling System

The NFPA system originates from the National Fire Protection Association's Standard 704, in their 1986 'Fire Protection Guide for Hazardous Material.' The labeling system consists of a diamond divided into four colored diamonds that designate the category of the hazard.



- Blue – Health (Left Side)
- Red – Flammability (Top)
- Yellow – Instability (Right Side)
- White – Special Hazards (Bottom)

The colored diamonds are further noted with a number of 0 through 4 that designate the degree of hazard for that colored section. Take Fire for example:

- 0 – Normal, Stable, Will not Burn
- 1 – Slightly Hazardous, May Ignite, Unstable if Heated
- 2 – Hazardous, Combustible, Can React Violently
- 3 – Extremely Hazardous, Flammable, Shock and Heat Sensitive
- 4 – Deadly, Extremely Flammable, May Detonate

OSHA recently came out with guidance for companies that use the NFPA 704 Diamond and the Hazardous Material Identification System (HMIS) that states that the company may numerically reverse the hazard rating system to match GHS by acquiring label making software or labels from the manufacturer. Under GHS, the new ratings will be 1 (severe hazard) to 5 (minimal hazard). Employers using this method of workplace labeling must ensure employees are trained and fully aware of the hazards of the chemicals used.

Special Codes: There are two codes authorized for use by the NFPA

- OX – Oxidizer
- W̶ – Water Reactive

You may also see COR for Corrosive, ALK for Alkaline, ACID for Acids, or RAD for radiation in the special codes section.

HMIS Labeling System

The Hazardous Material Identification System (From the American Coatings Association) labeling system consists of a rectangle divided into four colored strips that designate the category of the hazard

- Blue – Health (Top Line)
- Red – Flammability (Second Line)
- Yellow – Physical Hazard (Third Line)
- White – Personal Protective Equipment Symbols (Fourth Line)

The colored strips are further noted with a number of 0 through 4 that designate the degree of hazard. This numbering system may be reversed according to OSHA.

  - 0 – Minimal Hazard
  - 1 – Slight Hazard
  - 2 – Moderate Hazard
  - 3 – Serious Hazard
  - 4 – Severe Hazard

Personal Protective Equipment Symbols or Pictograms

  - Glasses – Eye Protection
  - Respirator – Respiratory Protection
  - Hard Hat – Head Protection
  - Gloves – Hand Protection
  - Boots – Foot Protection
  - Apron – Splash Protection

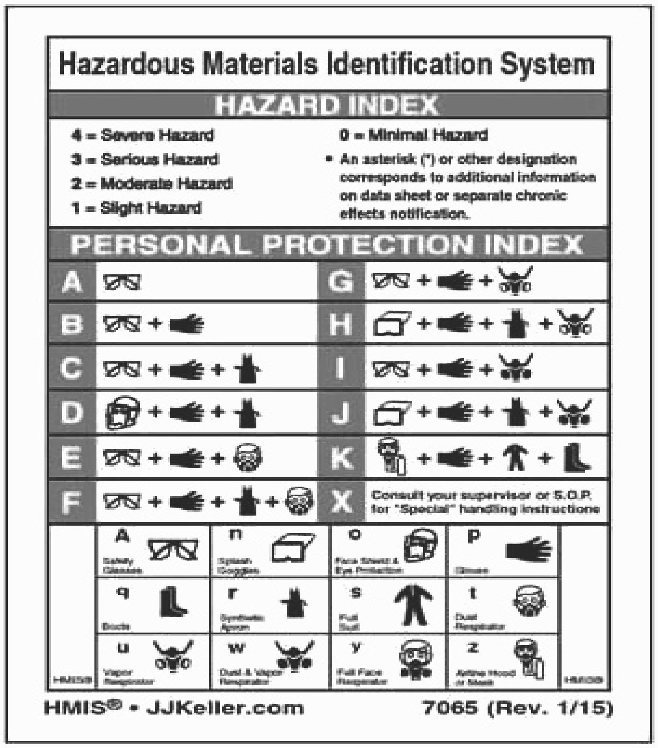
Chemical Name

HEALTH 0

FLAMMABILITY 0

PHYSICAL HAZARD 0

PERSONAL PROTECTION 0



Hazardous Materials Identification System

HAZARD INDEX

4 = Severe Hazard
3 = Serious Hazard
2 = Moderate Hazard
1 = Slight Hazard
0 = Minimal Hazard

* An asterisk (*) or other designation corresponds to additional information on data sheet or separate chronic effects notification.

PERSONAL PROTECTION INDEX

X Consult your supervisor or S.O.P. for "Special" handling instructions

HMIS® • JJKeller.com 7065 (Rev. 1/15)

One of the major differences between GHS and NFPA/HMIS is that a Category 1 degree of hazard chemical is the most hazardous in GHS where in NFPA/HMIS a Category 1 degree of hazard chemical is the least hazardous. This numbering system may be reversed according to recent guidance from OSHA using label making software or labels acquired from the manufacturer as long as employees understand the system used.

Department of Transportation Labeling (Placarding) System

Hazard Class Numbers

DOT classifies (groups) hazardous materials together by type of hazard or hazardous characteristic. These groups are referred to as Hazard Classes. The DOT uses a numbering system, 1 through 9 to identify these classes. In some hazard classes there may be divisions such as 2.3. This is a Gas, and is Toxic. This system is becoming uniform with the United Nations (UN) for international classification of Dangerous Goods. A **one-digit number** in the **bottom** corner of a diamond shaped hazard placard or label is the DOT or UN Hazard Class Number which also may include a period and division number. For example (4.1), or (2.2).

Class Number	Class Name
1	Explosives (Division 1.1 – 1.6)
2	Gases – Flammable (2.1), Non-flammable, Non-toxic (2.2), or Toxic (2.3)
3	Flammable Liquids (and Combustible Liquids)

4	Flammable solids (4.1); Spontaneously combustible materials (4.2); and Dangerous when wet materials/Water-reactive substances (4.3)
5	Oxidizing substances (5.1) and Organic Peroxides (5.2)
6	Toxic substances (6.1), and Infectious Substances (6.2)
7	Radioactive materials
8	Corrosive substances
9	Miscellaneous hazardous materials/Products, Substances or organisms

(Note: The words “poison” or “poisonous” are synonymous with the word “toxic”

Labels

Labels are 4” square/100 mm diamond shaped, color-specific stickers, with symbols and numbers on the bottom which designate the hazard classification(s) of the packaged material(s). Labels are used with either the hazard class, shipping name or numbers on non-bulk containers ≤ 119 gal/882 lbs, along with the shipping name and identification number of the substance in the container.

Placards

Placards are 10.7” square/273 mm color-specific diamonds with symbols and hazard class name or number used on freight containers, vehicles and bulk packages, > 119 gal/882 lbs., in addition to the identification number of material in the container(s). If required, placard(s) are required to be placed on each end and each side of the freight container(s), vehicle(s), and package(s), for a total of four (4) placards of each type on the container.

Identification Numbers (ID) either a UN or NA number

Both DOT and UN transportation systems use a **four-digit** identification number as a reference for substances and materials. If the UN does not have a UN number designated for a material that is considered hazardous under the DOT system, then the DOT issues a NA number.

UN – United Nations NA – North America

An ID number may be placed in the **center** of a placard or displayed on packages as part of the hazard identification system. For example, UN 1203 is the ID number for Gasoline.

Emergency Response Guidebook (ERG) exercise:

Page	Title
_______________	Example of a Shipping Paper
_______________	How to Use the Guidebook during an Incident
_______________	Safety Precautions
_______________	Notification and Request for Technical Information
_______________	Hazard Classification System
_______________	Introduction to the table of placards
_______________	Table of placards and initial response guide to use on-scene
_______________	Canada National Response Center
_______________	United States National Response Center (NRC)
_______________	CHEMTREC
_______________	Military Shipments

Color	
_______________	Chemicals listed by 4-digit ID Number
_______________	Chemicals listed alphabetically
_______________	Guide Numbers
_______________	Initial Isolation and Protective Action Distances
_______________	List of Dangerous Water Reactive Materials
_______________	Initial Isolation and Protective Action Distances for Different Quantities of Six Common TIH Gases

To use the guide (orange section) for response in the DOT Emergency Response Guidebook, you need to know either the identification number or shipping name of the substance.

- Look up either the **ID Number** in the yellow-bordered pages or the **Name of the Material** in the blue-bordered pages, and note the **Guide Number** referenced in the index.
- Turn to the referenced **Guide Number** in the orange-bordered pages, and follow the emergency response information in that guide for your situation.
- If either the name or number is highlighted in **Green** in either the yellow or blue pages follow these steps:

If there is no fire:

- Go directly to Table 1 in the green section
- Look up the ID number and name of material
- Identify initial isolation and protective action distances

If there is a fire or a fire is involved:

- Also consult the assigned orange guide
- If applicable, apply the evacuation information shown under PUBLIC SAFETY in the orange guide

Note: If the name in Table 1 is shown with "When Spilled in Water" in parentheses under the name, these materials produce large amounts of Toxic Inhalation Hazard (TIH) gases when spilled in water (Water Reactive) and the gases produced can be found in Table 2. Some Water Reactive materials are also TIH materials themselves (Bromine triflouride 1746, Thionyl chloride 1836). In these instances, two entries are provided in Table 1 in parentheses under the name and will have (when spilled on land) and (when spilled in water) for land or water-based spills. If the Water Reactive material is not a TIH (Guide 138) and this material is not spilled in water, Table 1 and Table 2 do not apply and safety distances will be found within the appropriate Orange Guide only. Table three is new in 2012 and contains six chemicals requiring special attention (Ammonia, Chlorine, Ethylene oxide, Hydrogen chloride, Hydrogen fluoride, and Sulfur dioxide).

- If the only information available is a **label** on the container or **placard** on the vehicle, turn to the '**Table of Placards and Initial Response Guide to use On-Scene p. 8-9 (2016 ERG)**,' where it says underneath to USE THIS TABLE ONLY IF MATERIALS CANNOT BE SPECIFICALLY IDENTIFIED BY USING THE SHIPPING DOCUMENT, NUMBERED PLACARD, OR ORANGE PANEL MARKER; then refer to the guide number referenced in the circle adjacent to the placard.

Shipping Papers

A shipment of hazardous material must have paperwork which provides specific information regarding the contents of the shipment. Shipping papers must include:

- Emergency Contact Phone Number
- Number and type of packages
- UN or NA ID number
- Proper Shipping Name
- Hazard Class or Division Number
- Packing Group (I, II, or III)
- Quantity of material(s) shipped
- Technical and handling information

In addition, either a Safety Data Sheet, or the appropriate guide pages must accompany the shipping papers and provide further information such as:

- Material description
- Health hazards
- Fire and explosion risks
- Public safety/Emergency actions
- Fire procedures
- Spill and leak procedures
- Preliminary first aid

See the inside front cover of the Emergency Response Guidebook for examples of Shipping Documents (Papers) including the hazardous material description in the rectangular box in the center of the page and an example of two placards at the bottom of the page including the orange panel that is an acceptable alternative for the ID number if the ID number is not displayed in the middle of a placard.

Environmental Protection Agency

Hazardous Waste

Hazardous wastes are identified by the EPA as described in 40 CFR 261. Criteria for listing hazardous wastes are located in part 40 CFR 261.11. **'Listed wastes'** are known as 'waste streams' generated by specific processes. According to RCRA, if a waste isn't listed, it must be tested to see if it exhibits one or more of the following 'characteristics.' Wastes that exhibit these characteristics are called **'Characteristic waste'** and have the:

- Characteristic of Ignitability: waste having a flash point of < 140°F, or an ignitable compressed gas, flammable liquid or solid, or oxidizer according to DOT
- Characteristic of Corrosivity: waste with a pH of <2.0 or >12.5
- Characteristic of Reactivity: wastes that explode, or react violently when exposed to water, or that generate toxic gases
- Characteristic of Toxicity: waste analyzed using the Toxic Characteristic Leachate Procedure (TCLP) test to check for toxic constituents at levels greater than those specified in the applicable environmental regulations

Toxin	US EPA Limits	AK H_2O Quality
Arsenic	5.0 mg/l	.05 mg/l
Cadmium	1.0 mg/l	.005 mg/l
Chromium	5.0 mg/l	.1 mg/l
Lead	5.0 mg/l	.015 mg/l
Mercury	.02 mg/l	.002 mg/l

Note: 1 % = 10,000 PPM

EPA Hazardous Waste Number

A four-digit number given to different wastes by the EPA for identification purposes.

- D001 – A solid waste that exhibits the characteristic of ignitability
- D002 – A solid waste that exhibits the characteristic of corrosivity

- D003 – A solid waste that exhibits the characteristic of reactivity
- D004 – D043 – Solid wastes that exhibits the characteristic of Toxicity. Examples:
    - D008 – Lead
    - D018 – Benzene
    - D019 – Carbon Tetrachloride

EPA ID Number

A unique EPA 12-digit number assigned to each generator, transporter, and treatment, storage or disposal (TSD) facility. The EPA assigns an identification number to each generator, transporter, and treatment, storage or disposal facility for tracking purposes.

Uniform Hazardous Waste Manifest Forms

A Hazardous Waste Manifest provides the means for ‘cradle-to-grave’ tracking of hazardous wastes as mandated by RCRA. It consists of numerous copies that are transferred from the generator, to the transporter and disposal facility via ‘hand-to-hand signature.’ The manifest is forwarded to the EPA when the disposal facility has certified permanent receipt and/or destruction of the hazardous waste. The waste manifest must contain the following:

- Name, address and EPA identification number of the:
    - Generator
    - Transporter(s)
    - Disposal Facility
- EPA and DOT Shipping Description of the Waste(s)
- Emergency Contact Information

You never lose the liability for the product you sent to the TSD facility.

Limitations of Documentation

While SDS, shipping papers, hazardous waste manifests, labels and placards contain important information, there are limitations preventing acquisition of complete information. Some limitations are listed below.

- SDSs may not be readily available
- Limited information
    - SDS may not be current, complete or accurate
    - May not be relevant for the specific use
- Insufficient time, particularly in an emergency
    - To read and understand the information
    - To call manufacturer/supplier contact
- Placards may not be visible due to accident, fire, damage to container
- Complete information may not be on a shipping container

Chapter 5

29 CFR 1910.120:

Hazardous Waste Operations and Emergency Response

Introduction

Hazardous waste operations expose personnel to a wide variety of occupational risk and hazards. Although the responsibility for providing adequate safety information, instruction and enforcing safety rules and procedures lies with the employer; **it is up to the employee to become as self-reliant as possible for his or her own safety.** Safety is not just the prevention of injuries or accidents, but also includes an awareness of potentially dangerous situations.

The purpose of the HAZWOPER standard is to identify major areas of concern regarding employee exposure to health and safety hazards, as well as provide guidelines for protection from injury.

29 CFR 1910.120: Hazardous Waste Operations and Emergency Response

a. *Scope, Application and Definitions*
b. *Safety and Health Program*
c. *Site Characterization and Analysis*
d. *Site Control*
e. *Training*
f. *Medical Surveillance*
g. *Engineering Controls, Work Practices and Personal Protective Equipment for Employee Protection*
h. *Monitoring*
i. *Informational Programs*
j. *Handling Drums and Containers*
k. *Decontamination*
l. *Emergency Response by Employees at Uncontrolled Hazardous Waste Sites*
m. *Illumination*
n. *Sanitation at Temporary Workplaces*
o. *New Technology Programs*
p. *Certain Operations Conducted Under the Resource Conservation and Recovery Act of 1976 (RCRA)*
q. *Emergency Response to Hazardous Substance Releases*
Appendix A to 1910.120.00 – Personal Protective Equipment Test Methods
Appendix B to 1910.120.00 – General Description and Discussion of the Levels of Protection and Protective Gear
Appendix C to 1910.120.00 – Compliance Guidelines
Appendix D to 1910.120.00 – References

29 CFR 1910.120: Hazardous Waste Operations and Emergency Response

a) Scope

OSHA standards contained in 29 CFR 1910.120 were created to protect the health and safety of workers who have the potential for exposure to chemical and physical hazards at or above permissible or published exposure limits. The **standard is applicable** to:

- Clean-up operations required by a governmental body, whether Federal, state, local or other involving hazardous substances that are conducted at uncontrolled hazardous waste sites (including but not limited to, the EPA's National Priority List (NPL)…
- Corrective actions involving clean-up operations at sites covered by the Resource Conservation and Recovery Act of 1976 (RCRA)…
- Voluntary clean-up operations at sites recognized Federal, state, local or other governmental bodies as uncontrolled hazardous waste sites
- Operations involving hazardous wastes that are conducted at treatment, storage, and disposal (TSD) facilities…
- Emergency response operations for releases of, or substantial threats of releases of, hazardous substances without regard to the location of the hazard

b) Safety and Health Program

The Safety and Health Program is developed to identify, evaluate and control health and safety hazards. In addition, it specifies emergency response procedures. Copies of the written plan must be located where workers, contractors, subcontractors' representatives, and government personnel have access to it at the work site.

The **written safety and health program must incorporate the following**:

- An Organizational Structure
- A Comprehensive Work Plan
- Site-Specific Safety and Health Plan (SSSHP)
- The safety and health training program
- The Medical Surveillance Program
- The employer's Standard Operating Procedures for safety and health
- Any necessary interface between general program and site-specific activities

There may be a generic Emergency Response Plan for your worksite, but when a spill, leak or release occurs, you must write a Site-Specific Safety and Health Plan (SSSHP).

A **Site-specific Safety and Health Plan (SSSP)** must be developed as a separate component of the Safety and Health Program for each site on which personnel are involved in hazardous operations. The safety and health supervisor generally develops, implements, and verifies compliance with the site plan.

The site-specific safety and health plan is used as a planning guide before any activity begins, as well as a reference tool throughout the operation. As situations in the work environment change, relevant sections of the site-specific safety and health plan are updated to reflect alterations in work activities.

- The site safety and health plan, as a minimum, must address the following:
    - A safety and health risk or hazard analysis for each site task and operation found in the work plan
    - Employee training assignments
    - Personal protective equipment to be used by employees for each of the site tasks and operations being conducted
    - Medical surveillance requirements
    - Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment
    - Site control measures
    - Decontamination procedures
    - An emergency response plan meeting the requirements for a safe and effective response to emergencies
    - Confined space entry procedures (If entering confined spaces)
    - A spill containment program

Key Personnel

Knowing the lines of authority and communication as well as responsibilities of each person involved in a hazardous waste operation is essential for effective work flow and quick resolution of unexpected circumstances. The Incident Command System (ICS) is used to fulfill this requirement and is an integral part of command and control at a HAZWOPER site. ICS will be described in detail later in the course.

Health and Safety Risk Analysis

The health and safety plan identifies all the potential exposures to chemical and physical hazards that could occur during each phase of the operation, along with the safe work practices used to minimize risk to employees. The analysis determines:

- Hazards and Risks associated with each task and operation
- Medical surveillance requirements
- Personal protective equipment
- Monitoring requirements and protocols
- Decontamination procedures
- Emergency response procedures

Comprehensive Work Plan

A work plan describes procedures, logistics and resources for each activity and includes:

- Work objectives
- Methods of accomplishment

- Personnel requirements
- Equipment requirements

c) Site Characterization and Analysis

Site characterization and analysis is a detailed process required to identify specific hazards present in the work environment. Analysis includes a preliminary evaluation, along with hazard identification and risk assessment to ensure appropriate measures are taken to protect employees. After site characterization, conditions must be constantly monitored to detect any changes in the work environment. The initial or preliminary site evaluation usually consists of: 1) Site Characterization, 2) Monitoring, 3) Control Actions, 4) Sampling.

Site Characterization – 1910.120 (c) states that:
The preliminary site evaluation should provide sufficient information to select PPE that will protect personnel from the hazards present on site. If sufficient information is not available as a result of initial site evaluations and characterizations, OSHA mandates the use of Level B protection (self-contained breathing apparatus – SCBA, possible chemical protective suit), along with direct-reading monitoring equipment at a minimum for site entry. If positive pressure SCBA is not part of the PPE ensemble during initial entry, a minimum of at least 5-minute escape breathing apparatus must be used to adequately safeguard workers.

- Site assessment includes:
    - Hazard and risk assessment
    - Site location, size, topography, and accessibility
    - Description and duration of work activities
    - Emergency response capability
    - Safety and health hazards expected on site
    - Potential pathways for hazardous substance dispersion

Hazard and Risk Assessment

This entails an investigation of all conditions that indicate potential inhalation, eye or skin absorption hazards, and/or immediately dangerous to life and health (IDLH) concentrations, as well as chemical and physical hazards. Record clues such as dead animals or vegetation, pits and ponds, visible liquids or stains on the ground, vapor clouds, bulging or deteriorating containers, noise such as hissing, fire or any other detectable hazard. Risk assessment starts as soon as possible upon arrival at the site, must be communicated to everyone on site, is ongoing and is evaluated once the presence of specific hazardous materials or conditions is identified. Specific situations that require evaluation are:

- Oxygen content
- Potential explosive or flammable atmospheres
- Toxic/IDLH concentrations
- Presence of ionizing radiation

Other Potential Hazards Include:

Biological
Bacteria – Colds
Virus – Rabies
Parasites – Giardia
Plant – Devils Club
Animal – Bears/Foxes/Moose

Physical
Topography – Slips, trips, falls
Weather – rain, snow, ice
Noise and/or Heat/Cold Stress
Ergonomics – vibration/back strain
Water – Hypothermia/Drowning
Confined Spaces
Energy – electricity/fluids/steam

Chemical
Caustics – Acids/Bases
Flammable/Explosive Atmospheres
Solids/Liquids/Gases
Vapors/Fumes/Dusts
Containers/Labels/Placards

Psychological
Stress
Fatigue
Monotonous jobs
Claustrophobia
Disorientation in PPE
Poor Working Conditions
Peer Pressure/Intimidation

d) Site Control

A site control program is designed to adequately control the exposure of employees to hazardous substances on site, and prevent the migration of contaminants to “clean” areas of the site. The site control program must be implemented before clean-up work begins, is part of the written Site Safety and Health Plan, and modified as often as necessary as a result of changing conditions during clean-up operations.

The standard requires that the site control program includes or addresses, as a minimum, the following items or topics:

- Site map
- Site work zones
- Buddy system
- Safe work practices or standard operating procedures (SOPs)
- Site communications including emergency alerting procedures
- Identification of the nearest source of medical assistance

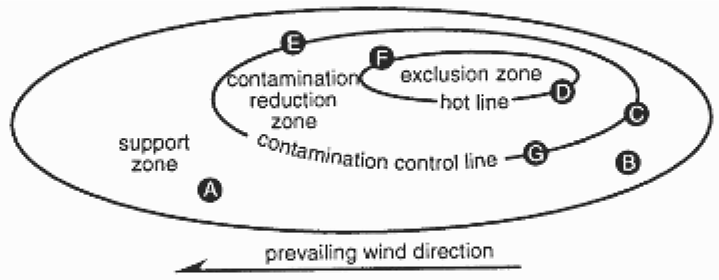
Site Map

A site map is a graphic representation of topographic features; prevailing wind direction; drainage; and location of buildings, containers, impoundments, pits, ponds, and tanks. It is used at health and safety briefings for planning work activities and evacuations routes. The site map is modified as needed to reflect changes in weather, work tasks and operational progress. It shows zones, entryways, staging areas, rally points, decontamination area, medical, showers and changing areas, as well as other pertinent information.

Work Zones

Work sites are divided into different zones to reduce the spread of toxins from a contaminated area to a clean area, control the number of personnel in high-risk areas, delineate required levels of protection to be worn, and plan emergency evacuation routes. Most sites will have at least three zones:

- Exclusion Zone (EZ) – the most contaminated area
- Contamination Reduction Zone (CRZ) – the decontamination area
- Support zone (SZ) – the uncontaminated area



The **Exclusion Zone** (EZ), also referred to as the “hot zone,” is the area of highest contamination. The outer boundary of EZ is called the **hotline.** It is clearly marked by lines, hazard tapes or enclosed by physical barriers such as chains, fences or ropes. Personnel working in the EZ are in the highest level of PPE required. Only authorized team members such as the field team leader, work parties, heavy equipment operators, entrants into confined spaces, or others with appropriate training and equipment are allowed access.

The transition area between the Exclusion Zone and the Support Zone is called the **Contamination Reduction Zone** (CRZ) or “warm zone.” This area contains the Contamination Reduction Corridor (CRC), where decontamination is performed. Decontamination has at least two lines; a personnel line where workers are decontaminated, and an equipment line where tools and machinery are decontaminated.

The **Contaminant Control Line** is the boundary between the SZ and CRZ. Field Team members, Site supervisor, Safety or possibly Security personnel are usually stationed here to ensure only authorized and equipped crew members enter the hot zone. Equipment resupplies and temporary rest areas may be here as well.

The **Support Zone** (SZ) or “cold zone” is where administrative, support and other functions not requiring protective equipment are performed. Personnel often present at this location are the command post supervisor, project team leader and support field team members. Personnel have no respiratory or skin exposure to hazardous chemicals in the support zone so they wear level D (normal work uniform) clothing. Location of support zone is based on accessibility (emergency vehicles), resources (power lines, water, shelter), distance (as far from the exclusion zone as necessary), visibility (line of sight to the exclusion zone if possible), topography (uphill of the exclusion zone where possible), and wind direction (upwind of the exclusion zone).

Buddy System

The Buddy System is an example of a safe work practice. Workers are organized into teams and assigned to observe the activities of at least one person in the group, keeping watch on his or her safety and health. Buddies work in line-of-sight contact or communications with each other. A buddy observes for signs of exposure, distress, heat stress, and fatigue. A buddy periodically checks the integrity of a partner's protective clothing, provides assistance, and notifies others if emergency help is needed. When wearing protective clothing, hand signals must be mutually understood or other effective communication must be in place.

Communication Systems

Communication systems are established to alert team members to emergencies, pass along safety information, initiate changes in work tasks, and maintain site control. Communication systems used at a work site are referred to as internal and external systems. Internal systems consist of visual cues such as hand signals, lights, flags, flares, and audio cues such as bells, sirens, whistles, or compressed air horns. External communication systems such as voice activated headsets, throat microphones, telephones or radios are useful, but may be limited by cost, possible contamination or when static electricity or protective clothing prohibits the clarity of sound transmission or pose a safety hazard.

Safe Work Practices or Standard Operating Procedures

Standard operating procedures (SOPs) are required written work procedures or policy descriptions that assure that site activities are conducted safely according to a uniform plan. See Chapter 9 for details. A Job Safety Assessment (JSA) should be completed for each work task and consists of identification of hazards, required mitigation including engineering controls, work practices and PPE required to complete the job safely.

e) Training

The HAZWOPER standard includes training requirements applicable to all employees who may be exposed to site hazards. Training requirements vary according to job assignment and potential for exposure to hazardous substances.

General Site Workers

- Laborers and equipment operators, who engage in activities which have high exposure potential are required to complete:
    - 40 hours of off-site instruction
    - 3 days of on-the-job training under the direct supervision of a trained, experienced supervisor
    - 8 hours of annual refresher training

Limited and Occasional Site Workers

- Employees regularly on site performing general tasks, as well as those on site occasionally for specific limited tasks; both of which work only in areas which have

been monitored and fully characterized; indicating that no respiratory protection is required and emergencies are unlikely, are required to complete:
  - 24 hours of off-site instruction
  - 1 day of on-the-job training under the direct supervision of a trained, experienced supervisor
  - 8 hours of annual refresher training

- **Supervisors must complete:**
  - Equivalent training as that required for the employees they supervise
  - At least 8 additional hours of specialized off-site training
  - 8 hours of annual refresher training

Scope of Training

The scope of training should be such that all employees are well versed in the following topics:

- Names of all site health and safety personnel and alternates
- Site chemical and physical hazards
- Symptoms that indicate overexposure to hazards
- Medical surveillance requirements
- Site control measures
- Safe work practices
- Safe use of engineering controls and site equipment
- Use of personal protective equipment (PPE)
- Decontamination procedures
- Confined space entry procedures
- Provisions of the emergency response plan
- Spill containment procedures

The Supervisor's additional training should cover topics such as:

- Employer's health and safety program
- Employee training program
- Personal protective equipment (PPE) program
- Health hazard monitoring techniques
- Spill containment program

f) Medical Surveillance

OSHA requires that each employer involved in hazardous operations institute a medical surveillance program. This program covers all employees who are:

- Potentially exposed to substances at or above permissible or published exposure limits, without regard to the use of respirator for 30 days or more per year
- Required to wear a respirator for 30 days or more per year
- Injured due to overexposure to hazardous substances

- Assigned to hazardous materials response (HAZMAT) teams

Medical examinations must be conducted:

- Before assignment
- At least annually during employment, unless the attending physician believes a longer interval is appropriate; **not to exceed two years**
- As soon as possible after accidental overexposure or the appearance of symptoms which may be exposure-related
- At the time of termination or reassignment, if more than six months has passed since the most recent examination

g) Hierarchy of Controls. In all situations, attempts should be made to 1) Eliminate the hazards, 2) Engineer out the hazards, 3) Administratively Control the hazards, 4) Ensure Safe Behaviors are being used, 5) Use proper Personal Protective Equipment according to the Job Hazard Analysis (JHA) written for that activity.

Engineering Controls, Work Practices and Personal Protective Equipment

Engineering controls, work practices and personal protective equipment (PPE) are used to protect employees from chemical and physical hazards present in the work environment. 29 CFR 1910.120 (g) requires that:

> Prior to considering the need for PPE, engineering controls and safe work practices be utilized to reduce or maintain employee exposure to hazards below the PEL. Whenever engineering controls and work practices are insufficient or not feasible, personal protective equipment (PPE) is incorporated into the site-specific health and safety plan to reduce or maintain employee exposure to hazards below the PEL.

Engineering and administrative controls target the source of exposure and/or limit the contact an individual has with a contaminant. When hazards cannot be ‘controlled,’ PPE is used to reduce employee exposures.

- Remove the hazard from the work environment
  - Engineering Controls
  - Administrative Controls
  - Safe Work Practices
- Prevent the hazard from contacting the worker
  - Administrative Controls
  - Safe Work Practices
  - PPE
- Prevent a hazardous situation from developing
  - Safe Work Practices or Standard Operating Procedures (SOPs)

Engineering controls remove an exposure before it becomes a hazard. Engineering controls reduce the level of the contaminant or hazard at the source.

- Substitution
- Isolation
- Ventilation

    - Air-conditioned Cab on Equipment
    - Remote Drum-Opening Rig
    - Shielding or Radiation

Administrative controls are written policies and/or required practices that are designed to minimize employee exposure to chemical and physical hazards. Administrative controls may prevent or minimize a hazardous situation from occurring and may include but are not limited to:

- Limiting the Duration of Exposure
    - Recommend 2-hr Work Shifts as applicable
- Monitoring Programs
- Medical Surveillance Programs
- Signs, Danger or Caution warning tape
- Written procedures
- Training
- Checklists
- Job Hazard Analysis (JHA)
- Work Permits
- Specific Work Practices that reduce or prevent exposure
    - Confined Space Entry Procedures
    - Lock Out/Tag Out Procedures
    - Hot Work Permits and Policies

Selection and Use of PPE

Since PPE is the last choice in the Hierarchy of Controls, where the hazard cannot be eliminated by other means, selection of PPE is based on site-specific conditions and circumstances. Its use is upgraded or downgraded as conditions change or additional information regarding contaminants becomes available. A written PPE program incorporates:

- Selection
- Use and limitations
- Work mission duration
- Maintenance
- Storage
- Decontamination and disposal
- Training and proper fitting
- Donning and doffing
- Inspection procedures
- Limitations during temperature extremes
- Program evaluation

PPE is discussed in detail in Chapter 7.

h) Site Monitoring

Monitoring is conducted when the site evaluation reveals the potential presences of an IDLH condition, ionizing radiation, or information gathered during initial site characterization and analysis is not sufficient to confirm the absence of contamination. Monitoring includes:

- Verifying oxygen content
- Checking for combustible or explosive atmospheres
- Checking for toxic or IDLH conditions
- Checking for hazardous levels of ionizing radiation

Monitoring programs include:

- Initial Entry
- Periodic Monitoring
- Monitoring of High-Risk Personnel
- An On-going Program

Monitoring is discussed in detail in Chapter 6

i) Informational Programs

An informational program shall be developed and implemented by the employer to inform employees, contractors and subcontractors of potential chemical exposure risks associated with site operations. This program could range from something as simple as a directory of "generic" safety data sheets to a computer data base for chemicals being stored or handled. It may also consist of a pre-job shift and post-job shift safety meeting for all members of the on-site team or other involved personnel.

j) Handling Drums and Containers

This includes specific rules and procedures applicable to sites where hazardous substances are stored in drums and other containers.

See Safe Work Practices - Chapter 9

k) Decontamination

Decontamination provisions require that all personnel, clothing and equipment be decontaminated before leaving the contaminated area of a site. Standard operating procedures (SOPs) must be developed to minimize contamination migration, as well as contact between contaminated and uncontaminated employees and equipment. A rule of thumb for water supply purposes is that one gallon of water is needed for each square foot of surface to be decontaminated.

l) Emergency Response at Uncontrolled Hazardous Waste Sites

This standard requires employers to develop an emergency response plan as a separate segment of the site health and safety plan. The emergency response plan must be designated to handle any emergencies which could reasonably be anticipated to occur in the work environment. It must be made available in writing to all employees, employee representatives and OSHA personnel.

The emergency response plan will address:

- Pre-emergency planning

- Personnel roles, lines of authority and communications
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Site topography, layout and prevailing weather conditions
- Incident reporting procedures to local, State and Federal agencies
- Evacuation routes and procedures
- Emergency decontamination procedures
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- Periodic plan review and amendment
- PPE and emergency equipment for emergency response
- Compatibility with the disaster, fire and emergency response plans of local, State and Federal agencies

Employers can be exempt from the requirement for emergency response plan development if they intend to immediately evacuate all employees in the event of any emergency response operation. However, an emergency action plan is required in this case.

m) Site Illumination

Requires that all work environments have adequate lighting.

n) Sanitation at Temporary Workplaces

Requirements cover:

- Water Supplies
- Toilet Facilities
- Food Handling
- Sleeping Quarters
- Washing/Shower Facilities

o) New Technology

Requires development and implementation of procedures to incorporate new technology into existing plans and programs.

p) RCRA Facilities

Operations conducted at RCRA treatment, storage and disposal (TSD) facilities are responsible for:

- Health and Safety Program
- Hazard Communications Program
- Medical Surveillance Program
- Decontamination Program
- New Technology Program

- Material Handling Program
- Training Program
- Emergency Response Program

q) Emergency Response to Hazard Substance Releases

Employers involved in Emergency response operations are responsible for:

- Emergency Response Plan
- Elements of an Emergency Response Plan
- Procedures for Handling Emergency Response
- Skilled Support Personnel
- Specialist Employees
- Training
- Trainers
- Refresher Training
- Medical Surveillance and Consultation
- Chemical Protective Clothing
- Post Emergency Response Operations
- Site Specific Safety and Health Plan (SSSHP)

Key Terms – HAZWOPER (See Chapter or Glossary)

Administrative controls

Buddy system

Contaminant control line

Contamination reduction zone (CRZ)

Engineering controls

Exclusion zone (EZ)

Hotline

Safety and health plan

Site control

Support zone (SZ)

Chapter 6

Monitoring

Chapter Objectives

Enable students to:

- Understand how monitoring supports workplace safety
- Identify- types of workplace monitoring
- Delineate air monitoring hierarchy
- Understand operating principles of monitoring instruments

Introduction

Monitoring confirms whether or not suspected hazardous substances are present in the work environment. Many of the decisions related to employee protection and workplace safety control procedures are a result of knowing the identification and quantification of harmful contaminants in the work environment. Although no single instrument can detect all hazards, proper use of monitoring equipment by a qualified individual can provide information necessary to protect life, the environment and property.

Monitoring confirms:

- If hazardous substances are present under normal operations
- If contaminants are present at or above permissible or published exposure limits, or IDLH levels
- If contaminants have changed location due to wind, leaching, etc.
- Sudden releases of material(s) that may require a change in work practice or protective equipment
- That no hazardous substances remain

Monitoring for IDLH and Other Dangerous Conditions

As a first step, monitoring is conducted to identify any IDLH and/or other dangerous conditions such as oxygen-deficient environment, a flammable or explosive atmosphere, or highly toxic levels of airborne contaminants.

Direct-reading monitoring instruments include oxygen meters, combustible gas indicators, colorimetric detector tubes, and organic vapor monitors.

Site Characterization – 1910.120 (c) states that:

> The preliminary site evaluation should provide sufficient information to select PPE that will protect personnel from the hazards present on site. If sufficient information is not available as a result of initial site evaluations and characterization, OSHA mandates the use of Level B protection (self-contained) breathing apparatus – (SCBA), along with direct-reading monitoring equipment for site entry. If positive pressure SCBA is not part of the PPE ensemble during initial entry, a minimum of at least a 5-minute escape breathing apparatus must be used to adequately safeguard workers.

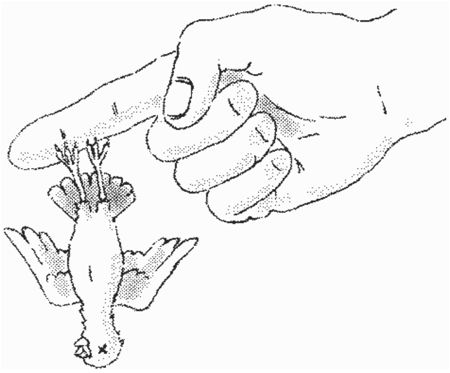
Site Monitoring

When harmful conditions exist, monitoring provides positive identification of substances and quantifies concentrations of contaminants. Monitoring verifies whether contaminants known to be present at a work site are stable, increasing or decreasing in concentration, as well as alerting working personnel to the introduction of additional contaminants not previously characterized. In addition, oxygen content, any radiation levels, presence of explosive atmospheres and other dangerous situations such as IDLH levels require verification.

Types of Monitoring

Depending on site conditions one or more types of monitoring may be necessary. Priorities for monitoring are based on information gathered during initial site characterization.

- Initial Entry
- Periodic Monitoring
- Monitoring of High-Risk Employees
- On-going Monitoring



Initial Entry

Monitoring during initial entry is necessary if results of the site evaluation indicate a potential for IDLH conditions, ionizing radiation, or when site evaluations do not indicate the possibility of these conditions.

Periodic Monitoring

Periodic monitoring should alert workers to every change in hazardous conditions. It is initiated after operations begin 'when the possibility of IDLH conditions, flammable atmospheres, or when there is an indication that exposures may have risen over permissible or published exposure limits since prior monitoring.' It is possible for a concentration to change when:

- Work begins in a different area of the site
- Contaminants other than those previously identified are encountered
- Different types of operations are initiated
- During drum handling

Monitoring of High-Risk Employees

Employers must monitor those employees likely to experience the highest exposure at or above permissible or published exposure limits after operations begin. If some workers are exposed at or above permissible or published exposure limits, then the program must be expanded to identify all employees that could be exposed.

Monitoring can document:

- Employee exposure
- Site conditions
- Reporting criteria for regulatory agencies.

On-going Monitoring

General monitoring is used to assure selected engineering controls, work practices and protective equipment are effectively protecting workers from exposure at or above permissible or published exposure limits. Industrial hygiene and/or safety personnel use monitoring results to determine:

- Selection of respiratory protection
- Selection of chemical protective clothing
- If medical monitoring is required

Atmospheric Monitoring Determines

- Oxygen Content (O_2 Content)
- Combustible, Flammable or Explosive Atmosphere
- Toxic Concentrations including IDLH Levels
- Radiation
- Biological Hazards

Oxygen Content

The normal atmosphere at 68˚ Degrees F at sea level contains 20.9% Oxygen. Oxygen content can be normal, deficient or enriched.

- Oxygen deficient atmosphere < 19.5% oxygen in an environment
- Oxygen enriched atmosphere > 23.5% oxygen in an environment

Fire and Explosion Hazard

Flammable and explosive atmospheres develop as a result of reactions with oxygen in the air, evaporation of flammables, gas leaks, or dust accumulation. Clothing and respirators which protect the worker from toxic hazards provide little, if any, protection against fire or explosions.

Explosive Limits

Monitoring results reported as percent of air volume provide information about vaporized substances which may potentially cause an explosion. Explosive limits are determined for flammable gases, vapors and dusts. The limits are described as:

- **Lower Explosive Limit** (LEL) – the minimum concentration of a substance in air which is required for ignition. Concentration below the LEL will not ignite. Below the LEL, the mixture is called “lean.”
- **Upper Explosive Limit** (UEL) – the maximum concentration of a substance in air which is required for ignition. Concentrations above the UEL will not ignite. Above the UEL, the mixture is called “rich.”
- **Explosive Range** – the concentration of a substance in air between the LEL and UEL. In this range, the substance will readily ignite. (See OSHA 3371-08 2009 Hazard Communication Guidance for Combustible Dusts)

Toxic Atmospheres

Chemical Concentration and Exposure Limits

Once a potential hazard has been recognized, the measured concentration is evaluated against OSHA’s PEL, NIOSH’s REL, and/or American Conference of Governmental Industrial Hygienist’s (ACGIH) TLV. These values are the maximum concentrations to which a worker may be exposed day after day without adverse effects. Employers are responsible to provide both air purifying or supplied air respiratory protection and ventilation for those workers who are required to work in environments with concentrations at or above the TWA.

Immediately Dangerous to Life or Health (IDLH) Atmospheres

Refer to the NIOSH Pocket Guide to Chemical Hazards for a listing of IDLH values. Note that the NIOSH IDLH values include a margin of safety. “In determining IDLH values, the ability of a worker to escape without loss of life or irreversible health effects was considered along with severe eye or respiratory irritation and other harmful effects that could prevent escape.” Employers are required to provide supplied air respiratory protection systems with emergency egress air systems or SCBA’s for those workers who are required to work in environments with concentrations at or above IDLH.

Radioactivity

It is important to identify any radiation that is present so that adequate precautions can be implemented to prevent exposure. The presence of radiation usually requires technicians referred to as Radiation Safety Officers (RSOs) to conduct monitoring. No single instrument can accurately measure all forms of radiation.

Biological Hazards

Workers may also be exposed to biological hazards such as bacteria, viruses and parasites. The identity of these agents determines the selection of protective equipment, decontamination and disposal procedures.

Analytical Samples

The ability to determine a specific hazard is limited by the capabilities of the monitoring instruments. For immediate results, atmospheres are measured with direct-reading equipment that verify the presence of gases, vapors or mists, yet may not identify a specific contaminant.

In some cases, samples are collected for laboratory analysis. Laboratory analysis presents a problem of time lag between sampling and obtaining results. Personal monitoring devices may also be used to monitor employee exposure. They are generally sent to a lab for reading.

Instrument readings and/or environmental samples are taken regularly and in different locations in and around the work environment. Two approaches available for identifying and/or quantifying airborne contaminants are:

- On-site use of direct-reading instruments
- Laboratory analysis of air samples obtained by gas sampling bag, filter, and absorbent, or wet contaminant collection methods.

Direct-Reading Instruments

Rapid Detection Instruments

Direct-reading instruments are the primary tools of initial site characterization. They are used to rapidly detect flammable or explosive atmospheres, oxygen deficiency, certain gases and vapors, and ionizing radiation. Information provided by direct-reading instruments is used to institute appropriate protective measures and determine the most appropriate equipment for further monitoring, as well as develop optimum sampling and analytical protocols.

Early Warning 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. 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. Today, direct-reading instruments can detect contaminants in concentrations down to one-part contaminant per million parts of air (1 ppm), although quantitative data can be difficult to obtain when multiple contaminants are present.

Operation of Equipment

It is imperative that direct-reading instruments be operated by a qualified individual. The resulting data must be interpreted by an individual who is thoroughly familiar with that particular device, its operating principles and its limitations.

Direct Reading Instruments include:

- Oxygen Meter (O_2 Meter)
- Combustible Gas Indicators (CGI)
- Colorimetric Tubes
- Photo or Flame Ionization Detector (PID or FID)

Oxygen Meter (O_2 Meter)

- Used to measure oxygen concentration

- Read-out is 0 – 100% oxygen concentration
  - <19.5% oxygen, need supplied air
  - >23.5% oxygen, explosion hazard as O_2 content increases
- Precautions:
  - Affected by temperature and pressure
  - Carbon dioxide levels may affect reading
  - Must be calibrated before and after each use
  - Requires maintenance
  - User must be trained

Combustible-Gas Indicator (CGI)

- Used to sample flammable vapor concentration
- Read-out is in percent (%) Lower Explosive Limit (LEL)
  - Reading > 10% entry is restricted
- Precautions:
  - Requires periodic factory calibrations
  - Does not respond the same to all vapors
  - Oxygen must be measured first. CGIs require sufficient oxygen to operate properly to determine LEL.
  - Models with a needle indicator require constant observation during use, as the needle may peg out (swing far to the right and back to 0 and then be misread as 0)
  - User must be trained
  - Must be field calibrated by a qualified individual before and after each use.

Colorimetric Detector Tubes (Drager, Sensidyne, Mine Safety Appliance (MSA))

- Used to sample gas or vapor concentration in any work space.
- Read-out is as parts per million (ppm) or percent (%) of concentration indicated by color change or length of color stain.
- Precautions:
  - Inaccurate + or – as much as 25% of value
  - Limited shelf life, the expiration date on the container must be checked before use
  - Results are affected by temperature and humidity
  - User must be trained to read the scales on the tubes
  - User must follow specific pump stroke and time requirements
  - Pump must be checked for leaks

Limitations of Equipment

All direct-reading instruments have inherent constraints in their ability to detect hazards:

- Detect and/or measure only specific substances
- Can cause interference and report false readings
- Not designed to measure and/or detect concentrations below 1 ppm

Advantages of direct-reading monitoring

- Information is immediately available at the site
- Available for a wide range of potential hazards
- Measures chemicals that cause acute health effects and IDLH situations
- Identification of high levels of toxic and flammable atmospheres
- Determines whether or not the atmosphere within a confined space is safe for entry (Is it oxygen-deficient, flammable or toxic?)

Disadvantages of real-time monitoring:

- May not be sensitive enough to detect low levels of contaminants
  At a “zero” reading contaminants may be present, but at levels below the detection level of the instrument.
- Cannot distinguish one contaminant from another

- May give a false alarm; however, any alarm should be considered real until an investigation is conducted
- May give an inaccurate reading because of the presence of chemicals other than the one being sampled (cross-sensitivity)
- Instruments may need to be sent to the factory for maintenance

Environmental Sampling

Water sampling, soil testing, wipe testing, compatibility testing, or drum sampling may be used to verify the presence of contaminants.

Water Sampling

Sampling and analysis of water from wells, ponds, streams, and effluent groundwater may be used to determine if hazardous substances are present.

Soil Testing

Soil testing may be done at a work site and neighboring property to determine if contaminants have been released into the soil and/or have migrated. Soil testing can indicate how much, if any, contamination there is, how deep it is, and the limits of the area contaminated.

Wipe Testing (Swipe Testing)

Surfaces may be wiped to determine if any contaminants are present. Tests are performed by wiping a surface with a piece of cloth or other material according to specified procedures and then submitting the sample for analysis.

Drum Sampling

Drum sampling is performed at waste sites to identify or verify the contents of drums or tanks. Usually, a sample is taken with a glass rod called a “drum thief,” by inserting the rod into the drum, placing a thumb over the upright end, and withdrawing the rod. The sample captured by the rod is then released into a sample bottle and sent for analysis. Other instruments used for drum sampling may include a coliwasa, bailer or peristaltic pumps.

Compatibility Testing

Tests performed by a laboratory can determine if hazardous materials can safely be mixed (compatible) or if they cannot be mixed (incompatible). Many emergency situations have resulted from mixing two incompatible wastes. Compatibility programs, available on software, have been developed by the U.S. EPA, Army Corp of Engineers, and other groups. These are qualitative approaches to incompatibility problems.

Open Spaces

In open spaces, toxic materials tend to be emitted into the atmosphere, transported away from the source and dispersed. Acutely hazardous conditions are not likely to exist in open spaces for extended periods of time unless there is a consistent, readily identifiable source of contaminant such as an overturned tank car. Open spaces are generally given a lower monitoring priority than are enclosed spaces.

Confined Spaces

Natural or artificial barriers such as hills, tall buildings or tanks allow chemical concentrations to build up. Cargo holds, mine shafts, silos, storage tanks, box cars, buildings, bulk tanks, and sumps are likely spaces for hazards to accumulate. Low-lying areas, such as hollows and trenches, are also suspect. Consider sampling on hilltops and under any cover or canopy where individuals might work or congregate.

Confined Spaces Hazards:

- Potential hazardous atmosphere
- Potential to engulf or entrap an employee
- Configuration that could result in entrapment or asphyxiation
- Any other recognized hazard

Characteristics of Hazardous Atmospheres:

- Flammable/Combustible gases or vapors above 10% of LEL
- Flammable/Combustible dust
- Oxygen Deficient or Enriched content
- Toxins above PELs
- IDLH Atmosphere

Oxygen Content

Oxygen Deficient Atmosphere:
Atmospheres where the percentage of oxygen-by-volume is < 19.5%.

Oxygen Enriched Atmosphere:
Atmospheres where the percentage of oxygen-by-volume is > 23.5%.

Confined Space Entry is forbidden unless you have received the training prescribed in 29 CFR 1910.146 for General Industry or 29 CFR 1926.1200-1213 for Construction Industry.

Chapter 7

Personal Protective Equipment

Chapter Objectives

Enable students to:

- List and Describe the Levels of Personal Protective Equipment (PPE)
- Identify and/or Select the Appropriate Level of PPE for the Environment in which Work will be Performed
- Understand Before and After Use PPE Maintenance Checklists
- Describe Advantages and Limitations of PPE

Introduction

Controlling hazards is the key element to reduce the risks of exposure to personnel. HAZWOPER regulation, 29 CFR 1910.120 (g) requires that: Prior to considering the need for PPE, engineering controls and safe work practices must be utilized to reduce or maintain employee exposure to hazards below the PEL. Whenever engineering controls and work practices are insufficient or not feasible, personal protective equipment (PPE) is incorporated into the Site-Specific Safety and Health Plan (SSSHP) to reduce or maintain employee exposure to hazards below the PEL.

General Requirements – 29 CFR 1910.132 states that:

> "Protective equipment, including personal protective equipment for eyes, face, head and extremities, protective clothing, respiratory devices, and protective shields and barriers, shall be provided, used and maintained in a sanitary and reliable condition wherever it is necessary by reason of hazards or processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact."

If employees provide their own protective equipment, employers are responsible to ensure it is adequate, including proper maintenance and sanitation. Employer may be assuming any liability for employee owned equipment in case of a malfunction or incident.

Employees must be aware that the equipment does not eliminate the hazard. If the equipment fails, exposure will occur.

PPE is generally broken into four main types of protection:

- General Safety Equipment
- Respiratory Protection
- Chemical Protective Clothing (CPC)
- Temperature Barriers

Personnel Training

Prior to being allowed to perform work using PPE, personnel must be trained, and demonstrate understanding of the ability to use the specific device(s) they may be required to use in the workplace. Training topics include:

- When PPE is necessary
- What PPE is necessary
- How to properly don, doff, adjust, and wear PPE
- Limitations of PPE
- Proper care, maintenance, useful life, and disposal of PPE.

PPE requirements stipulated in 29 CFR Subpart I, Sections 1910.132–1910.139 encompass protection for the entire body. Subpart I requirements include:

- 1910.132 – General Requirements
- 1910.133 – Eye and Face Protection
- 1910.134 – Respiratory Protection (Appendices A, B-1, B-2, C, D)
- 1910.135 – Head Protection
- 1910.136 – Foot Protection
- 1910.137 – Electrical Protective Devices
- 1910.138 – Hand Protection
- 1910.139 – Respiratory Protection for M. Tuberculosis
- 1910 Subpart I (Appendices A – B)

General Safety Equipment

Face and Eye Protection Equipment

Face and eye protective equipment complete with side protectors is used to prevent injuries that can result from flying objects, molten metals, liquid chemicals, acids and caustic liquids, chemical gases or vapors, or potentially injurious light radiation.

Face and eye protective equipment shall comply with American National Standards Institute ‘USA Standard for Occupational and Educational Eye and Face Protection, ‘Z87.1-or Z 87.1 +, 2020.

Types of protective face and eye equipment include:

Face Shields

Protect against splashes and small slow-moving projectiles. This device can attach to a hard hat or can be strapped directly to the forehead.

Goggles

Depending on the type of device, goggles can protect against chemical splashes, large particles and projectiles. ANSI rated ski goggles are also available where needed.

Safety Glasses

Safety glasses protect against large particles and projectiles. They are worn just like regular glasses and must comply with ANSI Z 87.1-2003. If an employee wears glasses off the job and requires them to do work; either Over The Glasses (OTG) safety glasses or goggles must be worn, or employee must acquire prescription safety glasses which include frame, lenses and side shields that comply with the ANSI Z 87.1-2003.

Respiratory Protection

Respiratory protection protects employees from toxic and oxygen-deficient atmospheres. Respiratory protection is discussed in detail later in this chapter.

Head Protection

Specially designed protective helmets or 'hard hats' are available that prevent injuries due to bumps, falling or flying objects and electrical shock hazards.

Hard Hat

Classes of Hard Hats are:

- G – General Hazards
- E – Electrical Hazards
- C – Conductive

Head protection must meet American National Standards Institute (ANSI) Z89.1-2009, "American National Standard for Industrial Head Protection," incorporated by reference in 29 CFR 1910.6; (ANSI) Z89.1-2003, "American National Standard for Industrial Head Protection," or American National Standard (ANSI) Z89.1-1997, "American National Standard for Personnel Protection--Protective Headwear for Industrial Workers—Requirements." Hard hats are also Type I – Top Impact, or Type II – Top and Side Impact rated.

Hard Hat Liner

Since more than 50% of the body's heat can be lost through the head, liners can fit inside hard hats to prevent heat loss. There are also Flame Resistant (FR) liners for work in classified (NFPA) areas.

Foot Protection

Protective footwear prevents injuries due to falling or rolling objects, objects that may pierce the sole, and/or electrical shock hazards.

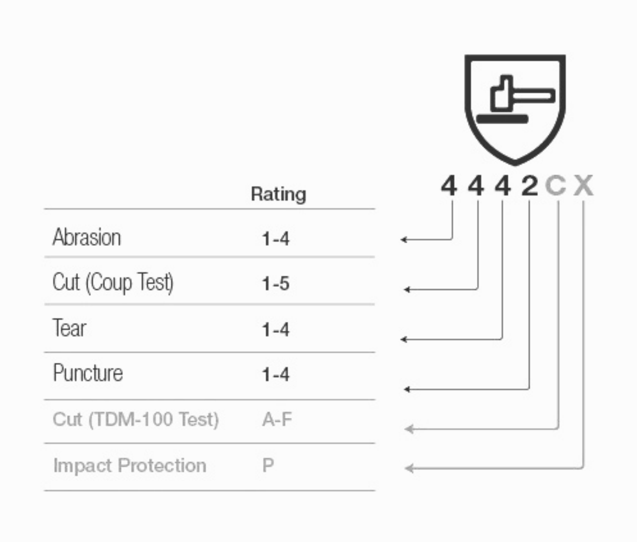
Foot protection must meet ANSI standards and be tested in accordance with – Protective Footwear or the American Society for Testing and Materials (ASTM) F-2412-2005, "Standard Test Methods for Foot Protection," and ASTM F-2413-2005, "Standard Specification for Performance Requirements for Protective Footwear," which are incorporated by reference in § 29 CFR 1910.6. The American National Standards Institute standard is ANSI Z41-1999, "American National Standard for Personal Protection -- Protective Footwear;" or ANSI Z41.1-1991, "American National Standard for Personal Protection -- Protective Footwear."

Electrical Protective Equipment

Protective equipment including blankets, matting, covers, line hose, gloves, hardhats, face shields, body protection, and sleeves made of rubber may be used to prevent electrocution, or arc flash where applicable.

Hand Protection

Protective equipment used to prevent hand injuries due to skin absorption of harmful substances; severe cuts, lacerations, abrasions, or punctures; chemical or thermal burns, and/or harmful temperature extremes is available.



	Rating
Abrasion	1-4
Cut (Coup Test)	1-5
Tear	1-4
Puncture	1-4
Cut (TDM-100 Test)	A-F
Impact Protection	P

Ratings for gloves have expanded recently. There are now ANSI/ISEA 138 standards, European EN 388 standards, and ISO 13997 standards. Glove surveys from suppliers or manufacturers are becoming more frequent due to these changes and the availability of specialized gloves for industry has expanded greatly.

Respiratory Protection

Introduction

Respiratory Protection, mentioned in 29 CFR 1910.120 (g), is covered in detail in 29 CFR 1910.134. Respiratory protection inhibits inhalation of airborne contaminants when neither ‘engineering nor administrative controls are able to provide adequate protection from workplace hazards. Respiratory protection works in conjunction with chemical protective clothing to provide a complete PPE ensemble.

The respiratory system is able to tolerate limited exposure to gases, vapors and particulates. When the respiratory system is exposed to harmful substances in quantities above published exposure limits (PEL, REL, TLV), these substances can impair

or destroy portions of the respiratory tract. In addition, harmful substances can be absorbed from the lungs directly into the blood stream, causing extensive, even fatal, damage to other organs and systems.

Determination for respirator usage is based on evaluation of respiratory hazards in the workplace. 'Where an employer cannot identify the workplace hazards or estimate exposure, workplace atmospheres are considered IDLH' 1910.134(d)(iii). Until air monitoring results are available, employees must wear atmosphere-supplying respiratory protection to prevent the inhalation of unknown airborne contaminants.

Site Characterization – 1910.120 (c) states that:

> 'The preliminary site evaluation should provide sufficient information to select PPE that will protect personnel from the hazards present on the site.

Respiratory Protection Program Requirements

A written respiratory protection program must be established and implemented by the employer if:

- Workers may be required to wear respirators
- Respirators are available for voluntary use

Where workers must wear respirators, there must be:

  - Procedures for selecting respirators and use
  - Medical evaluations for employees required to use respirators
  - Fit-test procedures for tight-fitting respirators
  - Procedures for both routine and emergency use respirators
  - Procedures and schedules for cleaning, disinfecting, inspecting, repairing, storing, discarding, necessary to maintain respirators

  - Procedures to ensure adequate air quality, quantity and flow of breathing air for atmosphere-supplying respirators
  - Training on hazards to which employees may be exposed during both routine and emergency situations
  - Training on respirator use, donning, doffing, limitations and maintenance
  - Procedures for evaluating program effectiveness

Types of Respiratory Protective Equipment

- **Air-Purifying Respirator** (APR) uses filters, neutralizing agents and/or sorbent materials to purify ambient air before it enters the lungs
- **Atmosphere-Supplying Respirator** supplies breathing air from a tank, cascade system or breathing air compressor independent of ambient air

Respiratory Protective Equipment Selection

Selection and use of respiratory protection is based on the Job Hazard Analysis (JHA) conducted in the workplace. Different types of hazards require different types of respirators. Both user and workplace factors influence the type of respiratory protection used.

- User Factors
  - User Training
  - Medical Evaluation
  - Fit Test
  - Worker exertion level
- Workplace Factors
  - Sufficient oxygen content
  - Identification of the hazard
  - Concentration of the hazard
  - Temperature
  - Humidity

User Factors

Respiratory Protection Training

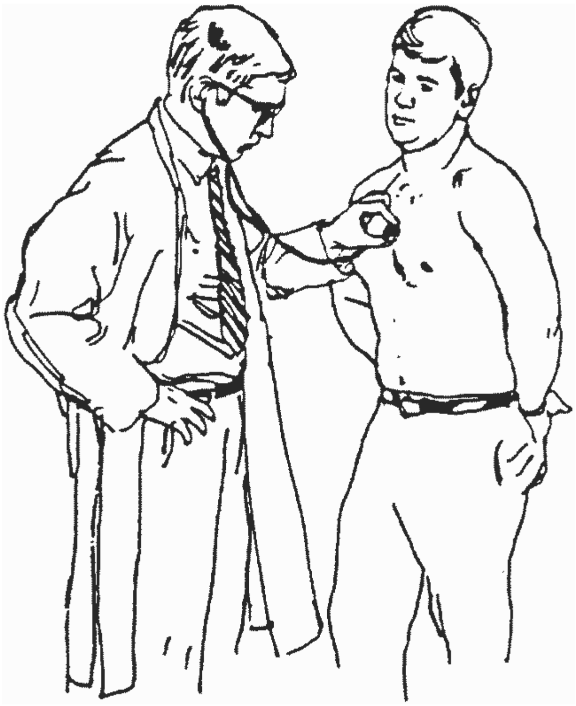
Employee health is protected as a result of how the respirator itself is used. If contaminants in the work environment require respirator use, workers **must** wear them. If respirators are needed for either routine or emergency situations, employers are required to provide the appropriate respirators. Employers also must conduct training on their use and limitations. Respirator training must:

- Be comprehensive and understandable
- Occur prior to workplace respirator use
- Reoccur annually

Training Includes

1. Reasons why a particular respirator is necessary and how its protective effect can be compromised by improper fit, use or maintenance
2. Capabilities and limitations of the respirator

3. How to use respirators in an emergency response, including situations in which malfunctions could occur
4. How to inspect, put on, conduct a positive and negative pressure seal check, use and remove the respirator.
5. Proper maintenance and storage of respirators
6. How to recognize signs and symptoms that may limit or prevent effective use of the respirator



Medical Evaluation Requirements

Individuals cannot be fit tested or assigned to tasks requiring respirator use until a physician or other licensed health care professional (PLHCP) has determined that those individuals are physically able to use the equipment and perform work. It is suggested that the respirator user's medical status be reviewed at least annually.

Medical Questionnaire

See Appendix C 29 CFR 1910.134

Fit Tests

A respirator is only effective if a good seal exists between the user's face and the face piece. Therefore, all persons required to use any respirator with a negative or positive tight-fitting facepiece must be tested with a respirator of the same make, model, style and size that will be used in the workplace.

Fit tests must take place:

- Prior to use in the workplace
- Annually thereafter
- If a change occurs in the respirator facepiece
- If a change occurs in the employee's physical condition or facial features
- If an employee requests another due to unacceptable fit

Fit Test Respirator Selection Process

Because many different face shapes exist, manufacturers have a number of sizes. The purpose of fit testing is to find the manufacturer/model/size combination which offers the best protection. A protection factor (PF) has been determined for each type of respirator mask, APR (half or full-face), PAPR, or SCBA.

The employee 'shall be allowed to choose the most acceptable respirator from a sufficient number of manufacturers, models and sizes so that the respirator is acceptable to, and correctly fits, the user.'

Face Fit

The fit should not be so tight that the participant is uncomfortable; however, the fit must be such that a seal is maintained throughout a seal test.

To seat the mask on their face, the employee shall:

- Move head side-to-side, and in an up-and-down motion slowly while taking in a few slow, deep breaths

To test the seal of the respirator, the employee shall perform a **seal check.** Seal checks consist of a **positive** and **negative**-pressure test.

Positive-Pressure Test

Employee covers the exhalation valve with hand and gently exhales for 10 seconds. Air should cause the mask to slightly expand on the face without allowing air to escape from around the facepiece.

Negative Pressure Test

Employee places hand over the intake valve(s) or cartridges and gently inhales. The mask should collapse slightly toward the face without allowing outside air into the facepiece when held for 10 seconds.

The test shall not be conducted if there is not a face to facepiece seal and if there is any hair growth between the skin and the facepiece sealing surface such as stubble beard growth, beard, mustache, or side burns (Must be less than 24 hours since last shaved).

Types of Fit Tests

See Appendix A 29 CFR 1910.134 for Fit Test protocols

- Qualitative Fit Test (QLFT)
- Quantitative Fit Test (QNFT)
  - Fit factor of $\geq$ 100 for half-face,
  - And $\geq$ 500 for full face respirators

Fit Test Record

A record form must be completed for each employee who is fit tested and maintained as a permanent record by his employer or site safety officer.

It is important for employees to know the size and make of the respirator that they have been fit tested with, therefore, a fit test card containing relevant information may be issued.

Workplace Factors

Oxygen Content

Is there > 19.5% oxygen in the atmosphere?

- Oxygen deficient atmosphere < 19.5% oxygen in an environment
  - For concentrations <19.5% oxygen, atmosphere-supplying respirators must be used to work in that environment
- Oxygen enriched atmosphere > 23.5% oxygen in an environment
  - For concentrations > 23.5% oxygen, work is prohibited due to explosive atmosphere potential

Identification of the Hazard

What contaminant is identified? Are additional contaminants present?

Air-purifying respirator filters, cartridges and canisters are designed for specific contaminants in concentrations above the Time Weighted Average (TWA) and below IDLH levels. Manufacturer's reference information must be checked for the exact cartridge and filter required for each contaminant.

Concentration and Exposure Limits of the Hazard(s)

What is the concentration of the substance(s) in air?

- Once the hazardous substance or particulate has been identified, the measured concentration is evaluated against the TWA.
    - For concentrations above the TWA, air-purifying respirators must be provided to work in that environment.

Immediately Dangerous to Life or Health (IDLH) Atmospheres

Is the concentration at or above IDLH levels?

- Refer to the NIOSH Pocket Guide for the IDLH value.
    - For the concentration at or above the IDLH limit, atmosphere-supplying respiratory systems must be provided to work in that environment

Air-Purifying Respirator (APR)

Air-purifying respirators may be used only if all of the following requirements are met:

- Oxygen content in the atmosphere is >19.5%
- Identity and concentration of the contaminant(s) are known
- Ambient concentrations of contaminant(s) are below IDLH
- Respirator assembly is approved for protection against the specific concentration of a contaminant(s)
- Respirator assembly has been successfully fit tested on the user
- Periodic monitoring of the work area is in place

Two extremely important factors effecting air-purifying respiratory protection are:

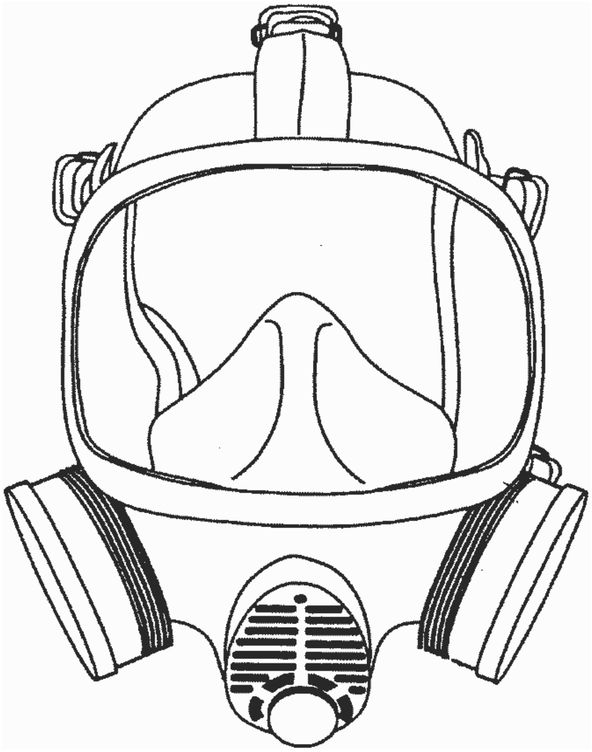
- The seal between the mask facepiece and the user's face
- Selecting the appropriate cartridge for the working environment

Air-Purifying Respirator Operation

Air-purifying respirators consist of a facepiece with an exhalation valve and inhalation valves, straps or headbands that maintain mask fit and suspension, and a means of attaching one or two filtering cartridges through which air is inhaled.

Ambient air is inhaled through a cartridge, or canister where filters, neutralizing agents, and/or sorbent materials trap contaminants or purify the air before it enters the lungs. Exhaled air is released through the exhalation valve. Inhalation check valves are used to prevent moist exhaled air from being passed through the filter element by forcing it out the exhalation valve. Exhalation check valves are used to allow exhalation through the diaphragm and sealing off the exhalation diaphragm while inhaling through the cartridges.

Most APRs use two separate cartridges to filter ambient air, although some designs accomplish filtration with a single unit. Each respirator manufacturer utilizes different means for attaching components to the facepiece to prevent mixing parts from different manufacturers (hybridization) which would void a respirator's approval.



Air-purifying respirators are available in a variety of styles. The most common are described below.

Disposable Particulate Respirators (Filtering Facepieces)
These are generally constructed of a cloth or paper filter element used for protection against dusts and mists or asbestos. A satisfactory face to respirator seal is required and achieved through fit testing. Models with Assigned Protection Factors (APF) of 10 or 25 are available for particulates.

Quarter-Mask Respirators
The facepiece fits from the top of the nose to the top of the chin, used for dusts (airborne exposure limits not less than 0.05 mg/m^3). Many are now being used in high rise buildings for escaping fire or other events.

Half-Mask Respirators
A half-mask respirator fits from above the nose to under the chin, and uses approved cartridges for pesticides, organic vapors, acid gases, dusts, mists, fumes, as well as several combination filtering units.

Full-Face Respirators
The full-face respirator fits from the top of the forehead to under the chin. Because the facepiece consists of lens, the full-face mask provides eye protection in addition to respiratory protection. The full-face mask may be used with a wide variety of filtration media that includes cheek- or chin-mounted cartridges, and chin- or chest/back-mounted canisters.

Gas Masks
Gas masks consist of a full facepiece and a canister of sorbent material. Gas masks usually have more purifying elements in the canister than other cartridge filters. These

masks typically protect against organic vapors, acid gases, ammonia, and certain combinations.

Powered Air-Purifying Respirators (PAPR)

Powered air-purifying respirators are available in quarter, half, and full-face designs as well as with specialized helmet assemblies. PAPRs utilize pumps or fans to force air through the purifying elements. This eliminates breathing resistance and may help to maintain positive pressure in the facepiece. PAPRs can only be used in environments with >19.5% oxygen content and models are available for use in classified atmospheres.

Protection Factors

A protection factor is a number assigned to a mask based on its ability to exclude harmful substances from an atmosphere into which it may be worn. The protection factor is based entirely on the fit of the mask to the worker's face and its ability to prevent entry of toxic substances. It is used to help determine contamination levels at which a mask may be used while providing protection.

- **Assigned Protection Factor (APF) – OSHA and NIOSH**

Assigned Protection Factors (APFs) Employers must use the assigned protection factors listed in Table 1 of 29 CFR 1910.134 to select a respirator that meets or exceeds the required level of employee protection. When using a combination respirator (e.g., airline respirators with an air-purifying filter), employers must ensure that the assigned protection factor is appropriate to the mode of operation in which the respirator is being used.

- Table 1. -- Assigned Protection Factors[5]

Type of respirator[1], [2]	Quarter mask	Half mask	Full facepiece	Helmet/ hood	Loose-fitting facepiece
1. Air-Purifying Respirator	5	[3]10	50	....	....
2. Powered Air-Purifying Respirator (PAPR)	....	50	1,000	[4]25/1,000	25
3. Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode	....	10	50	....	....
• Continuous flow mode	....	50	1,000	[4]25/1,000	25
• Pressure-demand or other positive-pressure mode	....	50	1,000	....	....
4. Self-Contained Breathing Apparatus (SCBA)					
• Demand mode	....	10	50	50	....
• Pressure-demand or other positive-pressure mode (e.g., open/closed circuit)	....	....	10,000	10,000	....

Notes:

[1] Employers may select respirators assigned for use in higher workplace concentrations of a hazardous substance for use at lower concentrations of that substance, or when required respirator use is independent of concentration.

[2] The assigned protection factors in Table 1 are only effective when the employer implements a continuing, effective respirator program as required by this section (29 CFR 1910.134), including training, fit testing, maintenance, and use requirements.

[3] This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

[4] The employer must have evidence provided by the respirator manufacturer that testing of these respirators demonstrates performance at a level of protection of 1,000 or greater to receive an APF of 1,000. This level of performance can best be demonstrated by performing a workplace protection factor (WPF) or simulated workplace protection factor (SWPF) study or equivalent testing. Absent such testing, all other PAPRs and SARs with helmets/hoods are to be treated as loose-fitting facepiece respirators, and receive an APF of 25.

[5] These APFs do not apply to respirators used solely for escape. For escape respirators used in association with specific substances covered by 29 CFR 1910 subpart Z, employers must refer to the appropriate substance-specific standards in that subpart. Escape respirators for other IDLH atmospheres are specified by 29 CFR 1910.134 (d)(2)(ii).

Protection Factor Calculation

When the concentration level of a contaminant outside the mask is divided by this number, the concentration level inside the mask can be determined and compared to the PEL.

- Divide the known chemical concentration by the assigned protection factor.

If the resulting ppm is lower than the exposure limit, then the selected respiratory protection would be sufficient. If the resulting ppm is higher than the exposure limit, then a more protective respirator would have to be selected.

Respirator Protection Factor Exercise

Quarter Mask	APF = 5
Half-face APR	APF = 10
Full-face APR	APF = 50
PAPR	APF = 25 – 1000 (See # 2 under table above)
SAR	APF = 10 - 1,000 (See # 3 under table above)
SCBA	APF = 10 - 10,000 (See # 4 in table above)

1. You are going to work in an area determined to have contamination of 1,500 ppm chlorobenzene. The PEL for chlorobenzene is 75 ppm. What type of respiratory protection should you use? Why?

2. You are working when an ammonia leak occurs. The PEL for ammonia is 50 ppm. The ambient concentration of ammonia is 3,500 ppm. What type of respiratory protection should you use? Why?

Air-Purifying Respirator Filters and Cartridges

OSHA requires that approved respirators must be used. Approved respirators have been tested and found to meet the minimum performance standards by the National Institute for Occupational Safety and Health (NIOSH) and the Mine Safety and Health Administration (MSHA).

Form of the Hazard

Since the selection of a respirator is based on specific respiratory hazards to which one may be exposed, just any respirator won't do. It is important to know the form of the contaminant(s) that may exist in the work environment. Inhalation hazards may be in the form of:

gases
vapors
mists
biological organisms
dusts
fibers
fumes
smoke and exhaust
radiation particles

Two types of filters are used with APRs.

- **Mechanical/Particulate filters** – used to protect against radiation particles (Alpha, Beta), dusts (Silica), mists, fibers (Asbestos), fumes (Welding), and organisms (tuberculosis) which are filtered by mechanical means
- **Chemical cartridges** – used to protect against certain vapors and gases which are removed by sorbents, filter elements, catalysts or other means.

Some atmospheres require a combination of mechanical/particulate filter and chemical cartridge to effectively remove multiple hazards.

Particulate-Removing Filters

Particulates may occur as dusts, fumes, fibers, mists or other solids. The particle size can range from macroscopic to microscopic and their toxicological effects can be severe or innocuous. The hazard posed by a particulate is determined by its Permissible Exposure Limit (PEL). A nuisance particulate may have a PEL of 10 mg/m^3, while a toxic particulate may have a PEL well below 0.05 mg/m^3.

Mechanical filters are classified according to the protection for which they are approved.

Three levels of efficiency:	Three categories of degradation resistance
○ 95%	N – not oil resistant
○ 99%	R – oil resistant
○ 99.97%	P – oil proof

A cartridge with a 99.97% efficiency is labeled "100."

A high efficiency particulate air (HEPA) filter, which is 99.97% effective against particles 0.3 microns or larger in diameter, is given an efficiency rating of "100." It is approved for dusts, mists, fibers, and fumes with a PEL less than 0.05 mg/m^3.

Gas and Vapor-Removing Cartridges and Canisters

When selecting a gas or vapor-removing cartridge, it is chosen for protection against a specific type of contaminant. Workers are rarely exposed to a single unvarying concentration of a contaminant; therefore, every user must understand the operation and limitation of each cartridge.

Warning Properties

Many contaminants have warning properties.

- Odor
- Taste
- Eye irritation
- Skin irritation
- Respiratory irritation

Adequate warning properties are considered to be those detectable well below the PEL. However, warning properties are unreliable due to individual human factors such as the inability of an employee to smell a particular contaminant below the Recommended Exposure Limit (REL) from NIOSH.

Because many contaminants either have no or inadequate warning properties, a firm method for indicating end of service life must be determined.

- Maximum Use Concentration (MUC)
  MUC = PEL x APF
- Maximum Use Limit (MUL)
  MUL = TWA x APF for APR
- End of Service Life Indicator (ESLI)

An ESLI can be active or inactive. Examples of active ESLIs include a pressure gauge or timer with an audible alarm or face plate vibrator. An example of a passive ESLI is a color change visible to the user such as with a Mercury Vapor cartridge.

Maximum Use Concentration (MUC) means the maximum atmospheric concentration of a hazardous substance from which an employee can be expected to be protected when wearing a respirator, and is determined by the assigned protection factor of the respirator or class of respirators and the exposure limit of the hazardous substance. The MUC usually can be determined mathematically by multiplying the assigned protection factor specified for a respirator by the permissible exposure limit (PEL), short-term exposure limit, ceiling limit, peak limit, or any other exposure limit used for the hazardous substance.

The MUC for respirators is most often calculated by multiplying the APF for the respirator by the PEL. The MUC is the upper limit at which the class of respirator is expected to provide protection. Whenever the exposures approach the MUC, then the employer should select the next higher class of respirators for the employees.

Employers must not apply MUCs to conditions that are immediately dangerous to life or health (IDLH); instead, they must use respirators listed for IDLH conditions in paragraph (d)(2) of 29 CFR 1910.134. When the calculated MUC exceeds the IDLH level for a hazardous substance, or the performance limits of the cartridge or canister, then employers must set the maximum MUC at that lower limit.

Air-Purifying Respirator Effectiveness

Every employer must establish and maintain ‘appropriate surveillance’ that ensures effectiveness of respiratory protection for all situations requiring employees to work in an environment(s) where respiratory protection is used. Respiratory protection effectiveness includes:

Seal Check

Positive and Negative seal checks are to be performed in an uncontaminated area each time a respirator is donned, prior to each use in the field. These checks do not replace annual fit testing, but do provide routine assessment as to whether or not the respirator fit is adequate.

Cartridge Life

Each filter or sorbent has a finite capacity for removing contaminants. When the limit is reached, the cartridge or canister is said to be saturated. At this point the element will allow the contaminant to pass through (breakthrough) and enter the face piece. The length of time a cartridge will absorb the contaminant is the service life of the element. Service life is dependent on the breathing rate of the wearer, exertion level, temperature, humidity, contaminant concentration and absorption efficiency. Therefore, Changeout of cartridges should be conducted at the beginning of each work shift or more frequently as specified by site safety personnel or as determined by logging onto the manufacturers’ web site to their Changeout frequency section and providing the required information. Manufacturers’ web site information will then give you the recommended Changeout frequency. This information should also be written into the site safety and health plan or the employers’ respiratory protection program.

What is end-of-service-life?

End-of-service-life is when a respirator no longer works correctly. It is when the filtering medium can no longer provide the expected level of protection from harmful air contaminants, has reached its capacity for capture and retention of the contaminant, when breathing while wearing the respirator becomes too difficult, or when the respirator becomes damaged, contaminated, or the integrity of the respirator is no longer intact.

Do respirators have end-of-service-life indicators on them?

Yes. Some do, for others like the N95 the “indicator” may be the appearance, whether the respirator is damaged, contaminated with visible blood or body fluids, or misshapen. For other types of respirators there are specific indicators integral in the device. All self-contained breathing apparatuses have an alarm that tells the wearer that he/she is going to run out of air from his cylinder and he/she must leave the contaminated area. Some gas- and vapor-removing air-purifying respirators are also equipped with end-of-service-life indicators (ESLI). The ESLI are usually specific to only one contaminant. The ESLI gives the wearer an indication, often a color change, that the contaminant will no longer be able to be removed by the cartridge or canister and that the cartridge or canister should be replaced.

What is the service life of an N95 filter or filtering facepiece respirator?

Unless the manufacturer identifies a specified duration of use, for example “single use only”, the service life of all filters is limited by considerations of hygiene, damage, and breathing resistance. All filters should be replaced whenever they are damaged, soiled, or causing noticeably increased breathing resistance. Follow manufacturer’s recommendations for specific information on the model you are using.

How is a cartridge changeout schedule calculated?

In the absence of an ESLI, a cartridge/canister changeout schedule is required for gas- and vapor-removing respirators and should be based on objective information or data that will ensure that canisters and cartridges are changed before the end of their service life. Usually, manufacturers have software to estimate a changeout schedule for their cartridges or canisters. Changeout schedules are not the same from one manufacturer’s cartridges or canisters to that of another manufacturer. This is because the volume and type of adsorbent varies between manufacturers. Additionally, the Occupational Safety and Health Administration (OSHA) has mandatory changeout schedules for cartridges for certain substances like acrylonitrile, benzene, butadiene, formaldehyde, vinyl chloride, and methylene chloride. Workers depending on respiratory protection who are exposed to any of these contaminants at or above the OSHA Permissible Exposure Limit (PEL) must change cartridges/canisters according to OSHA’s requirements. In any case, workers should consult their Respirator Program Administrator regarding when to change their cartridges/canisters.

OSHA provides guidance on using mathematical models to predict the service life of organic vapor respirator cartridges when used for protection against single contaminants. You can also find the service lives for respirator cartridges intended to protect against selected gases already calculated in a table. You can calculate others using a computer program called **Advisor Genius** from the OSHA website. OSHA suggests that you reduce the service life estimate by some safety factor and document the change schedule in your written respiratory program.

OSHA has no accepted way to determine a cartridge’s service life when exposed to mixtures; computer models have been developed that can estimate service life if you know all the canister physical attributes, environmental factors, contaminants and levels, and work rates [Note: Other research has been conducted to develop models for contaminant mixtures, but they have not yet been adopted by OSHA.] NIOSH has developed a computer tool for estimating breakthrough times and service lives of air-purifying respirator cartridges manufactured to remove toxic organic vapors from breathed air that can be used with the cartridge/canister manufacturer’s recommendations for multi-gas use of the specific canister/cartridge being used.

If respirators are required in your workplace, OSHA mandates that your employer establish and maintain a respiratory protection program that must describe the information and data relied upon and the basis for the canister and cartridge change schedule. Because of the complexity of factors involved in determining canister changeout schedules, consult your Respirator Program Administrator.

Is canister/cartridge end-of-service life information available on the manufacturers' website?

Most manufacturers provide information on their website to help in determining the appropriate changeout schedule for their product.

If I am using a combination cartridge with a PAPR, how do I know when to change the cartridge? Can the cartridge be decontaminated to extend its useful life?

The training you receive in the use of your assigned respirator as part of your employer's respiratory protection plan will tell you the frequency of cartridge changeout that has been determined to be appropriate for the conditions in your worksite. The Occupational Safety and Health Administration's Standard for Respiratory Protection (29 CFR 1910.134) requires employers to implement a changeout schedule for all cartridges used in the workplace for protection against vapors and gases when there isn't an end-of-service- life indicator on the cartridge. This schedule must be site specific and take into consideration worksite conditions such as humidity, worker breathing rate, as well as the contaminants and their concentrations.

The cartridge can't be decontaminated (i.e. reconditioned for reuse). The filter media in the cartridge has a finite capacity and the mechanism used to remove the contaminants from the air is usually not reversible.

Why do we need to change the respirator cartridge before we can smell something?

The purpose of this is to prevent contaminants from breaking through the respirator's sorbent (filtering) cartridge(s), and thereby exposing the wearer. Historically, respirator wearers have relied on the warning properties (e.g., odor, irritation) of a contaminant as a means to determine when it is time for replacing used cartridges. OSHA no longer allows the use of warning properties as the primary basis for changing respirator cartridges. The following factors shall be considered when developing a Respirator Cartridge Change Schedule which is required by OSHA and should be documented in the Respirator Protection Program:

- Contaminants
- Concentration
- Frequency of use (e.g., continuously, intermittently) throughout the shift
- Temperature
- Humidity
- Wearer's work exertion rate (Light, Medium or Heavy Duty)
- The presence of potentially interfering chemicals

Do we need to dispose of a filter (used with a PAPR) when used for/with a virus exposed person for only one hour?

Powered air purifying respirator filters used for protection against viruses have no time limit as to their ability to remove viruses from the air stream. Their use is subject to other considerations by the infection control or safety officer in the workplace. Therefore, it is recommended there be written standards for use and disposal of these filters. However, filters and cartridges cannot be cleaned, sanitized, or disinfected and should be properly disposed of after use.

At this time, neither the Centers for Disease Control and Prevention (CDC) nor the World Health Organization (WHO) have provided any recommendations for cleaning, sanitizing, or disinfecting respirators used for novel H1N1 virus exposures. The Occupational Safety and Health Administration (OSHA) requires respirator users to follow either the respirator manufacturer's instructions or OSHA's general procedures for cleaning respirators in 29 CFR 1910.134 Appendix B-2; however, OSHA's procedures are not specific for H1N1 virus and may not lead to disinfection.

Refer to the User Instructions for the specific PAPR unit and headgear to identify the components that can be cleaned.

Warning Properties

Given the provision of APFs, MUCs and ESLI, there are other indicators that filters need to be changed. For dust, a wearer may notice eye irritation or increased resistance to breathing as the filter becomes loaded. For gases/vapors, 'when you smell or taste the stuff,' it is time to get a new cartridge. Not all chemicals have obvious smells or taste and the OSHA respiratory protection standard does not specify that they must have them to wear respirators; so in the absence of warning properties the changeout schedule will protect the worker.

Breathing Rate

Mechanical filters become blocked with particulates as they are used. If the breathing (exertion level) rate of the user is rapid, the flow rate of the contaminated air drawn through the filter or cartridge is greater than it is at a moderate or slow breathing rate.

As the flow rate brings an increased amount of contaminant in contact with the mechanical filter in a given period, it becomes more efficient, as well as more difficult to breathe through, indicating time to replace it.

Monitoring

Employers must establish appropriate monitoring to evaluate whether or not environmental conditions are changing. Monitoring results indicate whether respiratory protection can remain the same, or be upgraded or downgraded

Atmosphere-Supplying Respirators

Atmosphere-supplying respirators supply uncontaminated grade 'D' breathing air ((Compressed Gas Association (CGA) standard)) or better to the user from a source independent from the surrounding atmosphere. (See 29 CFR 1910.134 (i) Breathing air quality and use).

Circumstances that automatically cause atmosphere-supplying respirators to be the only choice for respiratory protection are:

- <19.5% oxygen content
- IDLH atmosphere concentration or higher
- Unknown atmosphere

Atmosphere-supplying respirators are broken down into two subgroups:

- Supplied Air Respirators (SARs) – in which breathable air is conveyed to the user from a stationary source via an airline or hose up to 300' in length. Types of SAR systems are:
    - Cascade System (Bottled Grade D breathing air)
    - Breathing Air Compressor (BAC)

When using a SAR in an IDLH environment, the worker must wear an escape/emergency bottle containing an adequate supply of air to escape the area if the air supply is cut off.

- Self-Contained Breathing Apparatus (SCBA) – in which users carry a breathing air source, such as a compressed air tank or an oxygen generating device. SCBAs are either:
    - Pressure Demand
    - Positive Pressure

Pressure-demand SCBAs only supply air to the face when the user inhales (negative pressure inside face piece), thereby drawing air from the air supply. This negative pressure could allow contamination to pass into the face piece between the face piece sealing surface and user's face (APF 10 -1,000 –see table above).

Positive pressure SCBAs supplies a continuous air flow to the face piece. Since positive pressure exists continuously inside the face piece, contaminants are prevented from passing through the face piece to face contact area. If there is a break in the seal, positive pressure air will flow through the opening pushing contaminants away from the user's face (APF = 10,000).

Self-Contained Breathing Apparatus (SCBA) Operation

SCBAs consist of an air supply (tank or cylinder), backpack, regulator, gauge, safety valve, and a full-face piece connected to the bottled air. The bottle is equipped with an alarm to warn the wearer when air pressure in the tank is getting low; approximately 500 psi (about 5 minutes of air remain). SCBAs operate in an open-circuit mode; that is, the exhaled air is vented to the atmosphere and not re-breathed.

Respirator Limitations

Below is a list of some of the limitations encountered using respirators:

Communications

- Inability to hear clearly (Speech muffled)
- Inability to realize someone is attempting to communicate with you

Visual

- Limited peripheral and up/down vision
- Fogging and/or frosting of face piece

Movement Restriction

- APRs – loss of fine motor skills
- SARs restrictions as a result of:
    - Hose length limiting the area of coverage
    - Hose posing a tripping hazard
    - Hose becoming tangled around debris or equipment
    - Size and weight of SCBA may restrict climbing and movement in tight areas

Time

- APRs – end of service life
- SARs – limited by:
    - Air capacity of supply source
    - Volume of air breathed per minute

Work Rate

- APRs – could slow work to 60% - 75% normal capacity
- SARs – could slow work to 25% - 50% normal capacity

Ambient Temperature

- Increased perspiration and/or heat stress related concerns
- Increased physical fatigue

Respirator Care and Maintenance

Proper cleaning, disinfection, inspection, maintenance, and storage are essential to assure that a respirator is always ready for use. Every used respirator must be cleaned and disinfected before it is reissued. Emergency-use rescue equipment must be cleaned and disinfected immediately after each use. Clean respirators are stored in tagged storage units, protected from extreme temperatures, dusty environments, or conditions that could alter the shape of the mask. Always follow manufacturer's instructions and recommendations for the specific respirator.

Cleaning

Respirators are washed in a detergent solution, rinsed and sanitized by immersion in a solution recommended by the manufacturer. All detachable parts such as straps, valves and gaskets are removed, washed, rinsed, disinfected, double rinsed, and left to air dry. When dry, respirators are reassembled, put in a clean plastic bag and stored for future use.

- Remove the face piece from the air line or hoses
- Disassemble the respirator
- Inspect each component for serviceability
- Wash, rinse, disinfect, and rinse each component
- Allow to air dry completely
- Re-inspect the respirator

- Put it back together and store properly

There are also respirator washing machines available.

Inspection

All respirators must be inspected for wear and deterioration of components before and after each use. Special attention should be given to rubber or plastic parts which can deteriorate on all respirators. The face piece, especially the face seal surface, headband, valves, connecting tube, fittings, and canister, must be in good condition. Respirator inspection must include a check of tightness of connections.

SCBAs for emergency use must be inspected at least monthly. Air and oxygen cylinders must be fully charged according to manufacturer's instructions. Regulators and warning devices must be checked to see that they function properly.

If respirators are not in use, they must be inspected according to company policy or manufacturers specifications and may include more frequent inspections. Records must be kept of inspection dates and findings.

Inspection Checklists

For all respirators:

- Check condition of the face piece for rubber dry rotting, cracking, tearing or deformation
- Check headband for cracking and verify it can be tightened without breaking
- Ensure valves are present in face piece

For SCBA or SAR:

- Check the tank harness and straps for cracks, tears or other defects
- Check the regulator according to the manufacturer's directions
- Check the air tank valves and/or compressor for damage
- Defects or unusual conditions should be reported immediately
- Routinely practice donning the respirator if used infrequently or for emergency purposes
- Check the hose for cracking and attachment points to the face piece and tank for O-rings and tightness of fittings

Storage

Store respirators so that facepieces and exhalation valves will rest in a normal position to prevent the rubber or plastic from deforming into an abnormal shape. In addition, protect against any mechanical damage. Store away from:

- Dusty environments
- Sunlight
- Heat
- Extreme Cold
- High humidity
- Chemical exposure

Repairs

All respirators found to be defective upon inspection must be removed from service and evaluated for repair or disposal. Most repairs and adjustments to respirators require that units be taken to a manufacturer's approved facility where repairs are made by manufacturer approved or certified technicians only. No attempt may be made to make adjustments, replace components or perform repairs beyond manufacturer's recommendations.

Parts used to repair respirators must be specifically designed for the respirator. Parts from one respirator cannot be interchanged with one another unless the respirators are identical in make, model, size and manufacturer. Intermixing different manufacturer's parts will result in ineffective use of the respirator, as well as voiding a manufacturer's warranty. Manufacturer's instructions and recommendations must be followed for any repair.

Chemical Protective Clothing

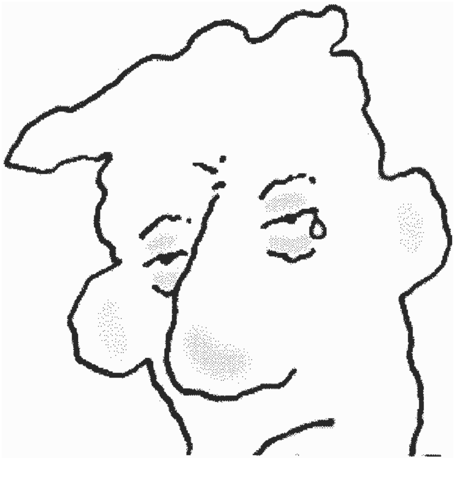
Chemical Protective Clothing (CPC)

Chemical Protective Clothing is a significant component of a worker's PPE. Proper selection and use of CPC and respiratory protection creates an ensemble or 'level of protection' that effectively prevents or reduces exposure to hazards.

CPC can protect employees from chemical exposure hazards that are likely to be encountered while performing tasks. CPC is made of special materials that are chemical **resistant**, which means it acts as a barrier to keep chemicals from coming in contact with an individual's skin. Different materials provide protection from different types of chemicals.

It is important to select CPC designed to protect against chemicals that may be encountered in the workplace. Remember that no single material protects against all chemicals, so double protective suits, boots and gloves are worn, and no material will resist any chemical and physical use indefinitely. Ideally, the selected material will resist penetration, degradation and permeation during work activities (defined below under PPE limitations).

Chemical Protection Clothing Selection



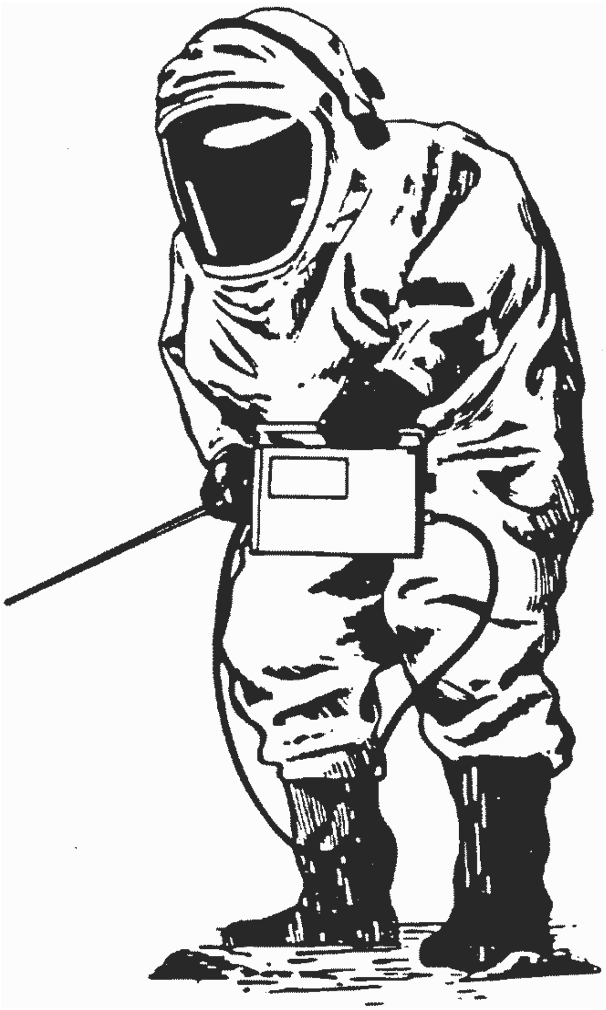
Selection of chemical protection clothing is based on:

- Contaminants are known
- Contaminants are unknown
- Multiple hazards exist

For unknown contaminants, selection usually assumes the worst-case scenario. For known contaminants, protection and performance may be balanced. In multiple hazard environments, a protection and performance compromise must be achieved.

Appropriate PPE is selected and used during initial site entry and characterization, as well as remediation activities. PPE must be selected that will protect employees from known or potential hazards. Proper selection of PPE is based on factors stated in 29 CFR 1910.120(g)(5):

- Site hazards
- Use and limitations of PPE
- Work mission duration
- PPE maintenance and storage
- PPE decontamination and disposal
- PPE training and proper fitting
- PPE donning and doffing procedures
- PPE inspections procedures prior to, during and after use
- Evaluation of the effectiveness of the PPE program
- Limitations during temperature extremes, heat stress and other appropriate medical considerations



Site Characterization – 1910.120 (c) states that:

> The preliminary site evaluation should provide sufficient information to select PPE that will protect personnel from the hazards present on the site. If sufficient information is not available as a result of initial site evaluations and characterization, OSHA mandates the use of Level B protection (self-contained breathing apparatus – SCBA) at a minimum, along with direct reading monitoring instruments for site entry. If a positive pressure SCBA is not part of the PPE ensemble during initial entry, a minimum of a 5-minute escape breathing air must be provided to adequately safeguard workers.

Chemical Protective Clothing Characteristics

Site workers are generally not responsible for CPC selection or purchase; however, it is important for employees to understand the considerations that effect selecting chemical protective clothing.

Chemical Resistance (Permeation rate/Breakthrough time)

Different materials are resistant to different chemicals. Management must select, supply and provide CPC which will provide protection against substances likely to be encountered at the site. This is true for the whole-body, as well as hand and foot protection. Manufactures have web sites that show what type of suit can be worn for a specified length of time around a specific chemical. There are other references that can be acquired and used such as: “The Quick Selection Guide to Chemical Protective Clothing”.

Physical Integrity

Construction of the suit is important for proper functioning. Seams and zippers must provide solid barriers to chemicals, as well as be constructed in a manner which provides some flexibility. There are different seam stitches to factors in which affects how hard it is to decontaminate non-disposable clothing.

Resistance to Temperature Extremes

Heat and cold can adversely affect CPC. Clothing which will be worn in cold temperatures could crack or become ineffective against chemicals. Likewise, heat may destroy or even melt it.

Ability to be cleaned

CPC must be cleaned and decontaminated after each use. If decontamination is not possible, clothing must be disposed of after use. Some models of suit have stitching that is extremely hard to completely decontaminate.

Cost

Initial and ongoing costs of purchasing PPE can be an important consideration. However, buying less expensive, inferior products which do not adequately protect employees can be more expensive in the long run, due to medical costs, lost work time, or at worst, loss of human life.

Flexibility

Materials need to be flexible enough for the wearer to move and work safely. Overly rigid suits may result in unnecessary accidents from slips, trips and falls. Gloves which are too rigid may create gripping problems which may lead to other hazards. Materials must maintain their flexibility and integrity in cold and warm temperatures.

Size

CPC should be available in a variety of sizes to accommodate varying heights and weights of individuals. Suits that are too small will restrict movement, tear easily and provide no protection. Suits that are too large will make moving and/or working challenging, as well as creating a safety hazard. Safety boots that are too big can create a tripping hazard.

Design

CPC should be selected so that all required respiratory protection can be used at the same time (Level A suit with room for SCBA). There are many Level B suit design options: hooded or not, booted or not, gloved or not and combinations of all three.

Levels of Protection

PPE or CPC is divided into four categories based on the degree of protection afforded. See 29 CFR 1910.120 Appendix B.

A helpful way to remember the levels of protection is:

- Level A – “A” all covered
- Level B – “B” breathing air
- Level C – “C” cartridge respirator
- Level D – “D” diminished hazard

A general rule for which level of protection to use is:

“The less you know, the higher you go”

Level A
Level A provides the highest level of chemical protection available.

Level A Protection Should Be Used When:

- The hazardous substance has been identified and requires the highest level of protection for skin, eyes and respiratory system
- Substances with a high degree of hazard to the skin are known or suspected to be present and skin contact is possible
- Operations are being conducted in confined, poorly ventilated areas, where the absence of conditions requiring Level A have not yet been established

Level A Protection consists of:

- Positive-pressure, demand-mode, full-face piece SCBA or positive-pressure SAR with escape SCBA (NIOSH approved)
- Totally encapsulating chemical-protective suit capable of maintaining positive-pressure. See 29 CFR 1910.120 (g)(ii) and Appendix A
- Inner and outer chemical resistant gloves
- Disposable protective suit, gloves and boots may be worn over totally encapsulating chemical-protective suit
- Chemical resistant boots with safety-toe and shank
- Coveralls*
- Long underwear*
- Hard Hat (under suit) *

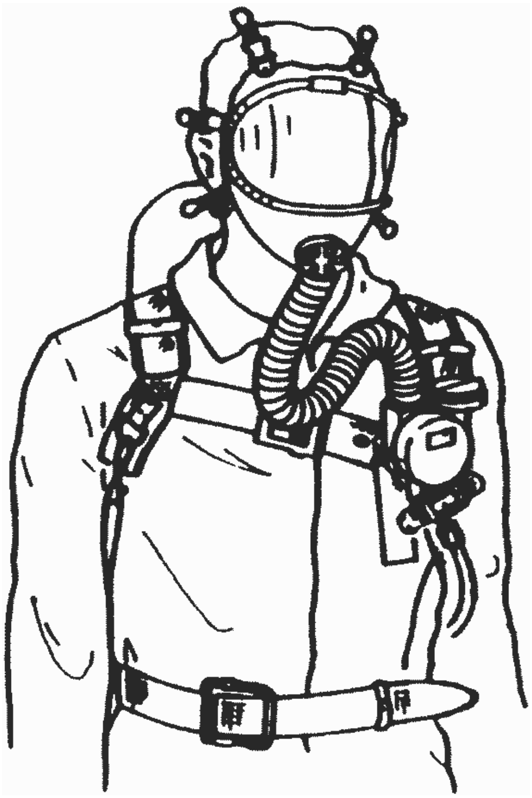
*Optional as applicable

Level B
Level B is used when the maximum level of respiratory protection is necessary, but a lesser level of skin protection is needed than with Level A.

Level B Protection Should Be Used When:

- The type and atmospheric concentrations of substances has been identified to require a high level of respiratory protection
- The atmosphere contains less than 19.5 percent oxygen
- The presence of incompletely identified vapors or gases is indicated by direct-reading organic vapor detection instrument(s), but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin

Level B Protection consists of:



- Positive-pressure, demand-mode full-face piece SCBA or positive-pressure, supplied-air respirator (SAR) with an escape SCBA (NIOSH approved)
- Chemical-resistant clothing
- Inner and outer chemical-resistant gloves
- Chemical-resistant boots with safety-toe and shank
- Boot covers: outer, chemical resistant (disposable)*
- Hard Hat*
- Face Shield*

*Optional as applicable

Level C

Level C provides less skin and respiratory protection than either Level A or B

Level C Protection Should Be Used When:

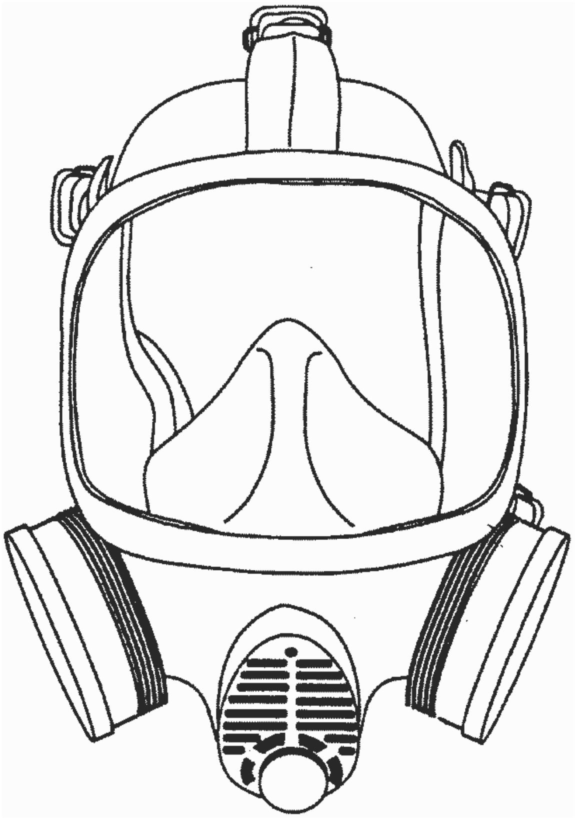
- The concentration(s) and type(s) of airborne substance(s) are known and the criteria for using an APR are met
- Air contaminants have been identified, concentrations are measured, and an APR is available that can remove the contaminant(s)
- An adequate level of oxygen (>19.5%) is available and all other criteria for use of air-purifying respirators are met

Level C Protection consists of:

- A full-face or half-mask APR (NIOSH approved)
- Chemical-resistant clothing
- Inner and outer chemical-resistant gloves
- 5-minute emergency air supply (Scott Scat Pak) *
- Coveralls*
- Boots (outer), chemical-resistant safety-toe and shank*
- Boot covers: outer, chemical-resistant (disposable)*

- Hard Hat*
- Face Shield*

*Optional as applicable



Level D

Level D offers no respiratory protection and low protection against chemical contact. Level D may be "typical work clothes."

Level D Protection Should Be Used When:

- Minimal protection from chemical exposure is needed. It is worn to protect against nuisance contamination only when:
    - The atmosphere contains no known hazards
    - Work functions preclude splashes, immersion or the potential for unexpected inhalation or, or contact, with hazardous levels of **any** chemicals

Level D Protection consists of:

- Coveralls (work uniform)
- Hard Hat
- Safety glasses or chemical splash goggles
- Gloves
- Chemical-resistant boots or shoes with safety-to and shank
- Outer, chemical-resistant boots (disposable)*
- Escape mask*
- Face shield*
- 5 minute emergency air supply (Scat Pak) *

*Optional as applicable

Limitations

Permeation / Breakthrough Time

Permeation is the process by which a chemical moves through a protective material on a molecular level. It is a process that involves the absorption of a substance on the outside surface, diffusion through and desorption of the substance from the inside surface of the protective material to the clothing or surfaces inside. A concentration gradient (high outside: low inside) is established. Because the tendency is to achieve concentration equilibrium, molecular forces drive the chemical into the material toward the area of no or lower concentration inside the suit. The rate or time of permeation is dependent on five major factors:

- Contact time
- Concentration
- Temperature
- Size of the contaminant molecules and pore space
- Physical state of the substance

Penetration

Penetration is the movement of substances through openings such as stitched seams, button holes, pinholes, zippers, or fabric weave. A well designed and constructed garment prevents penetration by using self-sealing zippers, seams overlaid with tape, flap closures and non-woven fabrics. Rips, tears, punctures, or abrasions also allow penetration.

Degradation

Degradation is action causing the breakdown of the material due to chemical contact. It is evidenced by physical change to the material such as shrinking or swelling, wrinkling, deterioration, or a decrease in strength, becoming brittle or soft, or a complete change in its structure. Other changes may include slight discoloration, rough or gummy surface, or cracks in the material.

Degradation may be from UV, heat/cold, mildew, excess use or wear. It is not exclusively chemically induced, but is generally a result of heavy use in a contaminated environment.

Taping Joints of CPC

All joints such as suit-to-boots and suit-to-gloves in Levels B and C protection should be sealed with tape. Sleeves and pant legs of the suits should be taped on the outside of gloves and boots with tape halfway on each with wraps directly over the previous wrap. Fold the end of the tape back onto the sticky side to make a 3”-4” tab for easy removal.

Durability

Due to the size and weight of some suits, motion is restricted, especially when climbing, working in tight areas, or using hand tools. Suit material must be durable enough to stand up to the work environment; resisting abrasions, rips, tears, and punctures.

Seams are the weak points of suits, especially disposable suits. Use caution not to strain or split them. If a breach occurs in your suit, leave the work area immediately. Follow decontamination and suit replacement SOPs.

Gloves

Make sure when donning and doffing inner and outer gloves that no cracks, tears or degradation are present. Care should be taken when doffing inner and outer gloves not to spread contamination.

Footwear

Wearing the correct size footwear may help prevent slips, trips and falls. Disposable booties can be slippery. If possible, ensure that soles provide a proper grip for surfaces that will be encountered. Safety-toe guards, metatarsal guards and steel shanks can help prevent foot injuries.

Face and Eye Protection

When ambient air temperatures are different from those inside a suit, safety glasses, goggle or face shields may become foggy, frosted or even freeze due to moisture condensation. Use of anti-fog film or spray may help reduce condensation thus improving visibility. When wearing Level A, it is useful to keep a cloth inside the suit to wipe fog off the inside face shield. Many safety glasses manufacturers provide a variety of models with anti-fog coatings already applied.

Temperature

Materials used for most suits do not "breathe." Because CPC is impermeable to the contaminant it is designed to protect against, perspiration cannot exit the clothing. This can lead to additional problems:

- Heat Stress – when the body cannot rid itself of body heat
- Cold Stress – when the moisture freezes and reduces the insulating properties of thermal clothing
- Condensation on the face piece

It is important to recognize and understand these problems so that work schedules and clothing use can be adjusted to meet the required work demand.

Communications

Speaking and hearing are difficult in CPC if one is wearing respiratory protection. It is important to establish other ways to communicate. Hand signals or audio signals such as horns, sirens and whistles should be used to communicate. Communication can also be improved by using two-way radios, radio headsets or Bluetooth connected device such as an ear bud. Remember, radios must be intrinsically safe or sealed from the outside potentially flammable atmosphere.

Decontamination

CPC must be purchased with decontamination in mind; will it be decontaminated or discarded? That decision will depend on the substance(s) encountered, the complexity and expense of the ensemble, and the ease of decontamination. CPC material must be durable enough to withstand decontamination if it is to be used again.

Inspection, Maintenance and Storage of CPC

It is important to inspect CPC to detect any evidence of damage. CPC that is damaged or degraded will not offer adequate protection to the wearer. The safety and health plan should describe or reference SOPs for inspection, maintenance and storage of CPC.

CPC should always be inspected when it is:

- Received from the distributor
- Issued to user
- Before and after use for work or emergency response
- Put into storage
- Taken out of storage
- Sent for maintenance

An inspection checklist should be developed for each piece of equipment. Factors to consider are:

- Cuts, holes, tears, swelling, and abrasions in fabric
- Weakness in seams, zippers or valve seals
- Signs of malfunctioning exhaust valves
- Signs of contamination such as discolorations or visible chemicals

Optional Levels of PPE Worksheet

Although you will usually be provided specific PPE selected by the health and safety officer, this exercise gives you an opportunity to determine which level of PPE is needed and why. For each situation, list the appropriate level of PPE and the reason for your decision. If you need additional information, list what would aid your decision.

At XYZ Dump grounds, 15 barrels are unearthed and identified as Dioxane. Which level of PPE should be used to remove the barrels?

Spent chlorine cylinders are being off-loaded from a truck into a staging area. Which level of PPE should be worn?

You are to conduct initial decontamination of a pump and piping area that is “crusted over” with corrosion before millwrights begin dismantling the unit. Which level of PPE is needed?

You are scheduled to clean an empty culvert, where oxygen concentrations have been measured at 18%. What level of PPE should be worn?

You are assisting the safety coordinator with monitoring air concentrations around a waste lagoon. You are told to draw necessary equipment from the tool crib area. What PPE and safety equipment are needed?

You are moving a 55-gallon drum of hydrochloric acid. The last shift reported that the drum integrity is poor. Which level of PPE should be worn?

Chapter 8

Decontamination

Chapter Objectives

Enable students to:

- Minimize exposure risks through proper decontamination
- Outline decontamination procedures for personnel and equipment
- Recognize the importance of partial decontamination for break periods
- Recognize the importance of emergency decontamination

Introduction

Decontamination is the process of removing or neutralizing contaminants that have accumulated on personnel, equipment and sampling containers. The purpose of decontamination is to ensure that contaminants that remain on tools, equipment and personnel from the exclusion zone (hot zone), are removed in the Contamination Reduction Zone (warm zone) within the contamination reduction corridor or stay in the hot zone. All PPE, tools, equipment and supplies or material that may exit the 'exclusion zone' must be '**cleaned**' to prevent the spread of dangerous substances to the environment, personnel, coworkers and/or family members. Decontamination procedures include a decontamination plan, decontamination methods and procedures, and emergency decontamination.

Individuals working at HAZWOPER sites must be able to:

- Understand the purpose of work zones and criteria to delineate them
- Understand the necessity and importance of proper decontamination
- Describe basic decontamination methods
- Demonstrate decontamination of personnel, PPE and equipment

General Procedures

Decontamination should be performed before breaks and meals, after each shift, or any other time a worker leaves the contaminated area. Specific decontamination methods and procedures vary according to location of contaminant(s), equipment, facilities, worker exposure and specific contaminant(s). Site zones, consisting of the exclusion zone, contamination reduction zone and support zone, or the hot, warm and cold zones, are designated to control contaminants and direct personnel from 'dirty,' to 'clean' areas.

Decontamination is required:

- When PPE or clothing becomes contaminated
- Before personnel go from a ‘contaminated’ area to a ‘clean’ area
- Before workers eat, drink, smoke, or use restroom facilities
- Before equipment leaves the work area

Proper decontamination procedures must:

- Control hazards
- Prevent permeation of substances into PPE, equipment and tools
- Position decontamination line in an area that eliminates the transfer of contaminants to employees in clean areas
- Prevent uncontrolled transfer of contaminants to the community
- Prevent mixing of incompatible substances
- Be monitored to ensure effectiveness, and revised as necessary

Preplanning for Decontamination

Proper decontamination or replacement of protective clothing or equipment is a critical element in controlling the spread of contaminants that exist in and around work areas. The decontamination plan must be operational **before** any personnel or equipment enters an area where the potential for exposure to hazardous substances exists.

Components of a Decontamination Plan:

- Description of the location and layout of decontamination stations
- List of the decontamination equipment needed at each station
- Appropriate PPE for persons assisting with decontamination
- Specific procedures for decontamination of site-specific substances
- Methods and procedures for preventing contamination of clean areas
- Methods and procedures for minimizing worker contact with contaminants during removal of PPE
- Safe disposal methods for PPE that is not completely decontaminated
- Revisions when changes affect the type of PPE, or equipment being used, site conditions change, and/or hazards are reassessed as a result of updated information

Preventing Contamination

It is important to establish a set of standard operating procedures (SOPs) that minimize contact with hazardous substances, thereby, maximizing worker protection. For example, properly donning PPE will minimize the potential inhalation or skin contact with contaminants. Other SOPs include:

- Inspecting PPE to ensure it is in proper condition before each use

- Completely closing zippers, buttons and snaps
- Tucking both inner and outer gloves under outer suit sleeves
- Tucking boots under the legs of outer clothing
- Taping all junctions to prevent contaminants from running inside gloves, boots and jackets

Partial Decontamination

Though it may not be feasible for workers to remove all contaminated protective gear each time they take a break, it is necessary that enough decontamination take place to prevent contamination from spreading into clean areas. More importantly, workers must clean their hands, face or other exposed body areas so that they don't inadvertently ingest or spread contamination to normally protected parts of their bodies.

Emergency Decontamination

Procedures should be in place that explains how an injured, ill or unconscious employee will be taken quickly through an emergency decontamination. Having a stretcher available will help to carry an injured person through an emergency decontamination. An injured person that needs immediate medical care to save their life can then be wrapped with visqueen and taken to an ambulance. The visqueen may be used to help prevent the spread of contaminants that might be missed while getting the employee to medical facilities by wrapping the employee. This will also help prevent the contamination of the ambulance or transport vehicle. Complete and thorough decon can then be done after stabilization of the patient.

Full Decontamination

At shift completion, workers returning to their living quarters or personal homes have the potential to expose others and facilities to secondary contamination. To prevent this risk, full decontamination must take place to remove all contamination prior to an individual leaving the work site.

Decontamination allows employees to safely remove contaminated protective gear within a dirty area without contaminating their work clothing. In some cases, they proceed to clean facilities, such as a shower room, to remove traces of contamination. Within the clean area they will don street clothes before going to their living quarters or to other clean areas. The intent of this process is to keep dirty work clothes in dirty zones, and clean clothing in clean zones. The following are examples of decontamination procedures:

- Prior to lunch, remove gloves and clean hands with waterless hand cleaner. If available, use soap and water
- Contaminated clothing must be removed carefully to avoid 'secondary' skin exposure. For example, hands can become exposed from handling boots and other gear if inner gloves are taken off prematurely.
- At shift's end, proceed to assigned decontamination area. Decontamination takes place in a sequence of segregated areas such as:
    - All outer clothing will be removed in the designated "dirty" area. This includes outer gloves, boots, rain gear, and hard hats. Serviceable outer gear will be decontaminated and reused when necessary.

  - Once outer gear is removed, proceed to an area to remove respiratory protection and place it in a designated container
  - Next, proceed to an area to remove inner suit, boots and lastly gloves, and dispose of them in a designated container
  - Next, move into the shower room; to wash and dry, if necessary
  - Change into street clothing and shoes that were left in the clean room at the beginning of the shift
  - Go see medical for post entry monitoring

Decontamination procedures will vary from site to site according to the contaminants present, categories of tasks and available facilities. The essence of decontamination procedures is to remove all contamination from work clothing to prevent direct skin contact and prevent secondary contamination of outer garments and clean areas.

Types of Decontamination

Decontamination can be accomplished by:

- Physically removing contaminants
- Chemically removing contaminants
- Rinsing off contaminants
- Disinfecting and sterilizing (infectious materials) PPE
- A combination of the above methods

Physical Removal

Contaminants that stick to the surface of PPE and equipment can be removed by scraping, brushing, washing, wiping, and vacuuming.

Chemical Removal

Water, a neutralizing or solvent solution can be used to ‘breakdown’ the contaminant, thereby allowing the removal of it from PPE and equipment (Orange Sol, Trisodium phosphate, dish soap, etc).

Rinsing off Contaminants

A soap and water solution or environmentally safe solvent (Orange Sol) is most frequently used to remove contaminants from PPE and equipment. Once washing occurs, rinsing simply removes contaminant.

Rinsing is an important procedure. Multiple rinses with clean water or solutions will generally remove more contaminants than a single rinse with the same volume of solution.

Decontamination Line

Workers are stationed in the Contamination Reduction Corridor to assist decontamination of those who performed duties in the Exclusion Zone (EZ).

Safety Precautions for Decontamination

- Ensure decontamination solutions are compatible with the substances being removed to prevent any reaction

- Station adequate staff to assist each worker through the decontamination line
- If plastic sheeting or other slippery surfaces may be encountered, sorbent rolls laid out on the containment barrier, ‘gripper’ decals or the like can be used to reduce the likelihood of slips
- Provide hand-holds at stations where boots and/or covers are washed or removed
- Provide seats for personnel to sit on at stations where boots and suits are removed (wood seats, if contaminated, will need to be disposed)
- Ensure all areas are cleaned after employees from hot zone are done
- Shower and change rooms provided outside of a contaminated area must meet the requirements of OSHA 29 CFR 1910.141

Decontamination Examples
An example of decontamination follows:

1. On-site, removal of as much contamination as possible from boots, gloves and clothing
2. Dirty equipment (trucks, boats) will move workers with contaminated clothes to the decontamination area
3. Place contaminated tools in the tool drop within the hot zone
4. Remove SCBA backpack if applicable but keep face piece on
5. Place outer clothing, safety glasses and hard hats in designated areas or containers for decontamination later, or
6. Wash, rinse and remove outer boots with gloves still on
7. Wash, rinse and remove outer pants, jackets, suits, then gloves
8. When removing outer clothing, fold it into itself as it is being removed to prevent contamination of inner clothing
9. Remove inner suit and discard
10. Remove and place respiratory equipment in designated areas or containers for decontamination
11. Remove inner gloves and discard
12. Wash hands and face with waterless hand cleaner
13. Shower and dress in street clothes and shoes

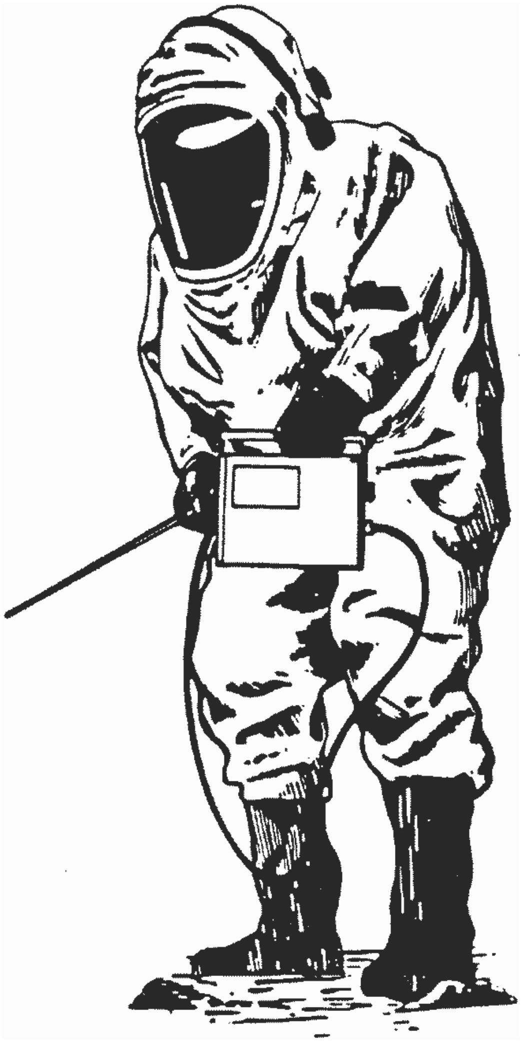
Equipment Decontamination
Decontamination of equipment is an important procedure in controlling the spread of hazardous substances and preventing deterioration of equipment.

Hand tools, small portable equipment, PPE, and other items that have become contaminated will also have to be decontaminated and cleaned.

Equipment that will not be disposed of must also be cleaned to prevent secondary contamination. This is generally part of the ongoing maintenance with one final cleaning when they are no longer needed.

Personnel who clean tools and equipment must be fully protected by wearing the same PPE that decontamination line workers use and go through the same personal decontamination procedure.

Decontamination of Equipment and Breathing Apparatus



- Monitors
    - Monitoring equipment requires special cleaning if contaminated. This need can be minimized by placing monitoring equipment in one or two gallon plastic, sealable bags where possible. The manufacturer can provide information on decontamination methods.
- Tools
    - Metal tools can be decontaminated by either chemical or physical means. The manufacturer can provide specific methods. Tools or handles made of wood are difficult to decontaminate because the wood can absorb chemicals. Wooden tools should be discarded if contamination is suspected.
- APRs and SCBAs
    - Certain parts of APRs and SCBAs, such as the harness assembly made of leather or cloth components, are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Depending on contaminant(s), rubber components may be soaked in soap and water and scrubbed with a brush. Regulators must be maintained according to manufacturer's recommendations.

Preventing Spread of Contamination

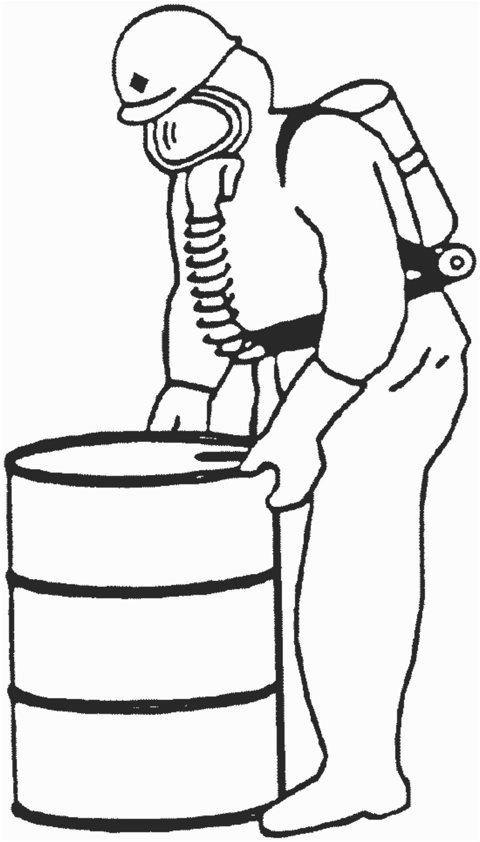
Contaminated wash and rinse solutions may be contained by using over pack containers to hold spent solutions. Tools that were used in the Exclusion Zone must not be removed without proper decontamination.

Disposal of Contaminated Materials

Contaminated material and equipment used for decontamination must itself be decontaminated or disposed of as waste. Clothing, tools, buckets, brushes, contaminated material and equipment are secured in drums or other containers and properly labeled. Cleaning solutions and rinse waters must be contained, collected, transferred to drums that are appropriately labeled and disposed of according to local, State and Federal regulations.

Assessing Effectiveness of Decontamination

There is not a reliable technique to immediately determine the effectiveness of decontamination so following the protocols outlined above is what should be done to minimize or eliminate the spread of contaminants. In some cases, an estimation of effectiveness can be made by visual observation. An exact determination of effectiveness can be gained by sending PPE out to be analyzed for the presence of contamination. Another way to analyze the contaminant is with a sample from the final rinse, but it may take several days to receive the results.



Chapter 9

Safe Work Practices and Standard Operating Procedures

Chapter Objective

Enable students to:

- Understand how safe work practices reduce the risk of injury

Safe Work Practices and Standard Operating Procedures (SOPs)

Safe work practices are carefully planned, detailed written work instructions or programs that provide workers with guidelines to safely perform work tasks. Safe work practices and SOPs are administrative controls that minimize risks to employees, nearby communities, and the environment. SOPs can be developed for routine operations, as well as emergency situations.

Although every hazardous waste operation possesses unique characteristics, similar techniques are used to work with power tools, prevent back injuries, as well as prevent contamination. Procedures don't usually vary from operation to operation. SOPs can include:

- Lifting Procedures (Lift w/legs not your back, keep back straight, etc.)
- Hand Washing Policy
- Employee Identification System
- Work Shift and Break Schedule
- Respirator Use and Maintenance Program
- Equipment and Vehicle Operation Procedures
- Drum Handling Procedures

Drum Sampling Standard Operating Procedure

A sample from a drum may be required to fully characterize the contents. Before sampling a drum, inspect the drum and surrounding area for evidence of hazardous conditions such as:

- Bulging top, vapor or mist – could have excessive pressure within
- Damaged, rusting, corroded – could be leaking

General procedures for pulling a sample from a drum include:

- Review available documents, labels and placards
- Wear appropriate PPE
- Prepare the sampling equipment
- Mark the drums and sample bottles
- Follow the established sampling plan
- Determine the number, volume and location of samples
- Follow recommended procedures when opening a drum
- Do not lean over drums to reach the drum being sampled
- Close drum

- Dispose of or decontaminate sampling equipment according to the sampling plan.
- Send samples in for analysis

SOPs for a Safety and Health Program (Example)

The goal of this program is to eliminate workplace injuries, illness and losses. Since no safety or health program can achieve its objectives without the full participation and cooperation of all personnel, our policy is to:

- Comply with, and where possible surpass local, State and Federal standards for occupational safety and health (OSH)
- Develop and maintain effective communication regarding safety and health matters between all employees and management
- Provide a program of training for all employees so that each may have the needed skills to do their work safely and efficiently
- Promote a sense of responsibility in each person for the welfare of the group, as well as the individual

The Program (Example)

This Safety and Health Program establishes safety rules and procedures for maintenance and construction work in our facilities maintained and serviced throughout the State of Alaska.

1) Management Personnel (Example)

Dennis Snow	Director
Joel Needham	Supervisor
Theodore Bear	Foreman

2) Management Objectives

- Oversee safety and health inspections of the facilities and projects
- Review annually, and update the Program and policies if necessary
- Provide and schedule personnel for training courses
- Maintain records to support compliance with this program

3) Safety Rules

Management shall:

- Ensure that safety rules are developed and provided to employees
- Evaluate employee compliance with safety rules
- Ensure that required signs, notices and warnings are posted
- Conduct a Risk Analysis with input from employees

Employees shall:

- Abide by all established safety rules for the workplace and occupation
- Submit recommendations for improvements in the safety rules
- Observe all posted signs, warnings and directions
- Participate in the development of the Risk Analysis

4) Task Analyses and Procedures

Task analyses include complete job descriptions, work orders, procedures to be followed and facility reports that describe the tasks to be performed by the employees. These documents identify tasks that are critical to safety, quality and productivity. They will facilitate the development of SOPs and training programs appropriate to each task.

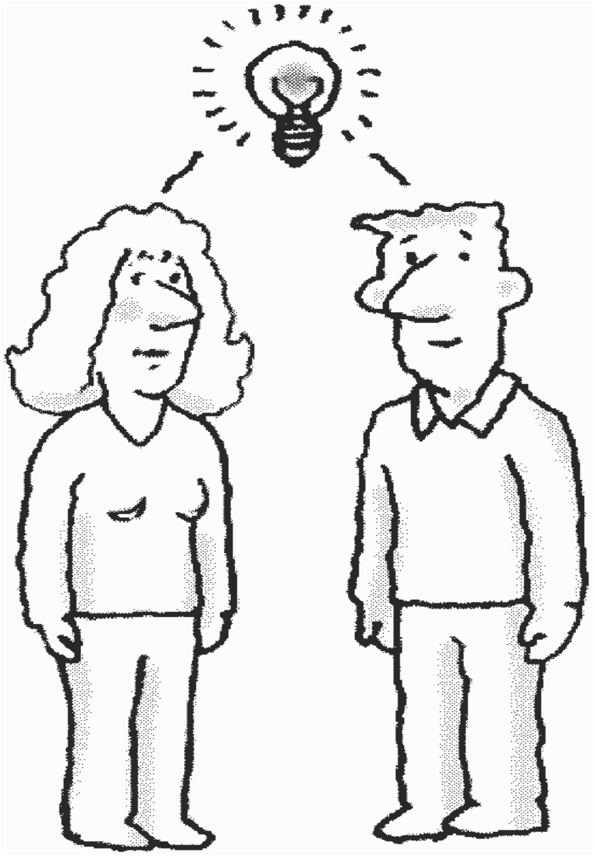
- Job: All work activities that a person performs
- Task: A specific assignment consisting of a defined sequence of steps
- Critical Task: A task that may cause an incident, or result in injury, property damage, or loss if not properly preformed.
- Mitigation: How a task risk will be lowered through elimination of the risk, engineering reduction of the risk, administrative control of risk (barriers, flagging tape, signs, employee rotation) or PPE (Level A, B, C or D)

5) Management Directives

- Review all related analyses with the employees on a timely basis. SOPs will be reviewed with employees during training, evaluations and safety meetings for tasks that are performed regularly.
- Instructions and the training necessary to complete the task safely must be given to employees before assigning a new or different task

6) Employee Directives

- Perform assigned tasks according to OSH safety regulations and SOPs.



Excavations

While remediating soil after a spill, an excavation may be required. Some excavations may also be considered confined spaces, so Confined Space Entry procedures must be followed. When excavating soil, the OSHA Construction Industry regulation, 1926.650-.652 plus appendices, must be followed. Any excavation deeper than four feet needs a competent person to supervise while workers are in the excavation. Procedures such as Sloping, Shoring and Shielding must be used to keep workers safe in a trench. Any excavation deeper than 20' must be designed by a Registered Professional Engineer (RPE).

Confined-Spaces Entry Procedures

Natural barriers such as hills and valleys may trap chemicals or their vapors and can allow hazardous conditions to exist. Low-lying areas, such as hollows and trenches, are also suspect. Cargo holds, mine shafts, silos, storage tanks, box cars, bulk tanks, basements, and sumps are likely spaces for hazardous vapors to accumulate.

A **confined space** has three distinct characteristics that increase the risk of injury or illness when working in this environment. They are:

- Large enough to allow entry for work
- Limited means of entry and exit
- Not intended for continuous occupancy

If a confined space has the potential to contain any hazard, it becomes a **Permit-Required Confined Space**. Something as simple as rusting metal or the operation of fuel powered engines can deplete the existing oxygen supply. Lack of natural ventilation makes it easy for toxic or flammable materials to accumulate.

Permit-Required Confined Space Characteristics:

- Potential to contain a hazardous atmosphere
- Potential to engulf or entrap an employee
- Configuration that could result in entrapment or asphyxiation
- Any other recognized hazard including:
    - Electrical hazards
    - Mechanical hazards
    - Pipes containing hazardous fluids, heat or steam
    - Hazards outside of the space that could get inside

Characteristics of Hazardous Atmosphere:

- Flammable/Combustible gases or vapors above 10% of the LEL
- Flammable/Combustible dust at or above LFL
- Oxygen Deficient (<19.5%) or Enriched (>23.5%) Atmosphere
- Toxins above PELs
- IDLH Atmosphere

Common confined-space injuries are asphyxiation from lack of oxygen, being overcome by very high concentrations of toxins, or rapid skin absorption of organic solvents. Many toxic gases don't have adequate warning properties, so workers about to enter a confined space don’t know what, if any, hazards they face without testing the atmosphere first. Even entering or exiting a confined space can cause injuries or hinder rescue efforts in emergencies.

Permit-Required Confined Space (PRCS) General Requirements

As of 1993, all workplace spaces must be evaluated to identify both confined spaces and permit-required confined spaces. Employers must maintain a list of the results, delineating those identified as permit-required confined spaces; usually by a sign stating that it is a PRCS.

Preventing Unauthorized Entry

If it is determined that employees will not enter **permit spaces**, employers **must** take adequate steps to prevent unauthorized entry into a **permit space** by closing the space when not working in it, by barricading or locking any entrances**.**

Testing Confined Spaces

Before an employee enters a space, the internal atmosphere must be tested with a calibrated direct-reading instrument, **in the following order:**

- Oxygen Content
- Flammable Gases and Vapors
- Potential Toxic Air Contaminants

Confined-Space Entry (CSE) Program

Once a space is identified as a permit-required confined space the following procedures must be in place for an entry to occur.

- A written CSE Program must be developed that includes:
  - Measures to prevent unauthorized entry
  - Procedures to identify and evaluate hazards
  - Procedures and practices for safe entry
  - Equipment to include:
    - Testing and monitoring
    - Ventilation
    - Communications
    - PPE
    - Rescue and emergency response
  - Procedures to evaluate permit space conditions
  - An entry attendant
  - Designate the individuals to perform and duties of:
    - Entrants
    - Attendants
    - Entry Supervisor/Competent Person
    - Testing and monitoring personnel (Safety Department)
    - Rescue team
  - Procedures to summon rescue and emergency services
  - Procedures to prepare, issue, use, and cancel an entry permit

    - Procedures to coordinate contractor activities
    - Procedures to review the program and canceled permits

The **entry permit** documents compliance and authorizes entry. See example in 29 CFR 1910.146.

Permit-Required Confined Space Entry is forbidden unless you have received the training for your assigned function prescribed in the General Industry standard 29 CFR 1910.146, or as applicable, the Construction Industry standard 1926.1200 - .1213.

- Duties of Entrants
    - Know hazards: signs, symptoms and consequences of exposure
    - Know proper equipment use
    - Communicate with the attendant
    - Know when to alert the attendant
    - Know when to exit spaces

- Duties of Attendant
    - Know hazards: signs, symptoms and consequences of exposure
    - Awareness of behavioral effects of exposure
    - Maintain an accurate identity and count of the entrants
    - Communicate with the entrant(s)
    - Remain outside the space
    - Monitor activities to ensure conditions/alert entrants to exit
    - Summon rescue and emergency response services
    - Prohibit unauthorized entry, if possible
    - Perform non-entry rescue
    - Perform no duties that interfere with attendant duties

- Duties of Entry Supervisor/Competent Person
    - Know hazards: signs, symptoms and consequences of exposure
    - Verify that permit requirements have been fulfilled
    - Terminate and cancel permit
    - Verify rescue services are available
    - Verify means to summon rescue services are operable
    - Remove unauthorized persons
    - Verify safe entry conditions remain consistent
        - At dictated intervals
        - If permit is transferred when another supervisor takes over

- Duties of Rescue and Emergency Services
    - Employees who enter to perform rescue must:
        - Be provided with/trained to use PPE and rescue equipment
        - Be trained to perform assigned rescue duties

        - Practice permit space rescue every 12 months
        - Be trained in basic first aid–CPR/hold a current certificate
    - Employees other than those who enter to perform rescue must:
        - Be provided with the identity of hazards they may confront
        - Be provided with access to all permit spaces
- Use non-entry rescue system (Tripod) unless use increases overall risk
- Provide SDS to medical facility treating exposed worker

Examples of Safe Work Practices

Confined Space Work (Example)

Permit-Required Confined Space work is not performed by our personnel. Any area signed as "Permit-Required" shall not be entered. Employees are forbidden to remove covers, doors or hatches from areas designated or suspected as Permit-Required Confined Spaces.

Work in non-permit required confined spaces shall be evaluated to determine if any prohibited condition(s) could evolve which would create a Permit-Required Confined Space condition: hazardous atmospheres, engulfment, entrapment or other serious risk.

Hazardous Atmospheres

Employees do not perform work in areas classified as hazardous due to oxygen deficiency/enrichment, or flammable and/or toxic atmospheres. A Task Hazard Analysis will be conducted to assess the potential for a hazardous atmosphere to develop, and necessary precautions taken to prevent such an occurrence. If such a condition arises or is suspected, all employees are to evacuate the area and notify their supervisor.

If you are ventilating a hazardous toxic atmosphere or flammable atmosphere from a confined space, consideration must be given to the end of the ventilation hose that is releasing contaminants. An exhaust ventilation area approximately 20' X 20' should be cordoned off with danger tape or equivalent to prevent employee exposure to vented atmosphere, or from vapor reaching a vehicles' catalytic converter or exhaust system and igniting.

Hot Work

Welding, cutting, burning, or other Hot Work is prohibited near or on any vessel, container, tank, pipe, etc. that contains or has contained flammable, toxic or combustible materials. If such work is deemed necessary, a hot work permit should be obtained and the containers shall be cleaned to completely remove all traces of grease, tars, residue, etc. that may produce toxic or flammable vapors when subjected to heat.

Control of Hazardous Energy – Lock Out/Tag Out (LO/TO) 29 CFR 1910.147

LO/TO procedures are to be used to disable, isolate or "release" energy from systems prior to work, inspection, maintenance or repair. Employees are required to utilize appropriate LO/TO procedures according to the written program and following the energy isolation list to prevent injury caused by unexpected energization, start-up or release of stored energy.

Lock Out/Tag Out Procedures

Never assume a machine, circuit or system is locked out because it should be. When in doubt, check it out and lock it out!

Minimum recommendations for lock-out procedure include:

- Get LO/TO permit if applicable, with lock, locking device and/or lock-out tag
- The first person to work on the system or equipment must:
  - Turn off the primary power
  - Render the system to a zero-energy state
  - Check system to ensure it does not start or reenergize
  - Warn others in vicinity
  - Install a personal lock with a lock-out device and tag

Where possible, a lock or lock-out device must be installed. Install the lock-out device so that power cannot be turned on with the lock-out device locked in place. In cases where a lock or lock-out device cannot be used, then a tag can be used.

- If additional persons are required to work on the system/equipment, each must complete the LO/TO process installing their own locks

After the job is complete and all personnel are out of the danger area, each person must remove their lock. Each lock may only be removed by the person who installed it.

- After the last lock and lock-out device are removed, the warning tag can be removed and the equipment reenergized

This is an example of a minimum procedure to be followed for LO/TO. Your company must develop its own site-specific procedures for your work area to ensure no one gets hurt and you are complying with the OSHA regulation LO/TO Control of Hazardous Energy 29 CFR 1910.147.

Chapter 10

Emergency Response

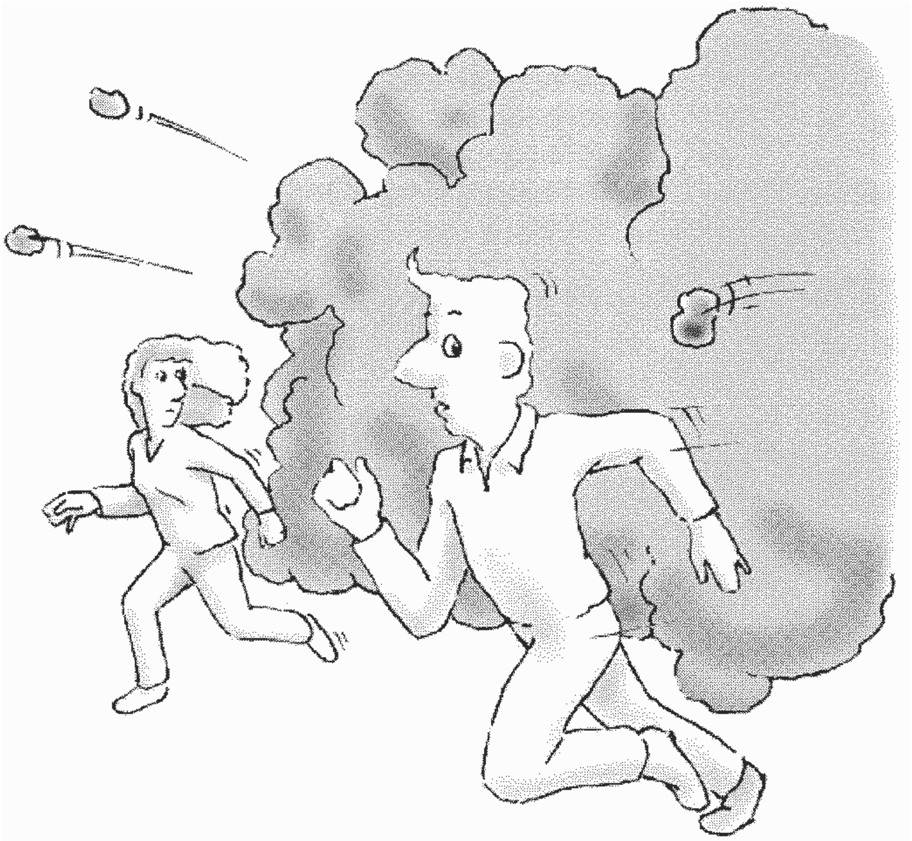
Chapter Objectives

Enable participants to:

- Identify required elements in an Emergency Response Plan
- Discuss responsibilities of personnel in the Incident Command System (ICS)
- Understand termination of the incident
- Understand containment

Introduction

A hazardous material emergency is a situation that cannot be controlled without help from outside the immediate release area. OSHA defines “help from outside the immediate area” to mean anyone other than employees working in the immediate area or maintenance personnel. Notify your supervisor as soon as an emergency is detected.



Your Responsibilities in an Emergency are to:

Activate the alarm system
Notify the supervisor/emergency coordinator
Carry out your designated activities

Emergency Response Plan (ERP)

Employers **must** develop an emergency response plan (ERP) to handle any anticipated emergency on their job site. Employees should be briefed on this plan prior to any emergency and have mock drills or table top practice before emergency response operations can begin. Inside of the ERP should be a generic Site-Specific Safety and Health Plan (SSSHP) that can be filled out for that event when and if an incident takes place.

The ERP is a dynamic document. Employers must evaluate the incident and their response capabilities based on information available at the time of the emergency and then proceed with the appropriate actions to implement the ERP. As conditions change or new information is available, the ERP is amended to incorporate the updated information. The ERP must be written and communicated to employees before they are called on to perform their assigned duties. Any training or drill requirements incorporated into the plan must be practiced before the event happens.

An emergency response plan must address the following topics:

- Pre-emergency planning and coordination with outside parties
- Personnel roles, lines of authority, training, and communication
- Emergency recognition and prevention
- Safe distances and places of refuge
- Site security and control
- Evacuation routes and procedures
- Decontamination
- Emergency medical treatment and first aid
- Emergency alerting and response procedures
- Critique of response and follow-up
- PPE and equipment for emergency response
- Site topography, layout and prevailing weather conditions
- Emergency decontamination procedures
- Incident reporting procedures to local, state and Federal agencies
- Compatibility with local, state and Federal agency emergency response plans
- Periodic plan review and amendment
- Site Specific Safety and Health Plan (SSSHP)

The goal of an Emergency Response Plan is to safely respond to and contain the release and minimize the impact to personnel, property or the environment. We do this by containment.

Containment

As part of an incident response to a spill, leak or release of a hazardous material, there may be the need for:

Spill Control Actions and Containment

A spill containment program is required wherever a container release could result in a major spill. This program may be part of an overall spill control actions plan, which describes the control actions to be taken if either a minor or major spill occurs.

Control Actions prevents further release, such as shutting off a valve or positioning a drum so the hole is at the top. Containment includes those procedures to keep a material in its container. Containment activities include:

Plugging

A plug is placed in the leaking drum to prevent or limit further release. Common plugging materials include rubber, wood, soap, rags and compounds commercially available such as "Plug and Dike". All plugging materials must be compatible with the chemical which is leaking.

Patching

A patch is applied over the leaking area. Patching materials must be compatible with the chemical which is leaking.

Over packing

Placing a leaking drum into a larger drum will contain the spread of the contents. Another means to contain and control a release is **confinement**. Confinement includes:

Diking

Dikes are built around the perimeter of the leak with sand, earth, snow, or sorbent materials. The type of diking material used must be compatible with the spill material. Plastic sheeting can be used as an additional barrier to slow leakage, if appropriate.

Blocking

Drains, ditches or storm sewers should be covered and blocked to prevent run-off of spilled materials. This blocking can be done with a sorbent pad, piece of plastic or rubber pad. If flammable or toxic materials enter these systems, the potential damage to property or people is increased.

Absorption

Run-off can sometimes be absorbed with dirt, sand, soda ash, sawdust, wood chips, peat moss, or vermiculite. The sorbent material should be positioned so that spilled material runs into it. Care must be taken to be certain that the sorbent is compatible with the material being cleaned up.

Non-Emergency Containment

Containment and remediation of minor spills or releases should be detailed in the spill containment program. Methods may include:

- Moving the container so that the leaking area is at the top
- Over packing a leaking container in a larger container
- Collecting substance in a second container or diked area
- Using absorbent or neutralizing materials

Make sure you know where to go and what to do before an emergency occurs.
When it happens, it's too late to read the plan!

Employee Alarm Systems

An alarm system that alerts all employees to an emergency situation must be in place prior to start-up operations. The alarms must be distinct; producing a signal that can be perceived by all employees as signaling a designated emergency action or evacuation.

The emergency message shall have priority over all other messages. All manually operated warning systems used to supplement the alarm must be unobstructed, conspicuous and readily accessible for use. The employer shall assure that all components of the alarm system are approved for the work area and operating properly. After use, for testing or alarm, the system must be returned to normal operation as soon as possible.

Example of an Accident/Incident Reporting Standard Operating Procedure (SOP)

1) Reporting Information

It is essential that employees report all incidents, including near miss incidents, minor accidents, to their nearest supervisor using the swiftest mode of communication.

- **Incident:** An undesired event that, under slightly different circumstances, could have resulted in injury, property damage or loss
- **Accident:** An unplanned, unintentional, undesired event that results in injury, property damage, environmental damage or other type of loss

Reports must contain the details necessary for investigation and settling claims. In the event of an incident possibly causing a delayed or latent illness or injury, or future loss claim, the information gathered in an investigation will be mandatory as well as useful. Reports shall include the following information:

- Name of the person(s) involved
- Nature and circumstances of the incident or injury
- Any bodily injury or illness sustained
- Nature and extent of first-aid treatment, if any
- Description of the machinery or equipment involved
- Time and place of the occurrence
- Names, address and phone number of all witnesses to the occurrence
- Steps taken to prevent a recurrence

2) Regulatory Reporting

The Supervisor is responsible for completing regulatory notifications, satisfying record keeping and reporting requirements, and providing other information as requested by these agencies. Depending on the incident, specific information must be obtained and reported, within established time frames, to the following agencies:

- AK DOL Occupational Safety and Health Administration (OSHA)
- AK DOL Workers Compensation Board
- AK DORM Division of Risk Management

When an accident occurs in which an employee suffers an injury requiring medical attention, is critically injured or killed, the reporting criteria of the AK Department of Labor and the AK Workers Compensation Board shall be completed by the Supervisor. In general, a worker who has an on the job injury and is admitted to a hospital and spends the night in Alaska, must be reported to State OSHA within 8 hours.

3) Accident/Incident Investigation

Supervisors shall participate in accident/incident investigations and reporting. Their duties may involve:

- Initiating a preliminary investigation and participating in interviews
- Assessing all Accident/Incident Investigation Reports and ensuring that proper action has been taken
- Notifying Management of accident and loss investigation findings

Employees shall immediately report accidents, injuries or incidents to their supervisor and participate in the investigation and make recommendations.

The HAZWOPER regulation divides the training requirements for first responders into different levels.

First Responders

First Responders or members of 'Hazmat Teams' are those who provide requested assistance from outside the immediate release area in an emergency situation. First Responder duties are covered in 1910.120 (q) (6) 'Training' delineated as follows:

- First Responder Awareness level – recognize an emergency, initiate the response plan and evacuate the area (usually a four-hour course)
- First Responder Operations level – take defensive actions to protect nearby persons, property and the environment, without putting themselves at risk (usually an eight-hour course)
- Hazardous Materials Technician – offensive action to stop a release, and contain and control emergency situations; referred to as the 'plug and patch guys' (usually a 24-hour course
- Hazardous Materials Specialist – individual with 'specialized' training in a specific discipline necessary to assist or give advice on how to properly manage the response actions (requires specialized training)
- On-Scene Incident Commander – senior official on site, usually has the highest level of training and authority to commit funds and resources (requires specialized training)

Incident Command System (ICS)

The Incident Command System is a preplanned method of communication and control used during emergency response. ICS is usually an interface of local, state, Federal and private industry personnel fulfilling designated roles. Preplanning, training and practice are required to ensure that everyone knows his role within the overall ICS. ICS is sometimes referred to as the FLOP system since it consists of:

- Finances
- Logistics
- Operations
- Planning

The number of people involved and the roles of each vary depending upon the type and nature of the emergency. The duties and actions of each member of the ICS require specialized training which is outside the scope of this program. For more information and free, online education, go to the Federal Emergency Management Agency (FEMA) Independent Study Program website at: training.fema.gov. Suggested ICS courses include: IS -100.c (Introduction to Incident Command System); IS – 200.c (Basic Incident Command System for Initial Response); IS – 700.b (An Introduction to the National Incident Management System ((NIMS)); and IS – 800.c (National Response Framework, An Introduction). There are approximately 86 free FEMA courses available to any interested person.

A brief summary of positions and duties in the ICS may include:

Incident Commander (IC)

The Incident Commander may also be referred to as an On-Scene Coordinator (OSC). The IC position may change as the emergency response progresses and more resources become available to respond. The IC has two staffs; one is an officer staff called the Command Staff (Safety Officer, Public Information Officer, Liaison Officer), and the other is a General Staff with Chiefs as leaders (Operations Section Chief, Logistics Section Chief, Planning Section Chief, Finance Section Chief). IC duties include:

- Directing all aspects of the response
- Setting the incident objectives, strategies, and priorities
- Having the authority to commit funds and resources
- Establishing a command post and chain-of-command
- Maintaining on-going communication with all teams
- Coordinating off-site personnel
- Keeping a log of all response activities and maintaining records

Safety Officer

Safety Officer's duties include:

- Implementing the safety plan
- Monitors safety conditions and develops measures for assuring the safety of all assigned personnel
- Conducting safety meetings and briefings
- Coordinating matters such as PPE and decontamination methods
- Acting as a liaison with emergency medical personnel

Public Information Officer (PIO)

- The PIO serves as a conduit for information to internal and external stakeholders, including the media or other organizations seeking information about the incident or event

Liaison Officer

- The Liaison Officer serves as the primary contact for supporting agencies assisting at an incident when the circumstances required further oversight under the expanded ICS structure called the Unified Command Structure

Operations Section (Chief) duties are:
The Operations Section Chief is also referred to as the emergency coordinator. They report directly to the IC. Operations Section Chiefs duties include:

- Supervising activity team leaders who coordinate operations
- Conducting operations to reach the incident objectives
- Establishing tactics and directs all operational resources
- Coordinating specific activities
    - Entry
    - Assessment
    - Sampling
    - Decontamination
    - Site security

Planning Section (Chief) duties are:

- Collecting, evaluating, and displaying incident intelligence and information
- Preparing and documenting Incident Action Plans
- Conducting long-range and/or contingency planning
- Developing plans for demobilization
- Maintaining incident documentation
- Tracking resources assigned to the incident

Logistics Section (Chief) duties are:

- Ordering, obtaining, maintaining, and accounting for essential personnel, equipment and supplies
- Providing communication planning and resources
- Setting up food services
- Setting up and maintaining incident facilities
- Providing support transportation
- Providing medical services to incident personnel

Finance Section (Chief) duties are:

- Contract negotiation and monitoring
- Timekeeping
- Cost analysis
- Compensation for injury or damage to property

There are many ways for the incident command system to grow, change or apply to a specific incident. The beauty of the ICS is it is flexible and can include the following positions if needed:

Security Officer
The Security Officer usually falls under the Operations Section Chief and coordinates with the Incident Commander and/or On-Scene Coordinator. Their duties include:

- Establishing all site zones and access points
- Maintaining records of all personnel location and activity
- Acting as a liaison with the mutual aid providers
- Coordinating evacuation

Research Officer
This position can fall under safety or planning and is generally occupied by an industrial hygienist, chemist or safety engineer. Research Officer's duties include:

- Research on substances on site and advice on matters such as:
    - Response approaches
    - Incompatibilities
    - Flammability and explosion hazard
    - Toxicity
    - First-aid methods
    - PPE
    - Decontamination methods

Task Force (Leader) duties:

- Task Forces are a combination of mixed resources with common communications operating under the direct supervision of a Leader

Strike Team (Leader) duties include:

- Strike Teams are a set number of resources of the same kind and type with common communications operating under the direct supervision of a Strike Team leader
- Coordinating all operational activities
- Monitoring the condition of the team members in each zone
- Ensuring compliance with the ERP

Strike Team Members duties include:

- Implementing activities and work plans as directed
- Utilizing appropriate PPE
- Following decontamination procedures
- Fulfill 'buddy' responsibilities to assigned team member(s)

ICS Summary

There are four main parts of an activity that involves the Incident Command System. They are:

- Emergency Response (ER of HAZWOPER)
- Termination of the Emergency Response portion
- Restoration or cleanup = Post-Emergency Response
- Finalizing the Incident

In the Emergency Response phase, the situation determines the level of activity. The Incident Commander sets the time frame for the first operational period. This could be 12 hours or 24 hours or less for a minor emergency.

Once the emergency is over, Termination of that phase begins.

In Termination, the Emergency Threat has been stabilized, Emergency Responders are still on scene, and clean-up has begun. Clean-up involves operations that are underway to make the site safe for people and the environment. The purpose of Incident Termination is to:

- Bring the emergency to a close
- Provide an official end to the emergency
- Transition to the clean-up phase
    - Involves safely transferring command

Some of the reasons for Incident Termination involve:

- Responder safety
- Legal Requirements
- Improvement of future Emergency Responses

There are three phases to Termination of the Emergency Response:

- Incident debriefing
- Incident critique
- Post-incident analysis

The Incident debriefing purpose is to:

- Disseminate pertinent information concerning
  - Identification of hazards and exposures
  - Inform all responders of these

Another aspect of the Incident debriefing is to:

- Identify follow-up items

  Such as: _____________

Some of the reasons for an Incident Debriefing include:

- Legal mandates
- Responder safety
- Environmental protection

Some of the elements of the Incident Debriefing include:

- Personnel involved
- Substances
- Exposures
- Symptoms
- Decon
- Equipment status
- Problems
- Organization
- Time line
- Wrap-up

Debriefing Procedures include:

- Select suitable location
- Include all responders
- Designate a facilitator
- Impose a time limit
- Provide means of follow-up

Another element of the Debriefing is the Incident Critique. Some of the reasons to conduct a critique are:

- To capture lessons learned
- Collect and organize incident documentation

- Improve future responses
- Use information for refresher training

Incident Critique Components are:

- Collect and organize documentation
- Interview responders
- Identify laws, policies and procedures that are applicable
- Draft a report and distribute
- Response review and feedback
- Performance of incident management
- Strategy and tactics
- Resources used
- Problems
- Have Key individuals provide input
- Lessons learned
- Ensure the critique is an open forum

Some Incident Critique Procedures include:

- Designate a facilitator
- Focus on improvement
- Set and follow an agenda
- Ensure critique is not a punitive procedure
- Record results and follow-up
- Generate and disseminate a written report

There may be some legal issues involved in the response so some considerations are:

- Not improving your response in the future can get you sued
- If something went wrong the lawyers will have ammunition from
  - Violation reports
  - Disgruntled employees
  - Witnesses

Some additional reasons to conduct an Incident Critique are:

- Reconstruct the incident
- Provide an incident timeline
- Capture response resources involved
- Analyze incident causal factors
- Determine financial responsibility
- Provide a formal investigation and report

The final part of Incident Termination is:

- Post Incident Analysis

The purpose of the post incident analysis is to look at lessons learned and to prepare for a better response the next time an incident occurs.

Another part of any HAZWOPER response is cleanup and restoration or remediation of the site to Federal and State contaminant levels or the condition the site once was in. This may take a lot of time and will be “Site Specific”.

The last thing to do is “Finalize the Incident”. This also may take time and involve litigation and record keeping and is also “Site Specific”.

We hope this student manual and course have been helpful. If you have any questions, please contact a staff member at Environmental Management, Inc. at (907) 272-8852. Thank You!

Student Manual End!

LAWS & REGULATIONS

CAA	Clean Air Act (1970, 1977, 1990): Federal law designed to enhance the quality of air resources by authorizing the EPA to set the criteria for our nation's air pollution control programs. The CAA mandates and enforces toxic emission standards for stationary sources and motor vehicles. CAA established a Pollutant Standard Index (PSI) and requires standardization of monitoring efforts. Air quality standards of pollutants are required to be achieved and maintained nationwide.
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (1980); also called Superfund: Federal law authorizing identification and remediation of abandoned hazardous waste sites. CERCLA provides for liability, compensation, cleanup, and cleanup of inactive hazardous waste disposal sites, as well as emergency response for hazardous substances released into the environment.
CWA	Clean Water Act (1948, 1972): Both EPA and Army Corps of Engineers have jurisdiction. CWA regulates the discharge of toxic and non-toxic pollutants into surface waters. The interim goal is to make surface waters usable for activities such as fishing and swimming; with the ultimate goal to eliminate all discharges into surface waters. The EPA sets guidelines and individual states issue permits through the National Pollutant Discharge Elimination System (NPDES) specifying the types of control equipment and discharges for each facility.
HMTUSA	Hazardous Material Transportation Uniform Safety Act (1975, 1990): Federal law administered by DOT that requires the identification, labeling, and specific packaging of hazardous materials to protect against risks associated with transportation.
NEPA	National Environmental Policy Act (1969): Federal act that establishes policy to prevent damage to the environment, as well as promoting human health and welfare.
OPA 90	Oil Pollution Act of 1990 (OPA 90): Federal legislation in response to the 1989 Exxon Valdez oil spill in Prince William Sound, Alaska to ensure safe transportation of petroleum products, particularly in a marine environment. It requires industry to develop spill response plans, as well as demonstrate their response capabilities.
OSHA	Occupational Safety and Health Act (1970): This act ensures, so far as possible, safe and healthful working conditions for every working person. OSHA considers NIOSH recommendations when setting particular standards.
RCRA	Resource Conservation and Recovery Act (1976, 1980, 1984): Federal law that requires the EPA to control hazardous waste from "cradle to grave".
SARA	Superfund Amendments and Reauthorization Act (1986): Federal law that safeguards the safety and health of workers and the community at large. SARA reauthorized money to continue site characterization to determine which locations belong on the NPL, as well as continuing abandoned site cleanup. SARA also mandated that OSHA establish worker safety and health standards for hazardous waste and emergency response operations. SARA requires training for both workers and management personnel covering safety and health risks at waste sites, TSD facilities, and emergency response operations. SARA initiated the requirement for local and regional emergency contingency planning. SARA is made up of three separate sections or Titles. Tile I and III cover hazardous waste operations, emergency response and planning, while Tile II targets a fund for hazardous waste clean-up.
TSCA	Toxic Substance Control Act (1976): The EPA administered federal law that regulates the manufacture, distribution and use of chemical substances. TSCA required the EPA to evaluate chemicals before they are sold to prevent any unreasonable chemical risk to humans or the environment, as well as create a list of reviewed harmful substances that need precautions and safe work practices when used by the public or industry.

AGENCIES & REGULATORY AUTHORITY

Alaska Department of Environmental Conservation (ADEC)

State agency that functions similar to the EPA, with enforcement powers to oversee protection of the environment on state and private lands. They work with other state agencies to ensure compliance with state law while overseeing development of lands and resources.

Alaska Department of Labor (ADOL)

State agency responsible for developing and administering occupational safety and health programs for the State of Alaska. The Alaska Division of Occupational Safety and Health (AKOSH) was created within ADOL to enforce worker safety laws and regulation.

Alaska Division of Occupational Safety and Health (AKOSH)

State Agency within ADOL that develops and enforces safety and health standards for the workplace.

American Conference of Governmental Industrial Hygienists (ACGIH)

An organization of professional personnel from government agencies and educational institutions devoted to the administrative and technical aspects of occupational and environmental safety and health programs. ACGIH develops and publishes threshold limit values for hundreds of chemical substances and physical agents.

American National Standards Institute (ANSI)

Privately funded voluntary membership organization that identifies industrial and public needs for national consensus standards, then coordinates development of such standards.

American Society for Testing and Materials (ASTM)

Voluntary membership organization with members from a broad spectrum of agencies and industries concerned with materials. The world's largest source of voluntary consensus standards for materials, products, systems, and services. ASTM is a resource for sampling and testing methods, health and safety aspects of materials, safe performance guidelines, effects of physical and biological agents and chemicals.

Bureau of Ocean Energy Management

The Bureau of Ocean Energy Management (BOEM) is an agency within the United States Department of the Interior established by Secretarial Order. The Outer Continental Shelf Lands Act (OCSLA) states: "...the outer Continental Shelf is a vital national resource reserve held by the Federal Government for the public, which should be made available for expeditious and orderly development, subject to environmental safeguards, in a manner which is consistent with the maintenance of competition and other national needs. BOEM (and its sister agency, the Bureau of Safety and Environmental Enforcement (BSEE) are the agencies to which this responsibility is delegated. They exercise the oil, gas, and renewable energy-related management functions formerly under the purview of the Minerals Management Service. Specifically, BOEM activities involve resource evaluation, planning, and leasing

Department of Transportation (DOT)

Federal agency that establishes and enforces regulations governing the transport of hazardous materials.

Environmental Protection Agency (EPA)

Federal agency responsible for setting environmental standards and regulations. The EPA enforces several environmental protection laws covering water and air pollution, in addition to hazardous waste management standards.

International Agency for Research on Cancer (IARC)

Agency that evaluates research data on substances tested for their carcinogenic potential. IARC publishes information on carcinogens and potential carcinogens. The IARC listing is one of the references that must be used to identify cancer-causing chemicals on SDSs.

Labor Standards and Safety

Alaska section under ADOL that deals with worker health and safety issues.

Mine Safety and Health Administration (MSHA)

Federal agency that functions as "OSHA" for the mining industry. MSHA certifies products and devices unique to mining operations.

National Emission Standard for Hazardous Air Pollutants (NESHAPS)

Program under the Clean Air Act aimed at regulating hazardous air pollutants.

National Fire Protection Association (NFPA)

An international volunteer membership organization that promotes improved fire protection and prevention, as well as establishing safeguards aimed at preventing loss of life and property due to fire.

National Institute for Occupational Safety and Health (NIOSH)

Agency of the Department of Health and Human Services (DHHS) that investigates incidents, researches occupational safety, and establishes Recommended Exposure Limits (RELs) to OSHA for hazardous chemicals. They also test and certify all respiratory and air sampling devices (except specific mining devices), as well as recommending assigned protection factors (APF) for respirators. NIOSH does not act in a regulatory capacity.

NIOSH Pocket Guide to Chemical Hazards

Presents general industrial hygiene and medical surveillance information for employers, workers, and occupational health professionals. Specifics include chemical structure or formula, synonyms, exposure limits, IDLH limits, physical description, chemical and physical properties, incompatibilities and reactivity, measurement methods, personal protection and sanitation, recommendations for respirator selection, Assigned Protection Factors (APFs) and health hazards.

National Response Center (NRC)

A hazardous substance spill notification center operated by the Coast Guard in Washington D.C. It acts as the notification, communications, technical assistance, and coordination center for the National Response Team (NRT).

Federal law requires that anyone who releases a reportable quantity (RQ) of hazardous substance (including oil when water is, or may be affected) or a material identified as a marine pollutant into the environment must immediately notify the NRC at 1-800-424-8802. When in doubt as to whether the amount released equals the required reporting levels for these materials, the NRC should still be notified. (See reportable quantity and marine pollutant).

* Note: Calling the shipping paper emergency response telephone number, or CHEMTREC, does not constitute compliance with requirements to call the NRC. (DOT Emergency Response Guidebook)

National Response Team (NRT)

The NRT is comprised of 15 federal agencies which may provide support during hazardous materials incidents. After receiving notification of an incident, the NRC will immediately notify the appropriate federal On Scene Coordinator and concerned federal agencies.

National Toxicology Program (NTP)

An organization that funds and conducts research on chemical substances and publishes lists of carcinogens and potential carcinogens that is one of the reference sources that must be used to identify cancer-causing chemicals located on SDSs.

Occupational Safety and Health Administration (OSHA)

Federal agency under the Department of Labor that oversees and enforces workplace health and safety. Their charter is to ensure that employers provide a safe and healthful workplace for all workers. States may enforce their own laws that are more restrictive than OSHA, but may not be less stringent.

United States Coast Guard (USCG)

Federal agency within DOT that is responsible for enforcing regulations governing the safe carriage of hazardous material, as well as response to hazardous material releases that threaten the navigable waterways of the United States.

ACRONYMS & ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
ADEC	Alaska Department of Environmental Conservation
ADOL	Alaska Department of Labor
AKOSH	Alaska Division of Occupational Safety and Health
AIHA	American Industrial Hygiene Association
ANSI	American National Standards Institute
APF	Assigned Protection Factor (NIOSH)
APR	Air Purifying Respirator
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
BLEVE	Boiling Liquid Expansion Vapor Explosion
BP	Boiling Point
C	Ceiling
Ca	NIOSH notation noting potential occupational carcinogens. Symbol for Calcium
CAA	Clean Air Act (1970)
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (1980); also called Superfund
CFR	Code of Federal Regulations
CGI	Combustible Gas Indicator
CIH	Certified Industrial Hygienist
CNS	Central Nervous System
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CPC	Chemical Protective Clothing
CPR	Cardiopulmonary Resuscitation
CRC	Contamination Reduction Corridor
CRZ	Contamination Reduction Zone
CSE	Confined Space Entry
CWA	Clean Water Act (1972)
DHS	Department of Homeland Security
DOL	Department of Labor
DOT	Department of Transportation
EPA	Environmental Protection Agency
ERP	Emergency Response Plan
ERT	Environmental or Emergency Response Team
FID	Flame Ionization Detector
EPCRA	Emergency Planning and Community Right-to-know Act; see SARA (1986)
ESLI	End of Service – Life Indicator
FEMA	Federal Emergency Management Agency
FIFRA	Federal Insecticide, Fungicide and Rodenticide Act (1947)
FI.P.	Flash Point
H_2S	Hydrogen Sulfide
HAZCOM	Hazard Communications
HAZMAT	Hazardous Materials
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HMTUSA	Hazardous Material Transportation Uniform Safety Act (1974, 1990)
IDLH	Immediately Dangerous to Life or Health
IH	Industrial Hygienist
IP	Ionization Potential
IR	Infrared
LEL/LFL	Lower Explosive Limit/Lower Flammable Limit
MP	Melting Point

MPRSA	Marine Protection, Research and Sanctuaries Act (1972)
MREM	Mill Roentgen Equivalent in Man
MSHA	Mine Safety and Health Administration
MUC	Maximum Use Concentration (air purifying respirator cartridges)
MUL	Maximum Use Limit (air purifying respirators)
MW	Molecular Weight
NEPA	National Environmental Policy Act (1969)
NFPA	National Fire Protection Association
NIOSH	National Institute of Occupational Safety and Health
NORM	Naturally Occurring Radioactive Material
NPL	National Priorities List – Federal list of hazardous waste sites under CERCLA
NTP	National Toxicology Program
O_2	Oxygen
OPA 90	Oil Pollution Act of 1990
ORM	Other Regulated Material
OSHA	Occupational Safety and Health Administration
OSHAct	Occupational Safety and Health Act (1970)
OVA	Organic Vapor Analyzer
PADS	Physical Agent Data Sheets (Alaska – adopted from ACGIH)
PAPR	Powered Air-Purifying Respirator
PCB	Polychlorinated Biphenyl
PDS	Personnel Decontamination Station
PEL	Permissible Exposure Limit (OSHA)
PF	Protection Factor (OSHA)
pH	Potential of Hydrogen
PHMSA	US DOT Pipeline and Hazardous Materials Administration
PID	Photo Ionization Detector
PNS	Peripheral Nervous System
PPE	Personal Protection Equipment (Respiratory and Chemical Clothing)
PRCS	Permit Required Confined Space
PVC	Polyvinyl Chloride
RCRA	Resource Conservation and Recovery Act (1976)
REL	Recommended Exposure Limit (NIOSH)
RGasD	Relative Gas Density
SARA	Superfund Amendments and Reauthorization Act (1986), see EPCRA
SCBA	Self-Contained Breathing Apparatus
SDS	Safety Data Sheet
SDWA	Safe Drinking Water Act (1974)
SOP	Standard Operating Procedures
Sp. Gr.	Specific Gravity
STEL	Short Term Exposure Limit
TLV	Threshold Limit Value (ACGIH)
TLV-C	Threshold Limit Value – Ceiling
TLV-STEL	Threshold Limit Value – Short Term Exposure Limit
TSA	Transportation Security Agency
TSCA	Toxic Substances Control Act (1976)
TSDF	Treatment, Storage, or Disposal Facility – covered under RCRA
TWA	Time-Weighted Average
UEL/UFL	Upper Explosive Limit/Upper Flammable Limit
USCG	United States Coast Guard
UST	Underground Storage Tank – regulated under RCRA
UHF	Ultra-high Frequency
UV	Ultraviolet
VHF	Very High Frequency
VP	Vapor Pressure

UNITS OF MEASUREMENT

<	Less Than
>	Greater Than
°C or C	Degrees Celsius
cm	Centimeter: a metric unit of distance equal to .394 inches
dB	Decibel: a unit for measuring the relative intensity of sound equal to 1/10 of a bel
°F or F	Degrees Fahrenheit
Hz	Hertz: standard unit of measurement for frequency, numerically equivalent to cycles per second
km	Kilometer: a metric unit of distance equal to .62 miles
L	Liter: a metric unit of volume or capacity equal to 1000 cubic centimeters of pure water at the temperature of its greatest density, -4 °C
LC	Lethal Concentration: concentration of a substance that is fatal to a test animal
LC_{50}	The concentration of an airborne contaminant that is fatal to 50% of the exposed organisms
LD	Lethal Dose: an amount or quantity of a substance that is fatal to a test animal
LD_{50}	The concentration of an airborne contaminant that is fatal to 50% of the exposed organisms
m	Meter: a metric unit of length equivalent to 39.371 inches
mg	Milligram: unit of mass equal to one thousandth of a gram
mg/kg	Milligrams per Kilogram/Parts per million: one million milligrams are in a kilogram. Dosage expressed in toxicology that is an amount administered per kg of body weight
mg/m^3	Milligrams per cubic meter: unit to express exposure limits of solids – the mass of chemical contaminant (in milligrams) allowed in each cubic meter volume of air
ml	Milliliter: unit of volume equal to one thousandth of a liter or about one cubic centimeter
ml/L	Milliliters per liter
mm	Millimeter: unit of length equal to one thousandth of a meter
ppb	Parts per billion (see ppm)
ppm	Parts per million: unit used to express concentration
psi	Pounds per square inch
u	Micron: a unit of measurement equal to one millionth of a specific unit; um equals one millionth of a meter

GLOSSARY

A

Absorption ► A route of entry where a substance enters the body through the skin or eyes. A sorbent material action that collects liquids by blotting or soaking.

Accident ► An unwanted, unplanned, unintentional event generally resulting in injury or death, loss of property, or disruption of service.

Accumulate ► The collection and storage of substances. The EPA limits hazardous waste accumulation for specific amounts over a set period of time.

Accuracy ► The agreement of a reading or observation obtained from an instrument or a technique with a true value. Often confused with precision.

Acid ► A corrosive chemical that has the ability to cause burns, tissue damage, and damage to steel or aluminum in high concentrations; ranges from 7-0 on the pH scale. As the number decreases the substance increases in acidity. A hydrogen donor; acids turn litmus paper red to blue and neutralizes bases.

Action Level ► A quantitative limit of a substance or physical agent at which protective actions are taken to prevent or reduce exposure, contact, or physical reaction.

Acute Effect ► An adverse effect with symptoms developing rapidly, generally < 24 hours.

Acute Exposure ► A dose that is administered in a single event or over a short period of time, generally which causes an acute effect in < 24 hours.

Acute Toxicity ► A short or high exposure to a toxin, administration of 1 does, or multiple doses within 24 hours; effects usually occur in 14 days or less.

Acutely Hazardous ► A waste that has been determined to be very dangerous in small quantities. A list of these wastes can be found in the EPA rules 40 CFR 261.33 in the “P list”.

Additive Effect ► An effect in which the combined effect of two chemicals is equal to the sum of the agents acting alone.

Administrative Controls ► Use of information, training, shift schedules, policies, housekeeping, and monitoring to reduce or eliminate exposures to hazardous substances.

Adsorption ► Attachment of a gas, liquid, or a dissolved substance to a solid surface, such as soil particles. A sorbent material action that collects liquids by attaching or adhering.

Aerosol ► A dispersion of extremely small solid or liquid particles suspended in the air or in some other gas.

Airborne ► Something that is suspended in the air.

Air-Purifying Cartridge ► Containers with a filter, sorbent, and/or catalyst which removes specific contaminants from the air drawn through it.

Air-Purifying Respirator (APR) ► A respirator that uses filters to remove specific gases and vapors or particulate matter from the air.

Alkali (Alkaline) ► A corrosive substance that is a strong base or hydroxide; water soluble; forms a salt when neutralized; ranges from 7.1-14 on the pH scale. As the number increases, the substance increases in alkalinity and corrosiveness. Bases, another term for alkalis, turn litmus paper blue to red and neutralize acids.

Alpha Radiation ► Large particles that only travel about 3 inches in air. They are composed of two protons and two neutrons originating from radon, uranium, and polonium among others. Alpha radiation can damage internal body parts if ingested or inhaled.

Ambient Conditions ► Typical surrounding temperature and pressure conditions.

Anoxia ► A lack of oxygen from inspired air; literally “without oxygen”.

Antagonism ► A situation in which two chemicals, when given together, interfere with each other’s actions, or when one chemical interferes with the action of the other.

Aromatic Hydrocarbons ► Volatile organic compounds containing a high ratio of carbon to hydrogen atoms, and possessing a fragrant aroma. This group of hydrocarbons and their derivatives are characterized by the presence of one or more six-carbon rings; examples are benzene, toluene, and xylene.

Assigned Protection Factor (APF) ► NIOSH designates an Assigned Protection Factor (APF) – A number assigned to respirators based on their ability to exclude harmful atmospheres to help determine safe contamination levels into which they may be worn. This number is used in a formula to determine that level. Also see Protection Factor.

Asphyxia ► Suffocation from a lack of oxygen.

Asphyxiant ► A vapor or gas which can displace oxygen and/or cause unconsciousness or death by suffocation due to lack of oxygen.

Asphyxiation ► A condition that causes asphyxia, suffocation.

Attendant ► An individual stationed outside a permit required confined space who monitors the authorized entrants in accordance with 29 CFR 1910.146 and the employer’s permit space program.

Atom ► The smallest particle of a chemical element that is made up of protons and neutrons in a central nucleus surrounded by electrons; atoms in various elements vary in mass or weight and in the number of electrons they contain.

Atomic Number ► The number of protons in the nucleus of an atom.

Audible Range ► The frequency range which a normal human ear hears; approximately 20 Hz through 20,000 Hz.

Audiometer ► A signal generator or instrument for objectively measuring the sensitivity of hearing in decibels (dB).

Auto-Ignition Temperature ► The lowest temperature at which a flammable gas or vapor air mixture will ignite from its own heat source or a contacted heat surface without the presence of a spark or flame.

Autonomic–Nervous System ► Portion of the peripheral nervous system that controls most organs and muscles.

B

Barrier Cream ► Protective cream applied to the skin to protect against skin contact/absorption hazards; often used in addition to gloves.

Base (Alkaline) ► A corrosive substance that is a strong alkali or hydroxide that is soluble in water. It reacts with an acid to form a salt; ranges from 8-14 on the pH scale. As the number increases the substance increases in alkalinity and corrosiveness. An acid and a base are chemical opposites that have the ability to neutralize each other in the absence of a buffer. Bases, another term for alkalis, turn litmus paper blue to red.

Beta Radiation ► Small particles composed of single electrons that can travel from 10 feet in air. They can originate from radioactive phosphorous and radioactive carbon. Beta radiation can damage the body in inhaled, ingested, or allowed to penetrate the skin. It can penetrate more deeply than alpha radiation, therefore can result in skin burns and even skin cancer.

Biological Hazard ► Living organism (or their products) that can cause sickness or death to exposed individuals.

Bio-transfusion ► A collective term for the various reactions that occur as a result of metabolism by organisms such as soil bacteria.

BLEVE ► Boiling Liquid Expanding Vapor Explosion: Fires involving compressed gases in cylinders or containers such as tank cars which rupture due to metal fatigue and extreme pressures, thus releasing a flammable vapor that explodes.

Boiling Point (BP) ► The temperature at which a substance will boil; when the vapor pressure of a liquid is equal to the atmospheric pressure acting upon the surface of the liquid; for example, the boiling point of water at sea level is 100°C/212°F.

Bonding ► A safety practice in which two objects (tanks, tankers, cylinders, etc.) are interconnected with clamps and wire. This equalizes the electrical potential between the objects and helps prevent static sparks that can ignite flammable materials transferred between tanks.

Breathing Zone ► The area of the ambient (surrounding) environment in which a person breaths.

Bronchitis ► Inflammation of the air passages in the respiratory system.

Buddy System ► A system of organizing employees into work groups in such a manner that each employee of the work group is designated to be observed by at least one other employee in the work group. The purpose of the buddy system is to provide rapid assistance to employees in the event of an emergency.

Buffer ► A substance in a solution that makes the degree of acidity (hydrogen ion concentration) resistant to change when an acid or base is added.

C

Carcinogen ► Any substance which causes cancer in animals or humans under certain quantified exposures. A chemical is considered to be a carcinogen, according to OSHA, if:

- It has been evaluated by the IRAC and found to be a carcinogen or potential carcinogen;
- It is regulated by OSHA as a carcinogen;
- It is listed as a carcinogen or potential carcinogen in the Annual Report on Carcinogens, as published in the latest edition by the NTP.

Carcinogenic ► The ability to cause cancer.

CAS Number ► A unique number assigned to a chemical by the Chemical Abstract Service, for identification only.

Catalyst ► A substance that usually increases the rate of a chemical reaction while undergoing no permanent change in composition itself.

Cataract ► A loss of the transparency of the crystalline lens of the eye or of its capsule.

Caustic ► Something which strongly irritates, burns or destroys living tissue.

Ceiling or "C" ► A chemical exposure standard established by OSHA which indicates the maximum allowable exposure level without protection for a given chemical.

Ceiling Concentration ► The concentration of an airborne substance that shall not be exceeded without the use of personal protective equipment, even instantaneously.

Celsius ► On this scale, 0°C is the melting point of ice; 100°C is the boiling point of water. Conversion to Fahrenheit is : °F = (°C * 9/5) + 32.

Cerebellum ► The portion of the brain that regulates motor activities, muscle tone, and equilibrium.

Cerebral Cortex ► The portion of the brain that receives and processes visual, hearing, smelling, motor, and associated stimuli.

Chemical ► Any element, chemical compound or mixture of elements or compounds.

Chemical Change ► Change in composition of the properties of a chemical due to rearrangement of elements, atoms, or molecules. See Reaction

Chemical Composition ► The chemical names(s) or test result(s) with percentages of chemicals. An example is a hazardous waste profile.

Chemical Family ► A group of individual elements or compounds with a common structural formula. Ketones: acetone, methyl ethyl ketone (MEK), methyl isobutyl ketone (MIBK)

Chemical Formula ► Way of identifying chemical materials by showing the number of each type of atom contained in one molecule of the chemical. Chemical formulas can be represented different ways:

- Empirical: used to represent ionic compounds which don't exist as distinct molecular entities.
- Molecular: shows the number and kinds of atoms in a molecule without indicating how the atoms are arranged.
- Structural: shows how the atoms are arranged.

Chemical Hazard ► Any chemical material that presents either a physical or health hazard.

Chemical Health Hazard ► Substances that cause injury or harm to and/or from the inside of a body.

Chemical Physical Hazard ► Substances that cause injury or harm to and/or from the outside of a body.

Chemical Name ► The scientific designation of a chemical in accordance with the nomenclature system developed by the International Union of Pure and Applied Chemistry (IUPAC) of the Chemical Abstracts Service (CAS); rules of nomenclature, or a name, will clearly identify the chemical for the purposes of conducting a hazard evaluation.

Chemical Symbol ► The letter or letters used to abbreviate chemical element names.

Chloroflouro-Carbon (CFC) ► A chemical substance used in air conditioners, refrigerators and fire suppression systems among other things.

Chronic Effect ► An adverse effect resulting from repeated exposure to a substance over a relatively prolonged period of time or that recur frequently.

Chronic Exposure ► Persistent, prolonged, and/or repeated doses of low concentrations of chemical substances administered over a long period of time.

Chronic Toxicity ► Toxic effect resulting from repeated doses or exposure to a substance over a relatively prolonged period of time.

Clean-Up Operation ► An operation where hazardous substances are removed, contained, incinerated, neutralized, stabilized, cleaned-up, or in any other manner processed or handled with the ultimate goal of making the site safer for people and/or the environment.

Colorimetric Indicator or Colorimetry ► An analytical method or instrument measuring the color intensity of a substance or a colored derivative of it, such as noting color changes. See Direct-Read Instrument

Combustible Liquid ► A term used by OSHA and DOT to classify certain liquids that will burn on the basis of flash point temperatures.
DOT- A liquid with a flash point > 140°F and < 200°F (transport)
OSHA – A liquid with a flash point between 100°F - 200°F (fixed facility)

Combustion ► The process of burning.

Compound ► A substance formed by chemical combination of two or more elements in definite proportions by weight; such as water is a compound composed of two parts hydrogen and one part oxygen.

Compressed Gas ► Substance stored inside a container at a pressure > 40 psi; it is a physical hazard due to the potential for sudden release of the energy when the gas expands.

Concentration ► The ratio of the amount of a substance to the amount of the medium it is mixed in; concentrations are measured in such units as mg/l, ml/l, mg/m3, or ppm.

Condensation ► A changing of gas or vapor to a liquid.

Confined Space ► (1) Has limited or restricted means for entry or exit (such as tanks, vessels, silos, storage tanks, hoppers, vaults, and pits); and (2) is not designed for continuous employee occupancy; and (3) is large enough and configured so that an employee can bodily enter and perform assigned work.

Confinement ► Control measures used to limit the physical size of release material or environmental control devices used for substance releases such as dams, berms and dikes.

Contact Hazard (Skin or Eyes) ► Chemical material that damages or irritates the skin or eyes on contact, or is systematically absorbed through the skin or eyes.

Container ► Bags, barrels, bottles, boxes, cans, cylinders, drums, reaction vessels, storage tanks and other vessels used to hold chemicals.

Containment ► Control measures used to keep substances in its container, such as plugging and patching or environmental control devices used for substance releases such as berms and dikes.

Contaminant ► An unwanted and non-beneficial substance (synonymous with, but not always interchangeable, pollutant); may also refer to something that may be natural, such as pollen or volcanic ash.

Contamination Reduction Zone ► An established area at a hazardous waste site between the exclusion zone and the support zone that provides a transition area between contaminated and clean zones.

Contingency Plan ► A document that sets out an organized, planned and coordinated course of action to be followed in case of a fire, explosion, or release of hazardous wastes or substances which could threaten human health or the environment.

Cornea ► Transparent structure of the external layer of the eyeball which covers the iris and the pupil.

Corrective Actions ► Efforts to bring a facility or site into compliance with safe operating conditions specified in the facilities permit or regulations.

Corrosive ► Substances that cause deterioration, destruction or alterations at the site of contact; corrosives may burn body tissue on contact or erode through inert materials such as steel.

Cryogen ► A liquefied or solidified gas or other substance existing at very low temperatures; a health hazard that freezes body tissue on contact; examples, liquid oxygen and dry ice.

Cutaneous ► Pertaining to the skin.

Cyanosis ► Blueness of the skin generally caused by lack of oxygen.

D

Dalton's Law ► Total pressure is equal to the sum of the partial pressures of the individual gases.

dBA ► Sound level in decibels read on the A-scale of a sound-level meter. There are "A", "B", and "C" weightings for various frequency filters that cover the frequency range of human hearing. The "A" weighted filter attempts to make the dosimeter respond more closely to the way the human ear hears. "A" weighting is the most commonly used filter in industrial noise application (OSHA).

Decomposition ► Breakdown of material or substance by heat, chemical reaction, electrolysis, decay or other process into elements or simpler compounds.

Decomposition Product ► Chemical or substance that forms when a material breaks down into simpler molecules; may be hazardous even if the parent material is not.

Decontamination ► Removal of hazardous substances from employees and their equipment to the extent necessary to preclude the occurrence of adverse health effects or environmental contamination.

Degradation ► A chemical action causing the breakdown of the material due to substance contact. It is evidenced by physical changes to the material such as shrinking or swelling, becoming brittle or soft, or a complete change in its structure. Other changes may include slight discoloration, rough or gummy surface, or cracks in the material.

Degree of Hazard ► Measurement of how serious an exposure is based on what can happen as a result of that exposure. Takes into account the type of chemical, exposure route, number and length of exposures, dosage, and individual differences.

Delayed Effect ► Health effect that appears after time, rather than right away; can be associated with either single or repeated exposures.

Dermatitis ► Inflammation of the skin caused by an external agent; the skin is red, itchy, and small blisters may form.

Dermal ▶ Skin

Dermal Toxicity ▶ Adverse effects resulting from skin exposure to a substance.

Designated Facility ▶ A licensed hazardous waste treatment, storage, or disposal facility.

Dike ▶ A barrier constructed to control or confine hazardous substances and prevent them from entering sewers, ditches, streams, or other flowing waters.

Direct Reading Instrument ▶ An instrument which gives an immediate indication of the concentration of vapors, gases, or aerosols being measured by either a numerical read out or an arrow on a dial. A colorimeter, also a direct reading instrument, indicates concentration of a substance by a chemical change showing either color intensity or a color change on a measured tube.

Disposal ▶ Getting rid of hazardous wastes either by recycling, incineration, land application, or other treatment.

Dose/Dosage ▶ The amount of chemical that enters the body over a specified period of time; the amount and length of exposure.

Dose Rate ▶ Amount of a toxic substance to which an organism is exposed; dose delivered per unit of time; the intensity of exposure.

Dose-Response ▶ Effect relationship between the dose-amount of a toxic substance to which an organism is exposed and the response-amount of damage that each dose causes.

Dosimeter ▶ An instrument for measuring doses of radiation received over a given period of time.

Dust ▶ Airborne solid particles, ranging in size from 0.1 to 25 microns, generated by physical processes such as handling, crushing, or grinding of solids.

E

Edema ▶ An excessive accumulation of fluid in the body tissues that results in swelling.

Element ▶ One of the building blocks of matter, distinguished form one another by their atomic number; a structure composed of atoms that are chemically alike and which cannot be separated into simpler parts by chemical means; only 103 chemical elements are presently recognized; elements are designated by chemical symbols.

Emergency Response to Hazardous Substance or Responding to Emergencies ▶ A response effort by employees from outside the immediate release area or by other designated responders (mutual-aid groups, local fire departments, etc.) to an occurrence which results, or is likely to result, in an uncontrolled release of a hazardous substance. Responses to incidental releases of hazardous substances, where the substance can be absorbed, neutralized, or otherwise controlled at the time of release by employees in the immediate release area, or by maintenance personnel, are not considered to be emergency responses within the scope of this standard. Responses to release of hazardous substances where there is no potential safety or health hazard (fire, explosion, or chemical exposure) are not considered to be emergency responses.

Engineering Controls ▶ Mechanical devices used to reduce potential hazards by isolating the worker from the hazard or removing the hazard from the work environment. Methods include enclosure, ventilation, and isolation.

Engulfment Hazard ► The surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

Entry permit ► The written or printed document provided by the employer to allow and control entry into a permit required confined space and that contains the information required in CFR 1910.146.

Environmental Assessment ► The measurement or prediction of the transport, dispersion, and final location of a released hazardous substance.

Environmental Emergencies ► Incidents involving the release (or potential release) of hazardous materials into the environment which require immediate corrective action.

Environmental Hazard ► A condition capable of posing an unreasonable risk to air, water, soil quality, and plants or wildlife.

Entry Supervisor ► The person responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by 29 CFR 1910.146.

EPA Hazardous Waste Number ► A number assigned to hazardous wastes by EPA in 40 CFR 261 to identify their hazardous characteristics. Examples are D001-Ignitability, D002-Corrosivity, D003-Reactivity, D008-Lead, and U019-Benzene.

Environmental Monitoring ► Type of administrative control that involves collecting, measuring, and analyzing samples of chemical substances in the environment to determine whether a hazard exists, or whether a known hazard is being effectively controlled.

EPA ID Number ► A unique EPA 12 digit number assigned to each generator, transporter, and Treatment, Storage, or Disposal Facility.

Epidemiology ► The study of the pattern of disease in a population; often epidemiologists seek to determine the causes of disease by looking for a pattern of overlap between those who get a particular disease and those who are exposed to some particular environmental factor such as an air pollutant.

Esophagus ► The tubular passage that leads from the throat to the stomach.

Evaporation ► The process of a liquid being changed into a vapor state.

Evaporation Rate ► The rate at which a particular material will evaporate when compared to the rate of a known material. The evaporation rate can be useful in evaluating the health and fire hazards of a material.

Exclusion Zone ► An established work zone at a hazardous waste site with the highest detection of contamination, therefore the highest appropriate level of PPE is needed and the actual remediation or removal work takes place.

Exhaust Ventilation ► An engineering control where a mechanical system is used for exhausting air containing contaminants from a work area.

Explosive ► Chemical material that can combust at such a high rate that there is physical destruction due to shock waves, flying objects, and heat.

Explosive Limits (Flammable Range) ► Indicates the explosive or flammable range of a vapor or gas as expressed in percentage by volume of gas or vapor in air. The lower explosive limit (LEL) is the minimum concentration below which the vapor-air mixture is too lean to burn or explode. The upper explosive limit (UEL) is the maximum concentration above which the vapor-air mixture is too rich to burn or explode. See Lower Explosive Lime and/or Upper Explosive Limit

Exposure Limit ► Exposure limits refer to the maximum amount of chemical substances and physical agents in a given environment to which workers may be exposed without the use of personal protective equipment. Most individuals can be exposed to this limit for an entire working lifetime without developing adverse health effects. Generally averaged over a specified period of time and presented as a time-weighted average.

Exposure Symptom ► Health effect, such as a headache or skin irritation, produced be exposure to a chemical material.

Extinguishing Medium ► Chemical used to put out a fire.

Extremely Toxic ► An amount of a hazardous material that in concentrations of 1 drop, or 1 mg/kg, will cause death to humans.

F

Fahrenheit ► On this scale, 32°F is the melting point of ice; 212°F is the boiling point of water. Conversion to Celsius is: °C=(°F-32)*5/9.

Fiber ► Fibers are solid particulates that are three times longer than wide.

Fire Hazard ► Chemical material that ignites and burns easily, or that could support fire in other materials; includes pyrophorics, flammables, combustibles and oxidizers.

Fire Point ► The lowest temperature at which a liquid produces sufficient vapor to flash near its surface and continue to burn, usually 50 to 86°F higher than the flash point.

First Responder ► The first trained personnel to arrive on the scene of a hazardous material incident. Usually officials from local emergency services, firefighters, and police.

Flammable ► Non-specific term meaning “easily ignited”, or any substance that burns intensely or has a rapid rate of flame spread.

Flammable Aerosol ► Any substance that yields a flame projection longer than 18 inches of full valve opening or a flashback (a flame extending back to the valve) an any valve opening.

Flammable Gas ► A gas that will burn or explode if combined with air over a wide concentration range. Examples include acetylene, hydrogen, and propane.

Flammable Liquid ► A term used by OSHA and DOT to classify certain liquids that will burn on the basis of flash point temperatures.

DOT – Any liquid that has a flash point < 141°F. (transport)
OSHA – Any liquid that has a flash point < 100°F. (fixed facility)

Flammable Range ► See Explosive Limits.

Flammable Solid ► A solid, other than a blasting agent or explosive, which is easily ignited and burns intensely without other fuel being required. Ignition can occur through friction, absorption of moisture, exposure to air or spontaneous chemical change. Examples are aluminum powder, magnesium strips or powder, and zirconium.

Flash Point (Fl. P.) ► The temperature at which a liquid or volatile solid gives off enough vapor to form a momentarily ignitable mixture near its surface or within a test vessel. There are open cup and closed cup flash point test methods, so flash points may vary for the same material depending on the method used. The test method is usually indicated on the SDS for the substance.

Frequency ► The number of times that any regularly repeated event occurs in a given amount of time; often referred to as pitch or highness and lowness of sound expressed in hertz (Hz).

Full-Face Respirator ► A respirator covering ones face from under the chin to the forehead. This broader coverage provides a better face fit, higher degree of respiratory protection and also some eye protection.

Fumes ► Minute airborne solid particles created by heating a solid body to the point of vaporization and then cooling. Fumes are often produced by heated metal operations, such as welding, soldering, melting or smelting.

G

Gamma Radiation ► Electromagnetic waves that can pass through the body. They include X-rays and radioactive cobalt. Gamma radiation can completely penetrate the body resulting in cancer, burns, or with massive exposure, death.

Gas ► A substance characterized by very low density and viscosity as compared with liquids and solids. The molecules are practically unrestricted by cohesive forces. Gases can expand and contract greatly in response to changes in temperature and pressure. They occupy the shape and volume of their container. The term “gas” is applied to those airborne molecules of a substance that will only be found in the liquid or solid state at very low temperatures, increased pressures or both.

Gas Chromatography ► A substance-separation technique that involves combining gas, such as nitrogen, with a mixture and them passing it through a long column of packing, such as charcoal, where it is held up for varying amounts of time. The eventual outcome separates the mixture into its components.

Gastro- ► Pertaining to the stomach.

Geiger Counter ► A gas filled electrical device which detects and counts the presence of an atomic particle or ray by detecting the ions produced.

General Exhaust ► A system for exhausting air containing contaminants from a general work area. Also see “local exhaust”.

General Ventilation ► Type of ventilation system that is used to mix an airborne hazard with fresh air to dilute the hazard, reducing its concentration to meet safe levels.

Generator ► Anyone who produces hazardous waste identified or listed by the EPA.

Generic Name ► The name used to identify a material regardless of which company manufactures it. For example, crank case oil.

Grade-D Air ► The minimum quality of air in supplied air or self-contained breathing equipment, for routine use, as used in fire fighting, general industry and asbestos abatement.

Groundwater ► Water in a saturated zone or formation beneath the surface of land or water.

<u>H</u>

Half-Face Respirator ► A respirator covering half of the face from under the chin to the bridge of the nose.

Hazard ► A circumstance or condition that can do harm. Hazards are categorized into four groups: chemical, physical, biological, and radiation.

Hazard Assessment ► The interpretation and evaluation of physical assessment data in order to set work priorities and rank areas for response actions after a hazard has been identified.

Hazard Classes ► DOT classification:

Class 1	Explosives
Class 2	Gases
Class 3	Flammable Liquids
Class 4	Flammable Solids
Class 5	Oxidizers and Organic peroxides
Class 6	Toxic Materials
Class 7	Radioactive Materials
Class 8	Corrosive Materials
Class 9	Miscellaneous Dangerous Goods
ORM-D	Other Regulated material-Domestic

Hazardous Communication Program ► Written document that describes how an employer or facility complies with all requirements of the Federal Hazard Communication Standard – 29 CFR 1910.1200, as well as the State Communication Standard – 8 ACC 61.1110.

Hazard Communication Standard ► 29 CFR 1910.1200: "Workers Right to Know Law." Requires chemical manufacturers and importers to assess the hazards associated with materials in the work place. Material Safety Data Sheets, chemical inventories, labeling, and hazard communication training are results of this standard.

Hazard Determination ► Process of finding out whether or not a chemical material is hazardous and what the hazards are. If a hazard is identified, a hazard assessment will need to be done.

Hazard Evaluation ► Determining the impact or risk the hazardous substance poses to public health and the environment.

Hazard Warning ► Any words, pictures, symbols, or combination thereof appearing on a label or other appropriate form or warning which convey the specific physical or health hazard(s), including target organ effects, of the chemical(s) in the container(s).

Hazardous Atmosphere ► An atmosphere that may expose employees to risk of death, incapacitation, impairment of ability to self-reduce (that is, escape unaided from a permit space), injury, or acute illness from one or more causes. Any atmosphere which is deficient in oxygen or contains a toxic or disease producing contaminant exceeding the legally established permissible exposure limit (PEL) or, where applicable, the threshold limit value (TLV).

Hazardous Chemical ► Any chemical which is a physical hazard or a health hazard. See Health Hazard and Physical Hazard.

Hazardous Ingredient ► Chemical, in a mixture or not, that presents either a physical hazard or a health hazard.

Hazardous Material ► DOT – Capable of posing an unreasonable risk to health and safety when transported in commerce. Capable of doing harm.

Hazardous Materials Response Team ► A designated group of employees who are expected to handle and control actual or potential leaks or spills of hazardous substances which requires possible close approach to the substance. The team members respond to releases or potential releases of hazardous substance for the purpose of control or stabilization of the incident.

Hazardous Substance ► Any substance, designated or listed below, from which exposure to results, or may result, in adverse effects to the health or safety of employees.

- Any biological agent and other disease-causing agent, which after release into the environment and upon exposure, ingestion, inhalation, or assimilation into any person, either directly from the environment or indirectly by ingestion through food chains, will or may reasonably be anticipated to cause death, disease, behavioral abnormalities, cancer, genetic mutation, physiological malfunctions (including malfunctions in reproduction) or physical deformations in such persons or their offspring.
- Any substance defined under section 101 (14) of CERCLA.
- Any substance listed by the DOT as hazardous materials under 49 CFR 172.101 and appendices.
- Any hazardous waste as herein defined.

Hazardous Waste ► A solid waste or combination of wastes, characteristic waste, or listed waste as defined in 40 CFR 261, or material defined as hazardous wastes in 49 CFR 171.8.

Hazardous Waste Number ► A four-digit number given to different wastes by the EPA for identification purposes.

Hazardous Waste Operation ► Any operation conducted within the scope of 29 CFR 1910.120.

Hazardous Waste Site ► Any facility location within the scope of 29 CFR 1910.120 at which a hazardous waste operation takes place.

Health Hazard ► A chemical, mixture of chemicals, or a pathogen for which there is statistically significant evidence that acute or chronic health effects may occur in exposed employees. The term “health hazard” includes chemicals which are carcinogens, toxic or highly toxic agents, reproductive toxins, irritants, corrosives, sensitizers, hepatotoxins, and nephrotoxins, agents which act on the hematopoietic system and agents which damage the lungs, skin, eyes, or mucous membranes. It also includes stress due to temperature extremes. Substances that cause injury or harm to and/or form the inside of a body. Appendix A in 29 CFR 1910.1200.

Heat Stress ► In a hot and humid environment, the body’s heat regulating mechanisms can become stressed, causing fatigue, excessive sweating and cramps.

Heat Stroke ► A response to heat characterized by extremely high body temperatures and disturbance of the sweating mechanisms. Heat stroke is an immediate, life threatening emergency. Body temperature can be 105°F and rising; 25% of the individuals suffering from heat stroke die.

Hemotoxin ► Toxic to the blood.

Hepatotoxin ► Toxic to the liver.

High Toxicity ► Description applying to a chemical that can produce either life-threatening or seriously disabling health effects.

Highly Toxic ► Substances that are considered highly toxic have LD_{50}s in the 1-50 mg/kg range.

Hot Work Permit ► The employer's written authorization to perform operations capable of providing a source of ignition; e.g., welding, riveting, cutting, burning, grinding and heating.

Housekeeping ► An administrative control that involves containing and removing chemical hazards, i.e., vacuuming, proper storage and handling, prompt removal and correct disposal of chemical wastes.

Hydrocarbons ► Composed solely of carbon and hydrogen which are the basic building blocks of all organic chemicals.

I

Ignitable ► Capable of burning or being set on fire.

Immediately Dangerous to Life of Health (IDLH) ► An atmospheric concentration of any toxic or asphyxiant substance that poses an immediate threat to life, or would cause irreversible or delayed adverse health effects, or would interfere with an individual's ability to escape from a dangerous atmosphere.

Immediate Effect ► Health effect that appears either during or shortly after an exposure.

Impervious ► A barrier through which a chemical cannot pass. Frequently used to describe gloves or chemical protective suits.

Inactivation ► A reaction between two chemicals to produce a less toxic product.

Incident ► The release or potential release of a hazardous substance into the environment.

Incident Characterization ► The process of identifying the substance(s) involved in an incident, determining exposure pathways and projecting the affect it will have on people, property, wildlife and plants, and the disruption of services.

Incident Evaluation ► The process of assessing the impact released or potentially released substances pose to public health and the environment.

Incompatible ► Materials that could cause dangerous reactions from direct contact with one another.

Incorporation by Reference ► Established by status and allows federal agencies to meet the requirement to publish regulations in the Federal Register by referring to materials already published elsewhere. The legal effect of incorporation by reference is that the material is treated as if it were published in full in the federal register. This material, like any other properly issued regulation, has the force of law according to 29 CFR. (e.g., NIOSH, ACGIH and ANSI publications)

Inert/Inerting ► Chemical substances which are stable or unable to react. Displacement of atmosphere in a permit space by a noncombustible gas such as carbon dioxide or argon to such an extent that the resulting atmosphere is noncombustible. NOTE: This procedure produces an IDLH oxygen – deficient atmosphere.

Ingestion ► Route of entry by which a substance enters the body through the mouth. Failure to wash hands before eating, drinking and smoking in the workplace can result in the ingestion of hazardous substances.

Inhibitor ► An agent which arrests or slows chemical action (or material used to prevent or retard rust or corrosion.)

Industrial Hygiene ► The scientific discipline devoted to protecting the health and well-being of people at work by recognizing, evaluating and controlling environmental conditions or stress in the workplace.

Industrial Hygienist (IH) ► An expert in the recognition, evaluation and control of safety and health hazards.

Inhalation ► Route of entry by which a substance enters the body when one breathes it through the nose or mouth.

Ionization ► The process by which uncharged, neutral atoms become electrically charged, either positively or negatively, by the loss or gain of electrons.

Irritant ► A chemical that is not corrosive, but causes a reversible inflammatory effect on living tissue by chemical action at the site of contact; health hazard that reacts with body tissues at the point of contact causing reddening, itching, tearing, irritation, and/or minor inflammation.

Isolation ► Engineering control that involves using an enclosure, barrier or safe distance to separate workers from hazards.

L

Label ► Any written, printed or graphic material displayed on or affixed to containers of hazardous chemicals.

Landfill ► A site for disposing of solid and liquid wastes that are generated.

Large Quantity Generator ► A generator that produces > 1,000 kg (2,205 lbs.) of waste per calendar month.

Latency ► The time interval between exposure and the development of a disease.

Leachate ► A substance that moves through or out of soil as a result of it mixing and moving with water. This is important when assessing a material's ability to contaminate groundwater. A good example is a liquid released into soil from a land disposal facility. Leachate is generated when water enters a landfill, migrates through it picking up soluble materials and seeps into the soil.

Lethal Concentration (LC) ► A concentration of an airborne contaminant that, when inhaled, is sufficient to kill a test animal.

LC_{50} ► Lethal Concentration 50% - The concentration of a toxic substance that kills 50% of the organisms exposed to it; sometimes a time period for exposure to that concentration is specified. It is expressed as parts per million (ppm) for gases and vapors, and milligrams per liter (mg/l) for mists, fumes and dusts.

Lethal Dose (LD) ► A concentration of a substance that when administered orally or by skin contact, is sufficient to kill a test animal.

LD_{50} ► Lethal Dose 50% - The single dose of a chemical administered orally or by skin contact that produces death in 50% of the treated animals exposed to it; a time period is often specified.

Limited Quantity ► The maximum amount of a hazardous material for which there is a specific DOT labeling and packaging exception.

Liquid ► A physical state of a substance that is between a solid and a gas. It is similar to a gas in that its molecules are relatively free to move with respect to each other, and similar to a solid in that the volume of a given mass remains nearly constant in spite of changes in pressure. Liquids assume the shape of their container and seek the lowest level.

Local Exhaust Ventilation ► An engineering control that is a ventilation system that captures an airborne hazard as it is released at the source and takes it out of the workplace.

Lockout ► The placement of a lockout device on an energy isolating device to ensure that the energy isolating device and the equipment being controlled cannot be operated until the lockout device is removed.

Lower Explosive Limit (LEL) or Lower Flammable Limit (LFL) ► The lowest concentration – percentage of a substance mixed with air, which will explode or produce a flash or fire when an ignition source is present. At a concentration lower than the LEL, the mixture is too "lean" to burn. When using a combustible gas indicator to take an LEL reading, a hazardous atmosphere would consist of an explosive gas, vapor, or mist in excess of 10% of its LEL; do not work in this atmosphere. 29 CFR 1910.146. See Upper Explosive Limit

Low Toxicity ► Chemicals that produce minor health effects; effects that usually go away with or without medical attention when exposure stops.

M

Marine Pollutant ► A hazardous material listed in 49 CFR 172.101 Appendix B which when discharged, must be reported to the NRC immediately at 1-800-424-8802.

Material Safety Data Sheet (MSDS) ► Document required by OSHA under the Hazard Communication Standard, 29 CFR 1910.1200, to communicate product information, hazards, first aid and emergency information to the chemical user. (As of 5/2012, now called Safety Data Sheets (SDS).

Maximum Use Concentration (MUC) ► Maximum concentration of contaminants in parts per million respiratory cartridges are recommended for use.

Maximum Use Limit (MUL) ► A formula for determining the maximum concentration in parts per million for which a specified respirator may be used. MUL = PF * PEL

Medical Monitoring ► Type of administrative control that involves physical examinations and/or laboratory tests to establish an individual's baseline health status and to check the effectiveness of other controls used to protect an individual form health hazards.

Medium ► An environmental vehicle such as surface or ground water by which a pollutant is carried to the receptor.

Melting Point ► The temperature at which a solid state changes to a liquid state under a pressure of one atmosphere (760 mmHg). Different substances have different melting points; for example, ice has a melting point of 0°C or 32°F.

Metabolism ► The sum of the chemical reactions that serve to maintain life or the chemical transformation of compounds foreign to an organism by various enzymes present in that organism.

Miscible ► Ability of a liquid or gas to dissolve uniformly in another liquid or gas.

Mist ▶ A suspension of very fine liquid droplets in the air above the ground.

Mitigation ▶ Actions taken to prevent or reduce the severity of harm.

Mixture ▶ Material that contains more than one chemical; the product of two or more substances mixed together, but not chemically combines.

Moderate Toxicity ▶ Chemicals that produce health effects requiring medical attention; damage may be permanent, but is neither life-threatening nor seriously disabling.

Monitoring ▶ An administrative control that checks the effectiveness of other controls by analyzing air samples, wipe samples, and personal exposure levels; may involve medical monitoring.

Mucous Membranes ▶ Mucous-secreting lining of many of the bodies passageways, including the respiratory, gastrointestinal and urinogenital passageways.

Mutagen ▶ An external agent that is capable of altering the genetic material in a living cell resulting in a mutation. If it occurs in a developing sex cell (sperm or egg), the mutation may be passed on to the offspring.

Mutation ▶ A change in the genetic material (DNA) of cells.

Molecular Weight (MW) ▶ The sum of atomic weights of the atoms in a molecule. Found in the Periodic Table of the Elements and the NIOSH Pocket guide to Chemical Hazards.

N

Narcosis ▶ Unconsciousness or stupor produced by overexposure to certain chemicals.

National Contingency Plan ▶ Policies and procedures that the federal government follows in implementing responses to hazardous substances.

Nephrotoxins ▶ Chemicals that produce kidney damage.

Neurotoxins ▶ Chemicals that affect primarily the nervous system; a toxin that can damage or destroy nerve tissue.

NFPA Fire Diamond ▶ Hazard Rating per NFPA 704 publication: Visual system providing a general idea of the inherent hazards and their severity relative to: health, flammability, reactivity, special.

Health Hazard (blue). Degree of hazards; level of short term protection.
0 = Normal Material
1 = Slightly Hazardous
2 = Hazardous
3 = Extreme Danger
4 = Deadly

Flammability (red). Susceptibility to burning.

0 = Will not burn
1 = Will ignite if preheated/FL. P.>200°F
2 = Will ignite if moderately heated/FL. P. between 100-200°F
3 = Will ignite at most ambient conditions/FL. P.<100°F
4 = Burns readily at most ambient conditions/FL. P.,73°F

Reactivity/Instability (yellow). If burned, decomposed, or mixed.

0 = Stable
1 = Unstable if heated
2 = Violent chemical changes
3 = Shock and heat may detonate
4 = May detonate

Special Hazard (white).

OX = Oxidizer
TOX = Toxic
EXP = Explosive
COR = Corrosive
~~W~~ = Use no water, reacts!

Noise (Occupational Noise Exposure) ► The federal standard which establishes the levels of protection against the effects of noise exposure when it exceeds a specific level. 29 CFR 1910.95

Non sparking Tools ► Tools made from beryllium – copper or aluminum – bronze that greatly reduce the possibility of igniting dusts, gases or flammable vapors. Although these may emit some sparks when striking metal, the sparks have low heat content and are not likely to ignite most flammable liquids.

NORM ► Naturally Occurring Radioactive Material – Radioactive elements found in the Earth's crust and cosmic radiation bombarding Earth from space.

O

Odor Threshold Limit ► The lowest concentration of a contaminant in the air that can be detected by smell.

Olfactory ► Pertaining to the sense of smell.

Oral Toxicity ► Adverse health effect resulting from taking a substance into the body via the mouth.

Organic ► A chemical term indicating compounds that contain one or more carbon atoms. Organic compounds form the chemical basis of living things.

Other Regulated Material (ORM) ► DOT classification of hazardous materials that are used by consumers for personal or household purposes. ORM-D-Consumer Commodities. An example is HEET.

Oxidation ► A reaction in which a substance combines with oxygen, provided by an oxidizer or oxidizing agent, which causes the substance to lose hydrogen from a compound or of an electron from an atom or molecule. For example, rust is formed when iron is oxidized.

Oxidizer ► A substance that promotes combustion in other materials causing fire either by itself or through the release of oxygen or other gases. Common oxidizers include chlorine gas, oxygen and peroxides; the process of stripping electrons from molecules, thereby changing their properties and altering chemical reactions and bonds.

Oxygen Deficient Atmosphere ► Atmospheres where the percentage of oxygen-by-volume is < 19.5%

Oxygen Enriched Atmosphere ► Atmospheres where the percentage of oxygen-by-volume is > 23.5%

Oxygen Generating Cartridge ► Containers filled with a chemical which generates oxygen by a chemical reaction.

P

Pathway ► A history of the flow of a pollutant from source to receptor, including qualitative descriptions of emission type, transport, medium, and exposure route.

Pathways of Dispersion ► The mode such as water, groundwater, soil, and air by which a chemical moves through the environment.

Penetration ► The movement of substances through openings such as stitched seams, button holes, pinholes, zippers, or fabric weave. A well designed and constructed garment prevents this by using self-sealing zippers, seams overlaid with tape, flap closures, and non-woven fabrics. Rips, tears, punctures, or abrasions also allow penetration.

Permeation ► Chemical movement of substances through intact material on a molecular level. A process that involves the sorption of a substance on the outside surface, diffusion through and desorption of the substance from the inside surface of the protective material. A concentration gradient (high outside: low inside) is established. Because the tendency is to achieve concentration equilibrium, molecular forces drive the chemical into the material toward the area of no or lower concentration inside the suit.

Permissible Exposure Limit (PEL) ► The exposure specified by OSHA in 29 CFR 1910.1000, Table Z-1. In Alaska, PELs are designated in Title 8, Alaska Administrative Code, Chapter 61 in Table Z-1-A, which are more stringent for some substances than the federal code.

Permit-Required Confined Space ► A confined space that has one or more of the following characteristics
Contains or has a potential to contain a hazardous atmosphere;
Contains a material that has the potential for engulfing an entrant;
Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or
Contains any other recognized serious safety or health hazard.

Persistent Chemicals ► A substance which resists biodegradation and/or chemical oxidation when released into the environment and tends to accumulate on land, in air, in water, or in organic matter.

Personal Protective Equipment (PPE) ► Equipment that protects the individual who wears it by placing a barrier between that individual and a hazards; includes safety glasses, face shields and masks, ear plugs or muffs, gloves, boots, hats, clothing, and respirators.

Personal Monitoring ► Environmental or air monitoring of personnel with the aid of air sampling equipment attached to the personnel.

Pesticide ► A general classification of a chemical that has the capability of destroying life of some form deemed undesirable by the person or society that applies it.

Photolysis ► The degradation of a chemical caused by exposure to light.

Physical Agent ► Hazards, other than chemical, determined by the ACGIH to cause injury or harm to the body if specific TWAs are exceeded. Categories of physical hazards covered include acoustic, electromagnetic, ergonomic, mechanical, and thermal.

Physical Agent Data Sheets (PADS) ► Documents similar to SDS adopted from ACGIH by Alaska Department of Labor for eight physical agents identified by the state as workplace hazards. Those eight physical agent data sheets are: Heat Stress, Cold Stress, Noise, Hand-Arm Vibration, Lasers, Ionizing Radiation, Ultraviolet Radiation, Radiofrequency (rf), and Microwave Radiation.

Physical and Chemical Characteristics ► Information on SDS that describes the appearance, odor, boiling point, vapor pressure, vapor density, evaporation rate, specific gravity, and water solubility of a chemical material.

Physical Hazard ► A chemical that is a combustible liquid, compressed gas, explosive, flammable, organic peroxide, oxidizer, pyrophoric, unstable (reactive) or water-reactive; any chemical material that can cause fire, explosion, violent chemical reactions, or other similar hazardous situations. Substances that cause injury or harm to and/or from the outside of a body. Appendix A 29 CFR 1910.1200

Planned Removal ► The removal of released hazardous substances from the environment within a non-immediate, long-term, time period. Under CERCLA: Actions intended to minimize increases in exposure such that time and cost commitments are limited to 6 months and/or one million dollars.

Point Source ► A known location of emissions identifiable by geographical coordinates, such as industrial discharges or disposal sites.

Pollutant ► A substance or mixture which after release into the environment and upon exposure to any organism will or may reasonably be anticipated to cause adverse effects in such organisms of their offspring.

Polymerization ► A chemical reaction in a substance in which one or more small molecules combine to form larger molecules. Polymerization may result in a substance that varies greatly in its reactivity from the original substance. If hazardous polymerization can occur with a given material, the SDS usually will list the conditions which could start the reaction.

Post Emergency Response ► The portion of an emergency response performed after the immediate threat of a release has been stabilized or eliminated and clean-up of the site has begun. If post emergency response is performed by an employer's own employees who were part of the initial emergency response, it is considered to be part of the initial response and not post emergency response. However, if a group of an employer's own employees, separate from the group providing initial response, performs the clean-up operation, then the separate group of employees would be considered to be performing post emergency response and subject to paragraph (g) (11) of 29 CFR 1910.120.

Potency ► The amount of a chemical that will produce and effect.

Potential Hydrogen (pH) ► A measure of the acidity or alkalinity of a solution in terms of the relative concentration of hydrogen ions in the solution. The scale is logarithmic so that pH 3, for example, is ten times more acidic than pH 4.

-pH values from 0 – 6.9 indicate acidity (decreasingly acidic)
-pH 7 is regarded as neutral (hydrogen ion concentration in pure water)
-pH values from 7.1 – 14 indicate alkalinity (increasingly alkaline/basic)

Substances with a pH between 0 and 0.2 or 12.5 and 14 are regulated as hazardous waste under the corrosivity characteristic.

Powered Air-Purifying Respirator (PAPR) ► A respirator powered by a battery pack that generates flowing air in the facepiece making it easier to breathe in comparison to the standard negative pressure air purifying respirator. The blower passes contaminated air through the cartridge or filter where the air is cleaned and forced through a hose to the facepiece.

Precision ► The degree of agreement of repeated measurements of the same property

Protection Factor (PF) ► OSHA – An arbitrarily assigned number which reflects the degree of protection offered by a respirator. When the concentration level of a contaminant outside the mask is divided by this number, the concentration level inside the mask can be determined and compared to the PEL. The protection factor is based entirely on the fit of the mask to the worker's face and its ability to prevent entry of toxic substances. Also see Assigned Protection Factor.

Published Exposure Level ► The exposure limits published in NIOSH Recommendations for Occupational Health Standards, dated 1990, and incorporated by reference, or if none is specified, the exposure limits published in the standards specified by the American Conference of Governmental Industrial Hygienists publication. Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices.

Pulmonary Agent ► Chemical that may damage the lungs.

Pulmonary Edema ► The condition of accumulating fluid in the lungs.

Pyrophoric ► Chemical material that spontaneously bursts into flame when exposed to air at temperatures below 130° F (54.4°C); no ignition source is needed.

Q

Qualified Individual ► A person who through education, experience or professional accreditation is competent to make judgment concerning a particular subject matter. A Certified Industrial Hygienist may be a qualified individual for preparing a site safety plan.

R

Reaction ► The chemical change in two or more substances resulting in a new substance.

Reactive Chemical ► Chemical that reacts violently on contact with certain other chemical materials to produce or release a hazard.

Reactives ► Chemicals that produce hydrogen gas or explode when mixed together. Undesirable effects such as pressure buildup, temperature increase, and formation of noxious, toxic or corrosive by-products may occur.

Reactivity ► A measure of the tendency for a substance to undergo an uncontrolled chemical reaction with the release of energy.

Reducing Agent ► Chemical which absorbs oxygen during reaction.

Regulated Material ► A substance or material that is subject to regulations set forth by the EPA, DOT or any other federal agency.

Recommended Exposure Limit (REL) ► NIOSH's designation of the highest allowable concentration that 95% of workers could be exposed to and not show signs of symptoms of overexposure. An REL is a time weighted average (TWA) concentration based on a 10-hour workday during a 40-hour workweek. If OSHA does not publish a PEL, then the NIOSH REL will be used and enforced. If OSHA and NIOSH do not publish PELs or RELs, then the ACGIH TLVs will be used.

Relative Gas Density ► A NIOSH term for which the relative density of gases referenced to air. Air is given the value of 1. Substances with RGasD values < 1 are lighter than air and will rise and disperse, while substances with RGasD values > 1 are heavier than air and will settle and collect in low laying areas. See vapor density.

Remedial Actions ► As in the National Contingency Plan, responses to releases on the National Priority List that are consistent with permanent remedy to prevent or mitigate the migration of a release of hazardous substances into the environment.

Reportable Quantity ► As set forth in the Clean Water Act, the minimum amount of a substance that may be discharged in a 24 hour period that requires notification of the appropriate government agency.

Representative Sample ► A sample of a whole that has the same characteristics or properties of the whole.

Reproductive Hazard ► health hazard that targets the human reproductive system; hazard category that includes teratogens and mutagens.

Respiratory System ► The breathing system including lungs, trachea (windpipe), larynx, mouth, nose, and associated portions of the nervous and circulatory systems.

Response Activities ► Activities taken to recognize, evaluate and control an incident.

Risk ► The probability that an unwanted event will occur.

Risk Assessment ► The use of a factual base to define the health effects of exposure of individuals or populations to hazardous materials and/or situations.

Risk Management ► The process of weighing policy alternatives and selecting the most appropriate regulatory action integrating the results of risk assessment with engineering data and with social and economic concerns to reach a decision.

Route of Entry ► The manner in which a chemical contaminant enters the body. They are inhalation, absorption, ingestion, and injection.

S

Safety ► Freedom from situations, equipment, material, and environmental interactions that result in injury or illness.

Safe Work Practices ► Standard operating procedures (SOPs) normally used to accomplish the job.

Safety Data Sheet (SDS) ► Document produced by the Chemical Manufacturer that contains information on the chemical. A document required by the United Nations under GHS, and OSHA under the Hazard Communication Standard, 29 CFR 1910.1200, to communicate product information, hazards, first aid and emergency information to the chemical user.

Sampling ► The collection of a representative portion of the environment. Example: the collection of a water sample from a contaminated stream.

Saturation ► The maximum concentration of matter that can be dissolved in a solution at a given temperature.

Self-Contained Breathing Apparatus (SCBA) ► An atmosphere supplying respirator for which the breathing air source is designed to be worn by the user.

Sensitivity ► An instrument's ability to discriminate between small differences of whatever property that instrument is designed to measure.

Sensitization ► An allergic reaction that increases in severity with subsequent exposures. A person previously exposed to a certain material is more sensitive when further contact with this material is encountered.

Sensitizer ► A substance which on first exposure causes little or no reaction but which on repeated exposure may cause a marked response not necessarily limited to the contact site. Skin sensitization is the most common form of sensitization in the industrial setting, although respiratory sensitization to a few chemicals is also known to occur.

Short Term Exposure Limit (STEL) ► A term used by the ACGIH when referring to the maximum concentration of a substance to which workers can be exposed to for 15 consecutive minutes without suffering adverse health effects. Workers may not be exposed to more than 4-STELs per day. There needs to be 1 hour of no exposure between each STEL.

Site Safety Supervisor/Officer (SSS or SSO) ► The individual located on a hazardous waste site who is responsible to the employer and has the authority and knowledge necessary to implement the site safety and health plan and verify compliance with applicable safety and health requirements.

Site Safety Plan ► Written site-specific safety criteria that established requirements for protecting the health and safety of responders during all activities conducted at an incident.

Skin Absorption ► An exposure route by which some chemicals pass through the skin on contact and enter the bloodstream.

Small Quantity Generator ► A generator of that produces < 1,000 kg/2,205 lbs of waste per calendar month.

Smog ► A form of air pollution resulting from the sun's effects on a combination of smoke, chemicals, pollutants (i.e., auto emissions) and fog in the air; the sun causes hydrocarbons and nitrogen oxides to combine in a photochemical reaction.

Smoke ► A mixture of gases, vapors, fumes, and small solid particles of carbon or soot resulting from combustion of material. Composition is based on substance(s) being burned and combustion and temperature.

Solid ► Physical characteristic of a substance that has a definite shape.

Solubility in Water ► A term expressing the percent of a material (by weight) that will dissolve in water at ambient temperature. Useful in determining cleanup methods for spills and fire extinguishing methods for materials. Solubility may be expressed as a percentage: by weight in a solution, as grams of solute per liter of solution, or as grams of solute dissolved in 100 g of water.

-negligible, less than 0.1%;
-slight, 0.1 to 1.0%;
-moderate, 1 to 10%
-appreciable, more than 10%
-complete, soluble in all proportions.

Solvent ► A substance, usually a liquid, which can dissolve or disperse other substances.

Sorbent ► A material found in canisters or cartridges which removes toxic gases and vapors from air; anything that absorbs or adsorbs.

Spasm ► A sudden involuntary contraction of a muscle or muscles.

Specific Gravity (Sp. Gr.) ► A measurement used to quantify the weight of a substance by comparing the weight of a given amount of material to the same volume of water. Water is given the value of 1. Material with a specific gravity of < 1 will float on the water if it does not dissolve. Material with a specific gravity >1 is heavier than water and will sink if it does not dissolve.

Spill ► The release of any hazardous waste or any byproduct that becomes a hazardous waste, into water or onto land.

Spontaneous Combustion ► The bursting into flame of a substance as a result of heat produced by slow oxidation of the constituents of the substance itself without heat from an outside source; this condition happens only when there is sufficient oxygen for oxidation but not enough ventilation to carry the heat away as fast as it is generated.

Stability ► The property of a compound that is not easily decomposed or easily reactive with other compounds; the tendency of a material to resist undesirable chemical changes during storage or transportation.

Substitution ► Administrative control that involves replacing a chemical, process or piece of equipment with a less hazardous one.

Supplied-Air Respirator (SAR) ► A respirator, mask and hose connected to an air line and Grade D breathing air source such as an air compressor or cylinders.

Support Zone ► An established area at a hazardous waste site. It is the outermost part of the site and is considered a non-contaminated or clean zone.

Synergistic ► A reaction in which the effect of two or more substances acting together is greater than the sum of their separate effects.

Systemic ► Having to do with, supplying, or affecting specific organ systems of an organism.

Systemic Poison ► A poison spreading throughout the body affecting specific body systems and organs depending on its affinity for specific tissue. Its adverse effect is not localized in one spot or area.

T

Tagout ► The placement of a tagout device on an energy isolating device to indicate that the energy isolating device and equipment being controlled may not be operated until the tagout device is removed.

Target Organ ► The specific organ or tissue that is harmed by exposure to a toxic substance; the target organ is not necessarily the organ containing the highest level of toxic concentration.

Teratogen ► A substance that causes birth defects in the developing fetus.

Thermal Decomposition ► Chemical breakdown by exposure to heat.

Threshold ► The lowest dose of a chemical at which a specific measurable effect is observed and below which it is not observed.

Threshold Limit Value (TLV) ► A safe exposure level set by the American Conference of Governmental Industrial Hygienists (ACGIH). A permissible exposure limit (PEL) is a similar level set by OSHA. Both refer to airborne concentrations of substances and represent an exposure level under which most people can work constantly for 8 hours a day, day after day, with no adverse effects without the use of APRs. NOTE: If any TLV is exceeded, a potential hazard from the substances is presumed to exist. Three categories of TLVs are specified:

> -Time-Weighted Average (TLV-TWA): The time-weighted average concentration for an 8-hour workday for 40-hour work week, to which all workers may normally be exposed day after day, with no adverse effect.
> -Short-Term Exposure Limit (TLV-STEL): The maximum concentration to which workers can be exposed for a period up to 15 minutes continuously without suffering from irritation, chronic or irreversible tissue change, or narcosis of sufficient degree to impair self-rescue or reduce work efficiency. No more than 4-15 minute exposure periods per day are permitted, with at least 60 minutes between exposure periods.
> -Ceiling Limit (TLV-C or CL): A concentration of a substance that should not be exceeded, even instantaneously without the use of respiratory protection.

Time-Weighted Average (TWA) ► The concentration of a material to which a person may be exposed, averaged over exposure time based on 8-hour day for OSHA and ACGIH, and a 10-hour day for NIOSH, but a 40-hour week for all three averages. Also see "TLV."

Toxemia ► Poisoning by way of the bloodstream.

Toxic ► A chemical falling into any one of the following categories listed in 29 CFR 1910.1200:

> -A chemical that has a medium lethal dose (LD_{50}) of 50 mg/kg but < 500 mg/kg of body weight when administered orally to albino rats weighing between 200 and 300 grams.
> -A chemical that has a median lethal dose (LD_{50}) of > 200 mg/kg but < 1000 mg/kg of body weight when administered by continuous contact for 24 hours (or less if death occurs within 24 hours) with the bare skin of albino rabbits weighing between two and three kilograms each.
> -A chemical that has a median lethal concentration (LC_{50}) in air > 200 ppm, but < 2000 ppm by volume of gas or vapor, or < 2 mg/l of mist, fume or dust when administered by continuous inhalation for one hour (or less if death occurs within one hour) to albino rats weighing between 200 and 300 grams each.

Toxicity ► The sum of adverse effects resulting from exposure to a material by the mouth, skin or respiratory tract. The measured degree of effect of a chemical on an organism; usually measured using a variety of animal tests; the potency of toxic substances. For testing definitions, see LC_{50} and LD_{50}.

Toxicology ► The scientific study of the adverse effects of toxic or poisonous chemicals on living systems, usually by controlled laboratory or chemical investigation.

Trade Name ► The trademark name or commercial trade name for a material.

Transport ► The hydrological, atmospheric or other physical processes that convey the mass of a pollutant through and across media from source to receptor.

Transporter ► A person engaged in the off-site transportation of hazardous waste by air, rail, highway, or water.

Transfer Facility ► A facility that is exempt from permits to store hazardous waste provided that storage does not exceed 10 days.

Treatment ► Any method designed to change the physical, chemical or biological characteristics or composition of any hazardous waste so as to neutralize, recover energy or material recourse form, or render the waste non-hazardous or less hazardous, safer to transport, store or dispose of, or amenable for recovery or reduce in volume.

Treatment, Storage or Disposal (TSD) facility ► An EPA permitted facility that is on the receiving end of hazardous waste for treatment, storage or disposal.

U

Uncontrolled Hazardous Waste Site ► An area where an accumulation of hazardous waste creates a threat to the health and safety of individuals or the environment, or both. Some sites are found on public lands, such as those created by former municipal, county or state landfills where illegal or poorly managed waste disposal has taken place. Other sites are found on private property, often belonging to generators or former generators of hazardous waste. Examples of such sites include, but are not limited to, surface impoundments, landfills, dumps, and tank or drum farms. Normal operations at TSD sites are not covered by this definition.

Underground Storage Tank (UST) ► Regulated under RCRA. A tank with 10% or more of its volume underground with piping connected to the tank. It is used to store hazardous chemicals regulated under CERCLA, and also petroleum products.

Unstable Chemical ► Material that can violently self-react under commonly occurring conditions; a type of physical hazard.

Unstable (Reactive) ► A chemical which in the pure state, or as produced or transported, will vigorously polymerize, decompose, condense, or will become self-reactive under conditions of shock, pressure or temperature.

Upper Explosive Limit (UEL) ► The maximum percent concentration of a vapor or gas in air that will explode or produce a flash or fire when an ignition source is present. At concentrations above the UEL, the mixture is too rich to burn and insufficient oxygen exists to support combustion.

V

Vapor ► Describes gaseous substances formed from a substance which is usually in the solid or liquid state at standard temperature and pressure. Often used interchangeably, but incorrectly, with the term "gas."

Vapor Density ► The weight of a vapor of gas compared to the weight of an equal volume of air; an expression of the density of the vapor or gas. Materials lighter than air have vapor densities less than 1.0. Materials heavier than air have vapor densities greater than 1.0. All vapors and gases will mix with air, but the lighter materials will tend to rise and mix (unless confined). Heavier vapors and gases are likely to concentrate in low places (along or under floors, in sumps, sewers, and manholes, trenches and ditches where they can create fire or health hazards. See Relative Gas Density.

Vapor Pressure ► Pressure exerted on the walls of a closed container of liquid by vapor formed above the liquid surface. A measure of how readily a material will evaporate indicates how volatile a liquid is. The lower the vapor pressure, the slower it evaporates and the longer it takes to build up toxic or explosive concentrations.

Vaporization ► Process by which liquids change to a gaseous state (evaporation).

Ventilation ► Engineering control that reduces airborne exposure levels by mixing the hazard with fresh air or by removing it as it is released at the source.

Viscosity ► A property of fluids that causes them to resist flowing as a result of internal friction from the fluid's molecules moving against each other.

Volatile Organic Compounds (VOC) ► Used in coatings and paint because they evaporate very rapidly. Regulated by the EPA under the Clean Water Act.

Volatile ► Easily converted from the liquid or solid state to the gaseous state under ambient conditions and therefore capable of rapid dispersal; these chemicals also tend to readily evaporate at comparatively low temperatures.

Volatility ► Measure of a material's tendency to vaporize or evaporate at ambient conditions.

W

Warning Label ► Signage affixed to chemical containers (or posted by stationary containers) that identifies the chemical material and all appropriate hazard warnings. See Hazard Warning

Warning Properties ► A contaminant an employee can smell and/or taste below the Permissible Exposure Limit

Water-Reactive ► A chemical that reacts with water to release a gas that is either flammable or presents a health hazard. An example is a metallic sodium

Work Plan ► Written directives that specifically describe all work activities that are to take place at a work site.

Work Practices ► Standard operating procedures (SOPs) normally used to accomplish the job. See Safe Work Practices

Emergency Response Guidebook Worksheet

Use the Emergency Response Guidebook to answer the following questions

1. For an incident involving a chemical with UN2038 use Guide number:
   A. 112 B. 125 C. 152 D. 169

2. A chemical is leaking from a rail car at the Alaska Railroad. The placard lists the ID number as 1076. What substance is in the rail car?
   A. Chlorine B. Fluorine C. Propane D. Phosgene

3. Which Guide should you use if the only detection clue is a green placard?
   A. 111 B. 112 C. 118 D. 120

4. Use Guide number ________ for an incident involving the chemical: ***pesticide, solid, poisonous, nos***.
   A. 131 B. 138 C. 151 D. 135

5. A vehicle carrying Class 1.4 placard is involved in an accident. Which Guide should you use?
   A. 111 B. 112 C. 113 D. 114

6. What is the highest potential hazard for the chemical with the UN3321?
   A. Health B. Reactivity C. Radioactivity D. Fire or Explosion

7. How far in all directions should the incident commander first isolate the area if a tank car of methyl isocyanate is leaking, but not burning?
   A. 75 feet B. 150 feet C. One half mile D. 3000 feet

8. How far should the isolation area extend in all directions, if an overturned tank car carrying ***boron trifluoride*** is leaking, but not burning?
   A. 50 feet B. 100 feet C. 600 feet D. 1250 feet

9. Which of the following would you most want to have available at the scene of an incident involving a stressed container of ***organic peroxide, type C, liquid, temperature controlled***, that is rapidly warming?
   A. Water B. Dry chemical C. Dry ice D. Carbon dioxide

10. According to the Emergency Response Guidebook, which substance should **<u>not</u>** be used on fires involving sodium?
    A. Sand and soil B. Water or foam
    C. Dry chemical and carbon dioxide D. Soil and hydrocarbons

NIOSH Pocket Guide Worksheet

1. Chemical Name: ______________________________
2. Common Synonyms: ______________________________
3. Exposure Limits: (REL/PEL) ______________________________
4. ( ) Organic   ( ) Inorganic   ( ) Solid   ( ) Liquid   ( ) Gas   @STP (Standard Temperature and Pressure, 68^{o}F @ sea level
5. Physical Description: ______________________________
6. Flash point: ________ [ ] Fahrenheit   [ ] Celsius
7. Flammable Range: ______________________________
8. Specific Gravity: ______________________________or
9. RGasD: ______________________________
10. Vapor Pressure: ______________________________
11. Incompatibilities/Reactivities: ______________________________
12. DOT ID Number/Guide Number ______________________________
13. What are the symptoms of exposure? (Pick 3) ______________________________
14. What should you do if you got the chemical on your skin? ______________________________

ConocoPhillips

Crude Oil, Sweet

Safety Data Sheet

Section 1: Identification of the substance or mixture and of the supplier

Product Name:	Crude Oil, Sweet
SDS Number:	724160
Synonyms/Other Means of Identification:	Crude Oils, Desalted, Sweet Field Crude Petroleum Crude Petroleum Oil Rock Oil Separator Crude Sweet Crude
MARPOL Annex I Category:	Crude Oils
Intended Use:	Refinery Feed
Manufacturer:	ConocoPhillips 600 N. Dairy Ashford Houston, Texas 77079-1175
Emergency Health and Safety Number:	Chemtrec: 800-424-9300 (24 Hours)
SDS Information:	Phone: 855-244-0762 Email: SDS@conocophillips.com URL: www.conocophillips.com

Section 2: Hazard(s) Identification

Classification

H224 -- Flammable liquids -- Category 1
H304 -- Aspiration Hazard -- Category 1
H319 -- Eye damage/irritation -- Category 2
H336 -- Specific target organ toxicity (single exposure) -- Category 3
H350 -- Carcinogenicity -- Category 1B
H373 -- Specific target organ toxicity (repeated exposure) -- Category 2
H411 -- Hazardous to the aquatic environment, chronic toxicity -- Category 2

Hazards not Otherwise Classified

May contain or release poisonous hydrogen sulfide gas

Label Elements

DANGER

Extremely flammable liquid and vapor. (H224)*
Causes serious eye irritation. (H319)*
May contain or release poisonous hydrogen sulfide gas
May be fatal if swallowed and enters airways. (H304)*
May cause drowsiness or dizziness. (H336)*
May cause damage to organs through prolonged or repeated exposure. (H373)*
May cause cancer. (H350)*
Toxic to aquatic life with long lasting effects. (H411)*

Precautionary Statement(s):
Obtain special instructions before use. (P201)*
Do not handle until all safety precautions have been read and understood. (P202)*
Keep away from heat/sparks/open flames/hot surfaces. - No smoking. (P210)*
Keep container tightly closed. (P233)*
Ground/bond container and receiving equipment. (P240)*
Use with explosion-proof equipment. (P241)*
Use only non-sparking tools. (P242)*
Take precautionary measures against static discharge. (P243)*
Avoid breathing dust/fume/gas/mist/vapours/spray. (P261)*
Wash thoroughly after handling. (P264)*
Use only outdoors or in a well-ventilated area. (P271)*
Wear protective gloves / protective clothing / eye protection / face protection. (P280)*
IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. (P361)*
Rinse skin with water/shower. (P353)*
IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing. (P305+P351+P338*)
If eye irritation persists: Get medical advice/attention. (P313)*
IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. (P301+P310)*
Do NOT induce vomiting. (P331)*
IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. (P304+P340)*
Call a POISON CENTER or doctor/physician if you feel unwell. (P312)*
In case of fire: Use dry chemical, carbon dioxide, or foam for extinction.(P370+P378)*
Store locked up. (P405)*
Store in a well-ventilated place. Keep cool.(P403+P235)*
Dispose of contents/container to approved disposal facility. (P501)*

** (Applicable GHS hazard code.)*

Section 3: Composition / Information on Ingredients

Component	CASRN	Concentration[1]
Crude Oil (Petroleum)	8002-05-9	100
Naphthalene	91-20-3	0-0.9
Benzene	71-43-2	<1
Hydrogen Sulfide	7783-06-4	<0.2

Total Sulfur: < 0.5 wt%

[1] All concentrations are percent by weight unless ingredient is a gas. Gas concentrations are in percent by volume.

Crude oil, natural gas and natural gas condensate can contain minor amounts of sulfur, nitrogen and oxygen containing organic compounds as well as trace amounts of heavy metals like mercury, arsenic, nickel, and vanadium. Composition can vary depending on the source of crude.

Section 4: First Aid Measures

Eye Contact: For direct contact, remove contact lenses if present and easy to do. Immediately hold eyelids apart and flush the affected eye(s) with clean water for at least 20 minutes. Seek immediate medical attention.

Skin Contact: Remove contaminated shoes and clothing and cleanse affected area(s) thoroughly by washing with mild soap and water or a waterless hand cleaner. If irritation or redness develops and persists, seek medical attention.

Inhalation (Breathing): If respiratory symptoms or other symptoms of exposure develop, move victim away from source of exposure and into fresh air in a position comfortable for breathing. If symptoms persist, seek immediate medical attention. If victim is not breathing, clear airway and immediately begin artificial respiration. If breathing difficulties develop, oxygen should be administered by qualified personnel. Seek immediate medical attention.

Ingestion (Swallowing): Aspiration hazard: Do not induce vomiting or give anything by mouth because this material can enter the lungs and cause severe lung damage. If victim is drowsy or unconscious and vomiting, place on the left side with the head down. If possible, do not leave victim unattended and observe closely for adequacy of breathing. Seek medical attention.

Most important symptoms and effects

Acute: Headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue

Delayed: Dry skin and possible irritation with repeated or prolonged exposure.

Notes to Physician: At high concentrations hydrogen sulfide may produce pulmonary edema, respiratory depression, and/or respiratory paralysis. The first priority in treatment should be the establishment of adequate ventilation and the administration of 100% oxygen. Animal studies suggest that nitrites are a useful antidote, however, documentation of the efficacy of nitrites in humans is lacking. If the diagnosis of hydrogen sulfide poisoning is confirmed and if the patient does not respond rapidly to supportive care, the use of nitrites may be an effective antidote if delivered within the first few minutes of exposure. For adults the dose is 10 mL of a 3% NaNO2 solution (0.5 gm NaNO2 in 15 mL water) I.V. over 2-4 minutes. The dosage should be adjusted in children or in the presence of anemia, and methemoglobin levels, arterial blood gases, and electrolytes should be monitored closely.

Epinephrine and other sympathomimetic drugs may initiate cardiac arrhythmias in persons exposed to high concentrations of hydrocarbon solvents (e.g., in enclosed spaces or with deliberate abuse). The use of other drugs with less arrhythmogenic potential should be considered. If sympathomimetic drugs are administered, observe for the development of cardiac arrhythmias.

Federal regulations (29 CFR 1910.1028) specify medical surveillance programs for certain exposures to benzene above the action level or PEL (specified in Section (i)(1)(i) of the Standard). In addition, employees exposed in an emergency situation shall, as described in Section (i)(4)(i), provide a urine sample at the end of the shift for measurement of urine phenol.

Other Comments: Before attempting rescue, first responders should be alert to the possible presence of hydrogen sulfide, a poisonous gas with the smell of rotten eggs, and should consider the need for respiratory protection (see Section 8). Remove casualty to fresh air as quickly as possible. Immediately begin artificial respiration if breathing has ceased. Consider whether oxygen administration is needed. Obtain medical advice for further treatment.

Section 5: Fire-Fighting Measures

NFPA 704 Hazard Class

Health: 1 **Flammability:** 3 **Instability:** 0 (0-Minimal, 1-Slight, 2-Moderate, 3-Serious, 4-Severe)

Unusual Fire & Explosion Hazards: Extremely flammable. This material can be ignited by heat, sparks, flames, or other sources of ignition (e.g., static electricity, pilot lights, mechanical/electrical equipment, and electronic devices such as cell phones, computers, calculators, and pagers which have not been certified as intrinsically safe). Vapors may travel considerable distances to a source of ignition where they can ignite, flash back, or explode. May create vapor/air explosion hazard indoors, in confined spaces, outdoors, or in sewers. This product will float and can be reignited on surface water. Vapors are heavier than air and can accumulate in low areas. If container is not properly cooled, it can rupture in the heat of a fire. Hazardous combustion/decomposition products, including hydrogen sulfide, may be released by this material when exposed to heat or fire. Use caution and wear protective clothing, including respiratory protection.

Extinguishing Media: Dry chemical, carbon dioxide, or foam is recommended. Water spray is recommended to cool or protect exposed materials or structures. Carbon dioxide can displace oxygen. Use caution when applying carbon dioxide in confined spaces. Simultaneous use of foam and water on the same surface is to be avoided as water destroys the foam. Water may be ineffective for extinguishment, unless used under favorable conditions by experienced fire fighters.

Fire Fighting Instructions: Long-duration fires involving crude or residual fuel oil stored in tanks may result in a boilover. The contents of the tank may be expelled beyond the containment dikes or ditches. All personnel should be kept back a safe distance when a boilover is anticipated (reference NFPA 11 or API 2021).

For fires beyond the initial stage, emergency responders in the immediate hazard area should wear protective clothing. When the potential chemical hazard is unknown, in enclosed or confined spaces, a self contained breathing apparatus should be worn. In addition, wear other appropriate protective equipment as conditions warrant (see Section 8).

Isolate immediate hazard area and keep unauthorized personnel out. Stop spill/release if it can be done safely. Move undamaged containers from immediate hazard area if it can be done safely. Water spray may be useful in minimizing or dispersing vapors and to protect personnel. Cool equipment exposed to fire with water, if it can be done safely. Avoid spreading burning liquid with water used for cooling purposes.

Hazardous Combustion Products: Combustion may yield smoke, carbon monoxide, and other products of incomplete combustion. Hydrogen sulfide and oxides of nitrogen and sulfur may also be formed.

See Section 9 for Flammable Properties including Flash Point and Flammable (Explosive) Limits

Section 6: Accidental Release Measures

Personal Precautions: Extremely flammable. Spillages of liquid product will create a fire hazard and may form an explosive atmosphere. Keep all sources of ignition and hot metal surfaces away from spill/release if safe to do so. The use of explosion-proof electrical equipment is recommended. May contain or release poisonous hydrogen sulfide gas. If the presence of dangerous amounts of H2S around the spilled product is suspected, additional or special actions may be warranted, including access restrictions and use of protective equipment. Stay upwind and away from spill/release. Avoid direct contact with material. For large spillages, notify persons down wind of the spill/release, isolate immediate hazard area and keep unauthorized personnel out. Wear appropriate protective equipment, including respiratory protection, as conditions warrant (see Section 8). See Sections 2 and 7 for additional information on hazards and precautionary measures.

Environmental Precautions: Stop spill/release if it can be done safely. Prevent spilled material from entering sewers, storm drains, other unauthorized drainage systems, and natural waterways. Use foam on spills to minimize vapors. Use water sparingly to minimize environmental contamination and reduce disposal requirements. If spill occurs on water notify appropriate authorities and advise shipping of any hazard. Spills into or upon navigable waters, the contiguous zone, or adjoining shorelines that cause a sheen or discoloration on the surface of the water, may require notification of the National Response Center (phone number 800-424-8802).

Methods for Containment and Clean-Up: Notify relevant authorities in accordance with all applicable regulations. Immediate cleanup of any spill is recommended. Dike far ahead of spill for later recovery or disposal. Absorb spill with inert material such as sand or vermiculite, and place in suitable container for disposal. If spilled on water remove with appropriate methods (e.g. skimming, booms or absorbents). In case of soil contamination, remove contaminated soil for remediation or disposal, in accordance with local regulations.

Recommended measures are based on the most likely spillage scenarios for this material; however local conditions and regulations may influence or limit the choice of appropriate actions to be taken.

Section 7: Handling and Storage

Precautions for safe handling: Keep away from ignition sources such as heat/sparks/open flame – No smoking. Take precautionary measures against static discharge. Nonsparking tools should be used. Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. May contain or release dangerous levels of hydrogen sulfide. Do not breathe vapors or mists. Wear protective gloves/clothing and eye/face protection. Wash thoroughly after handling. Use good personal hygiene practices and wear appropriate personal protective equipment (see section 8).

Extremely Flammable. May vaporize easily at ambient temperatures. The vapor is heavier than air and may create an explosive mixture of vapor and air. Beware of accumulation in confined spaces and low lying areas. Open container slowly to relieve any pressure. Electrostatic charge may accumulate and create a hazardous condition when handling or processing this material. To avoid fire or explosion, dissipate static electricity during transfer by grounding and bonding containers and equipment before transferring material. The use of explosion-proof electrical equipment is recommended and may be required (see appropriate fire codes). Refer to NFPA-70 and/or API RP 2003 for specific bonding/grounding requirements. Do not enter confined spaces such as tanks or pits without following proper entry procedures such as ASTM D-4276 and 29CFR 1910.146. Do not wear contaminated clothing or shoes. Keep contaminated clothing away from sources of ignition such as sparks or open flames.

Mercury and other heavy metals may be present in trace quantities in crude oil, raw natural gas, and condensates. Production and processing of these materials can lead to "drop-out" of elemental mercury in enclosed vessels and pipe work, typically at the low point of any process equipment because of its density. Mercury may also occur in other process system deposits such as sludges, sands, scales, waxes, and filter media. Personnel engaged in work with equipment where mercury deposits might occur (confined space entry, sampling, opening drain valves, draining process lines, etc), may be exposed to a mercury hazard (see sections 3 and 8).

Conditions for safe storage: This material may contain or release poisonous hydrogen sulfide gas. In a tank, barge, or other closed container, the vapor space above this material may accumulate hazardous concentrations of hydrogen sulfide. Check atmosphere for oxygen content, H2S, and flammability prior to entry. Keep container(s) tightly closed and properly labeled. Use and store this material in cool, dry, well-ventilated areas away from heat, direct sunlight, hot metal surfaces, and all sources of ignition. Store only in approved containers. Post area "No Smoking or Open Flame." Keep away from any incompatible material (see Section 10). Protect container(s) against physical damage. Outdoor or detached storage is preferred. Indoor storage should meet OSHA standards and appropriate fire codes.

"Empty" containers retain residue and may be dangerous. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose such containers to heat, flame, sparks, or other sources of ignition. They may explode and cause injury or death. "Empty" drums should be completely drained, properly bunged, and promptly shipped to the supplier or a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations. Before working on or in tanks which contain or have contained this material, refer to OSHA regulations, ANSI Z49.1, and other references pertaining to cleaning, repairing, welding, or other contemplated operations.

Section 8: Exposure Controls / Personal Protection

Component	ACGIH	OSHA	Other
Crude Oil (Petroleum)	---	---	TWA:100 mg/m^3 - 8 hr (ConocoPhillips Guidelines)
Naphthalene	STEL: 15 ppm TWA: 10 ppm 2 ppm TWA; skin; A3 - confirmed animal carcinogen with unknown relevance to humans; TLV basis: upper respiratory tract irritation Skin	TWA: 10 ppm : 50 mg/m^3	TWA: 0.2 mg/m^3 (as total of 17 PNA"s measured by NIOSH Method 5506) (ConocoPhillips Guidelines)
Benzene	STEL: 2.5 ppm TWA: 0.5 ppm Skin	Ceiling: 25 ppm STEL: 5 ppm TWA: 10 ppm TWA: 1 ppm	---
Hydrogen Sulfide	STEL: 5 ppm TWA: 1 ppm	Ceiling: 20 ppm	TWA: 5 ppm 8hr TWA: 2.5 ppm 12hr STEL: 15 ppm (ConocoPhillips Guidelines)

Note: State, local or other agencies or advisory groups may have established more stringent limits. Consult an industrial hygienist or similar professional, or your local agencies, for further information.

Engineering controls: If current ventilation practices are not adequate to maintain airborne concentrations below the established exposure limits, additional engineering controls may be required.

Eye/Face Protection: The use of eye protection (such as splash goggles) that meets or exceeds ANSI Z.87.1 is recommended when there is potential liquid contact to the eye. Depending on conditions of use, a face shield may be necessary.

Skin/Hand Protection: The use of gloves impervious to the specific material handled is advised to prevent skin contact. Users should check with manufacturers to confirm the breakthrough performance of their products. Suggested protective materials: Nitrile

Respiratory Protection: Where there is potential for airborne exposure to hydrogen sulfide (H2S) above exposure limits, a NIOSH approved, self-contained breathing apparatus (SCBA) or equivalent operated in a pressure demand or other positive pressure mode should be used. Under conditions where hydrogen sulfide (H2S) is NOT detected, a NIOSH certified air purifying respirator equipped with organic vapor cartridges/canisters may be used.

A respiratory protection program that meets or is equivalent to OSHA 29 CFR 1910.134 and ANSI Z88.2 should be followed whenever workplace conditions warrant a respirator's use. Air purifying respirators provide limited protection and cannot be used in atmospheres that exceed the maximum use concentration (as directed by regulation or the manufacturer's instructions), in oxygen deficient (less than 19.5 percent oxygen) situations, or under conditions that are immediately dangerous to life and health (IDLH).

If benzene concentrations equal or exceed applicable exposure limits, OSHA requirements for personal protective equipment, exposure monitoring, and training may apply (29CFR1910.1028 - Benzene).

Workplace monitoring plans should consider the possibility that heavy metals such as mercury may concentrate in processing vessels and equipment presenting the possibility of exposure during various sampling and maintenance operations. Implement appropriate respiratory protection and the use of other protective equipment as dictated by monitoring results (See Sections 2 and 7).

Suggestions provided in this section for exposure control and specific types of protective equipment are based on readily available information. Users should consult with the specific manufacturer to confirm the performance of their protective equipment. Specific situations may require consultation with industrial hygiene, safety, or engineering professionals.

Section 9: Physical and Chemical Properties

Note: Unless otherwise stated, values are determined at 20°C (68°F) and 760 mm Hg (1 atm). Data represent typical values and are not intended to be specifications.

Appearance:	Amber to Black
Physical Form:	Liquid
Odor:	Petroleum. Rotten egg / sulfurous
Odor Threshold:	No data
pH:	Not applicable
Vapor Pressure:	0.6-10 psia (Reid VP) @ 100°F / 37.8°C
Vapor Density (air=1):	>1
Initial Boiling Point/Range:	-128 to 1000 °F / -89 to 538 °C
Melting/Freezing Point:	No data
Solubility in Water:	Negligible
Partition Coefficient (n-octanol/water) (Kow):	No data
Specific Gravity (water=1):	0.7-1.03 @ 60ºF (15.6ºC)
Bulk Density:	5.83-8.58 lbs/gal
Evaporation Rate (nBuAc=1):	No data
Flash Point:	< 20 °F / < -7 °C
Test Method:	(estimate)
Lower Explosive Limits (vol % in air):	1.1
Upper Explosive Limits (vol % in air):	6.0
Auto-ignition Temperature:	590 °F / 310 °C

Section 10: Stability and Reactivity

Stability: Stable under normal ambient and anticipated conditions of use.

Conditions to Avoid: Avoid high temperatures and all sources of ignition. Prevent vapor accumulation.

Materials to Avoid (Incompatible Materials): Avoid contact with strong oxidizing agents and strong reducing agents.

Hazardous Decomposition Products: Not anticipated under normal conditions of use.

Hazardous Polymerization: Not known to occur.

Section 11: Toxicological Information

Information on Toxicological Effects of Substance/Mixture

Acute Toxicity	Hazard	Additional Information	LC50/LD50 Data
Inhalation	Expected to have a low degree of toxicity by inhalation	May contain or release poisonous hydrogen sulfide gas - see Other Comments.	> 5 mg/L (vapor)
Skin Absorption	Unlikely to be harmful		> 2 g/kg
Ingestion (Swallowing)	Unlikely to be harmful		> 5 g/kg

Aspiration Hazard: May be fatal if swallowed and enters airways.

Skin Corrosion/Irritation: Causes mild skin irritation. Repeated exposure may cause skin dryness or cracking.

Serious Eye Damage/Irritation: Causes serious eye irritation.

Signs and Symptoms: Effects of overexposure may include irritation of the digestive tract, irritation of the respiratory tract, nausea, vomiting, diarrhea and signs of nervous system depression (e.g., headache, drowsiness, dizziness, loss of coordination, disorientation and fatigue).

Skin Sensitization: Not expected to be a skin sensitizer.

Respiratory Sensitization: No information available.

Specific Target Organ Toxicity (Single Exposure): May cause drowsiness and dizziness.

Specific Target Organ Toxicity (Repeated Exposure): May cause damage to organs through prolonged or repeated exposure. Laboratory animal studies of crude oil by the dermal and inhalation exposure routes have demonstrated toxicity to the liver, blood, spleen and thymus

Carcinogenicity: May cause cancer Chronic application of crude oil to mouse skin resulted in an increased incidence of skin tumors. IARC concluded in its Crude Oil Monograph that there is limited evidence of carcinogenicity in animals, and that crude oil is not classifiable as to its carcinogenicity in humans (Group 3). It has not been listed as a carcinogen by NTP or OSHA.

Germ Cell Mutagenicity: Inadequate information available.

Reproductive Toxicity: Inadequate information available. Dermal exposure to crude oil during pregnancy resulted in limited evidence of developmental toxicity in laboratory animals. Decreased fetal weight and increased resorptions were noted at maternally toxic doses. No significant effects on pup growth or other developmental landmarks were observed postnatally.

Other Comments: This material may contain or liberate hydrogen sulfide, a poisonous gas with the smell of rotten eggs. The smell disappears rapidly because of olfactory fatigue so odor may not be a reliable indicator of exposure. Effects of overexposure include irritation of the eyes, nose, throat and respiratory tract, blurred vision, photophobia (sensitivity to light), and pulmonary edema (fluid accumulation in the lungs). Severe exposures can result in nausea, vomiting, muscle weakness or cramps, headache, disorientation and other signs of nervous system depression, irregular heartbeats, convulsions, respiratory failure, and death.

This material may contain varying concentrations of polycyclic aromatic hydrocarbons (PAHs) which have been known to produce a phototoxic reaction when contaminated skin is exposed to sunlight. The effect is similar in appearance to an exaggerated sunburn, and is temporary in duration if exposure is discontinued. Continued exposure to sunlight can result in more serious skin problems including pigmentation (discoloration), skin eruptions (pimples), and possible skin cancers.

Information on Toxicological Effects of Components

n-Hexane

Target Organs: Excessive exposure to n-hexane can result in peripheral neuropathies. The initial symptoms are symmetrical sensory numbness and paresthesias of distal portions of the extremities. Motor weakness is typically observed in muscles of the toes and fingers but may also involve muscles of the arms, thighs and forearms. The onset of these symptoms may be delayed for several months to a year after the beginning of exposure. The neurotoxic properties of n-hexane are potentiated by exposure to methyl ethyl ketone and methyl isobutyl ketone.
Reproductive Toxicity: Prolonged exposure to high concentrations of n-hexane (>1,000 ppm) resulted in decreased sperm count and degenerative changes in the testes of rats but not those of mice.

Xylenes

Target Organs: Rats exposed to xylenes at 800, 1000 or 1200 ppm 14 hours daily for 6 weeks demonstrated high frequency hearing loss. Another study in rats exposed to 1800 ppm 8 hours daily for 5 days demonstrated middle frequency hearing loss.
Reproductive Toxicity: Both mixed xylenes and the individual isomers produced limited evidence of developmental toxicity in laboratory animals. Inhalation and oral administration of xylene resulted in decreased fetal weight, increased incidences of delayed ossification, skeletal variations and resorptions, but no evidence of teratogenicity.

Ethyl Benzene

Carcinogenicity: Rats and mice exposed to 0, 75, 250, or 750 ppm ethyl benzene in a two year inhalation study demonstrated limited evidence of kidney, liver, and lung cancer. Ethyl benzene has been listed as a possible human carcinogen by IARC.
Target Organs: In rats and mice exposed to 0, 75, 250, or 750 ppm ethyl benzene in a two year inhalation study there was mild damage to the kidney (tubular hyperplasia), liver (eosinophilio foci, hypertrophy, necrosis), lung (alveolar epithelium metaplasia), thyroid (hyperplasia), thyroid (hyperplasia) and pituitary (hyperplasia). In animal models (particularly rats), ethyl benzene affects the auditory function mainly in the cochlear mid-frequency range and ototoxicity was observed after combined exposure to noise and ethyl benzene. There is no evidence of either ethyl benzene-induced hearing losses or ototoxicity with combined exposure to ethyl benzene and noise in workers.

Naphthalene

Carcinogenicity: Naphthalene has been evaluated in two year inhalation studies in both rats and mice. The US National Toxicology Program (NTP) concluded that there is clear evidence of carcinogenicity in male and female rats based on increased incidences of respiratory epithelial adenomas and olfactory epithelial neuroblastomas of the nose. NTP found some evidence of carcinogenicity in female mice (alveolar adenomas) and no evidence of carcinogenicity in male mice. Naphthalene has been identified as a carcinogen by IARC and NTP.

Benzene

Carcinogenicity: Benzene is an animal carcinogen and is known to produce acute myelogenous leukemia (a form of cancer) in humans. Benzene has been identified as a human carcinogen by IARC, the US National Toxicology Program and the US-Occupational Safety and Health Administration.
Target Organs: Prolonged or repeated exposures to benzene vapors can cause damage to the blood and blood forming organs, including disorders like leukopenia, thrombocytopenia, and aplastic anemia.
Reproductive Toxicity: Some studies in occupationally exposed women have suggested benzene exposure increased risk of miscarriage and stillbirth and decreased birth weight and gestational age. The size of the effects detected in these studies was small, and ascertainment of exposure and outcome in some cases relied on self-reports, which may limit the reliability of these results.
Germ Cell Mutagenicity: Benzene exposure has resulted in chromosomal aberrations in human lymphocytes and animal bone marrow cells. Exposure has also been associated with chromosomal aberrations in sperm cells in human and animal studies.

Section 12: Ecological Information

Toxicity: Experimental studies of acute aquatic toxicity show values for crude oil in the range of 2 to over 100 mg/L. These values are consistent with the predicted aquatic toxicity of these substances based on their hydrocarbon compositions. Crude oil should be regarded as harmful to aquatic organisms, with the potential to cause long term adverse effects in the aquatic environment. Classification: H411; Chronic Cat 2.

Persistence and Degradability: Most crude oils are not regarded as readily biodegradable. Most of the non-volatile constituents are inherently biodegradable; some of the highest molecular weight components are persistent in water.

Persistence per IOPC Fund definition: Persistent

Bioaccumulative Potential: Log Kow values measured for the hydrocarbon components of this material range from less than 2 to greater than 6, and therefore would be regarded as having the potential to bioaccumulate.

Mobility in Soil: Crude oil spreads as a film on the surface of water, facilitating loss of its lighter components by volatilization. In air, the volatile hydrocarbons undergo photodegradation by reaction with hydroxyl radicals with half-lives varying from 0.5 days for n-dodecane to 6.5 days for benzene. The lower molecular weight aromatic hydrocarbons and some polar compounds have low but significant water solubility. Some higher molecular weight compounds are removed by emulsification and these also slowly biodegrade; others adsorb to sediment and sink. A further removal process from water involving the heavier fraction is agglomeration to form tars, some of which sink.

Other Adverse Effects: None anticipated.

Section 13: Disposal Considerations

The generator of a waste is always responsible for making proper hazardous waste determinations and needs to consider state and local requirements in addition to federal regulations.

This material, if discarded as produced, would not be a federally regulated RCRA "listed" hazardous waste. However, it would likely be identified as a federally regulated RCRA hazardous waste for the following characteristic(s) shown below. See Sections 7 and 8 for information on handling, storage and personal protection and Section 9 for physical/chemical properties. It is possible that the material as produced contains constituents which are not required to be listed in the MSDS but could affect the hazardous waste determination. Additionally, use which results in chemical or physical change of this material could subject it to regulation as a hazardous waste.

Container contents should be completely used and containers should be emptied prior to discard. Container residues and rinseates could be considered to be hazardous wastes.

EPA Waste Number(s)
- D001 - Ignitability characteristic
- D018 - Toxicity characteristic (Benzene)

Section 14: Transport Information

U.S. Department of Transportation (DOT)

Shipping Description:	UN1267, Petroleum crude oil, 3, I ***or*** II
Non-Bulk Package Marking:	Petroleum crude oil, UN1267
Non-Bulk Package Labeling:	Flammable liquid
Bulk Package/Placard Marking:	Flammable / 1267
Packaging - References:	49 CFR 173.150; 173.201; 173.243 ***[PG I]*** ***-or-*** 49 CFR 173.150; 173.202; 173.242 ***[PG II]*** ***(Exceptions; Non-bulk; Bulk)***
Hazardous Substance:	See Section 15 for RQ`s
Emergency Response Guide:	128
Note:	***Packing group is dependent on boiling point (BP) of the material:*** **I if BP <=35° C (95° F); II if BP > 35° C (95° F)** ***The following alternate shipping description order may be used until January 1, 2013:*** **Proper Shipping name, Hazard Class or Division, (Subsidiary Hazard if any), UN or NA number, Packing Group** ***Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code:*** *Not applicable* ***Other shipping description elements may be required for DOT compliance.***

International Maritime Dangerous Goods (IMDG)

Shipping Description:	UN1267, Petroleum crude oil, 3, I ***or*** II, (FP° C cc), *[where FP is the material's flash point in degrees Celsius closed cup]*
Non-Bulk Package Marking:	Petroleum crude oil, UN1267
Labels:	Flammable liquid
Placards/Marking (Bulk):	Flammable / 1267
Packaging - Non-Bulk:	P001
EMS:	F-E, S-E
Note:	***U.S. DOT compliance requirements may apply. See 49 CFR 171.22, 23 & 25. If transported in bulk by marine vessel in international waters, product is being carried under the scope of MARPOL Annex I.***

International Civil Aviation Org. / International Air Transport Assoc. (ICAO/IATA)

UN/ID #: UN1267
Proper Shipping Name: Petroleum crude oil
Hazard Class/Division: 3
Subsidiary risk: None
Packing Group: I ***or*** II
Non-Bulk Package Marking: Petroleum crude oil, UN1267
Labels: Flammable liquid
ERG Code: 3H
Note: ***U.S. DOT compliance requirements may apply. See 49 CFR 171.22, 23 & 24.***

	LTD. QTY	**Passenger Aircraft**	**Cargo Aircraft Only**
Packaging Instruction #:	*Forbidden* - ***[PG I]*** Y341 - ***[PG II]***	351 - ***[PG I]*** 353 - ***[PG II]***	361 - ***[PG I]*** 364 - ***[PG II]***
Max. Net Qty. Per Package:	*Forbidden* - ***[PG I]*** 1L - ***[PG II]***	1L - ***[PG I]*** 5 L - ***[PG II]***	30 L - ***[PG I]*** 60 L - ***[PG II]***

Section 15: Regulatory Information

CERCLA/SARA - Section 302 Extremely Hazardous Substances and TPQs (in pounds):

This material contains the following chemicals subject to the reporting requirements of SARA 302 and 40 CFR 372:

Component	TPQ	EPCRA RQ
Hydrogen Sulfide	500 lb	100 lb

CERCLA/SARA - Section 311/312 (Title III Hazard Categories)

Acute Health: Yes
Chronic Health: Yes
Fire Hazard: Yes
Pressure Hazard: No
Reactive Hazard: No

CERCLA/SARA - Section 313 and 40 CFR 372:

This material contains the following chemicals subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR 372:

Component	Concentration[1]	de minimis
n-Hexane	0-5	1.0%
Xylenes	0-3	1.0%
Ethyl Benzene	<2	0.1%
Naphthalene	0-0.9	0.1%
Benzene	<1	0.1%

EPA (CERCLA) Reportable Quantity (in pounds):

EPA's Petroleum Exclusion applies to this material - (CERCLA 101(14)).

California Proposition 65:

Warning: This material may contain detectable quantities of the following chemicals, known to the State of California to cause cancer, birth defects or other reproductive harm, and which may be subject to the warning requirements of California Proposition 65 (CA Health & Safety Code Section 25249.5):

Component	Type of Toxicity
Ethyl Benzene	Cancer
Naphthalene	Cancer
Various Polycyclic Aromatic Hydrocarbons	Skin Cancer
Toluene	Developmental Toxicant Female Reproductive Toxicant
Benzene	Cancer Developmental Toxicant Male Reproductive Toxicant

International Hazard Classification

Canada:
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all the information required by the Regulations.

WHMIS Hazard Class:
B2 - Flammable Liquids
D2A
D2B

National Chemical Inventories

All components are either listed on the US TSCA Inventory, or are not regulated under TSCA
All components are either on the DSL, or are exempt from DSL listing requirements

U.S. Export Control Classification Number: 1C981

Section 16: Other Information

Date of Issue:	06-Jul-2011
Status:	FINAL
Previous Issue Date:	02-Apr-2012
Revised Sections or Basis for Revision:	Identified Hazards (Section 2) Precautionary Statement(s) (Section 2) First Aid (Section 4 Shipping information (Section 14) Regulatory information (Section 15)
SDS Number:	724160

Guide to Abbreviations:
ACGIH = American Conference of Governmental Industrial Hygienists; CASRN = Chemical Abstracts Service Registry Number; CEILING = Ceiling Limit (15 minutes); CERCLA = The Comprehensive Environmental Response, Compensation, and Liability Act; EPA = Environmental Protection Agency; GHS = Globally Harmonized System; IARC = International Agency for Research on Cancer; INSHT = National Institute for Health and Safety at Work; IOPC = International Oil Pollution Compensation; LEL = Lower Explosive Limit; NE = Not Established; NFPA = National Fire Protection Association; NTP = National Toxicology Program; OSHA = Occupational Safety and Health Administration; PEL = Permissible Exposure Limit (OSHA); SARA = Superfund Amendments and Reauthorization Act; STEL = Short Term Exposure Limit (15 minutes); TLV = Threshold Limit Value (ACGIH); TWA = Time Weighted Average (8 hours); UEL = Upper Explosive Limit; WHMIS = Worker Hazardous Materials Information System (Canada)

Disclaimer of Expressed and implied Warranties:
The information presented in this Material Safety Data Sheet is based on data believed to be accurate as of the date this Material Safety Data Sheet was prepared. HOWEVER, NO WARRANTY OF MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE, OR ANY OTHER WARRANTY IS EXPRESSED OR IS TO BE IMPLIED REGARDING THE ACCURACY OR COMPLETENESS OF THE INFORMATION PROVIDED ABOVE, THE RESULTS TO BE OBTAINED FROM THE USE OF THIS INFORMATION OR THE PRODUCT, THE SAFETY OF THIS PRODUCT, OR THE HAZARDS RELATED TO ITS USE. No responsibility is assumed for any damage or injury resulting from abnormal use or from any failure to adhere to recommended practices. The information provided above, and the product, are furnished on the condition that the person receiving them shall make their own determination as to the suitability of the product for their particular purpose and on the condition that they assume the risk of their use. In addition, no authorization is given nor implied to practice any patented invention without a license.

SDS Worksheet

1. What is the emergency phone number for this product?

____

2. What two GHS hazard classifications are rated in the highest risk category for this product?

____

3. What is the NFPA flammability risk category for this product?

____

4. On a label for this product, what pictograms and signal word would you find?

____

5. On a label for this product, what would be the aspiration hazard statement?

____

6. The primary route(s) of exposure for this product are:

____

7. What is the recommended eye protection when working with this product?

____

8. The recommended engineering control measures for this substance are:

____

9. When this product burns, what five (5) hazardous combustion products may be produced?

____

10. What is the flash point for this product?

____

11. Under what conditions would an SCBA be required for respiratory protection when working with or near this product?

____

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2050-0039

GENERATOR

UNIFORM HAZARDOUS WASTE MANIFEST	1. Generator ID Number AK2000000	2. Page 1 of 1	3. Emergency Response Phone 1-800-424-9300 (CCN: 12345678)	**4. Manifest Tracking Number** 000732424

5. Generator's Name and Mailing Address

Slurp Chemical Company, 503 Acid Way, Anchorage, AK 99501

Generator's Site Address (if different than mailing address)

Generator's Phone: (907) 272-8852

6. Transporter 1 Company Name: Toxic Turtle Express

U.S. EPA ID Number: AK2345003

7. Transporter 2 Company Name: N/A

U.S. EPA ID Number:

8. Designated Facility Name and Site Address

Waste-Away, Inc. 206 Industrial Way, Wasilla, AK 99654

U.S. EPA ID Number: AK2345004

Facility's Phone: (907) 123-4567

9a. HM	9b. U.S. DOT Description (including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))	10. Containers No.	10. Containers Type	11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes
X	1. UN1809, Waste Phosphorus Trichloride, 6.1(8), PG I	003	6HA2	150	G	D002
RQ	2. UN1689, Waste Sodium Cyanide Solid, 6.1, PG I	001	DF	10	P	P106
X	3. UN1307, Waste Xylene, 3, PG II	001	DM	50	G	D001
	4.					

14. Special Handling Instructions and Additional Information

A. Treatment, B. Burial, C. Incineration

15. **GENERATOR'S/OFFEROR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable international and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent.

I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.

Generator's/Offeror's Printed/Typed Name: J. Q. Slurpie

Signature:

Month Day Year: 01/03/20

INT'L

16. International Shipments ☐ Import to U.S. ☐ Export from U.S.

Port of entry/exit:

Transporter signature (for exports only):

Date leaving U.S.:

TRANSPORTER

17. Transporter Acknowledgment of Receipt of Materials

Transporter 1 Printed/Typed Name: G. Imasikk

Signature:

Month Day Year: 02/01/20

Transporter 2 Printed/Typed Name:

Signature:

Month Day Year:

DESIGNATED FACILITY

18. Discrepancy

18a. Discrepancy Indication Space ☐ Quantity ☐ Type ☐ Residue ☐ Partial Rejection ☐ Full Rejection

Manifest Reference Number:

18b. Alternate Facility (or Generator): N/A

U.S. EPA ID Number:

Facility's Phone:

18c. Signature of Alternate Facility (or Generator)

Month Day Year:

19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)

1. Deactivation to remove hazardous waste characteristics	2. Tested to below 590 MG/KG	3. Tested to below 30 MG/KG	4.

20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a

Printed/Typed Name: Finally Is Here

Signature:

Month Day Year: 02/08/20

EPA Form 8700-22 (Rev. 3-05) Previous editions are obsolete.

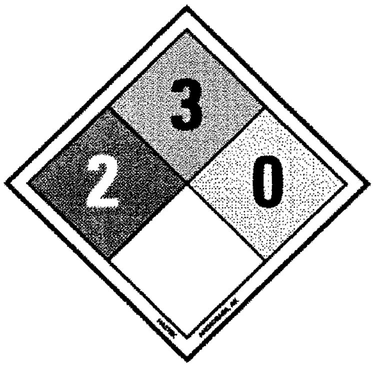
DESIGNATED FACILITY TO DESTINATION STATE (IF REQUIRED)

What's in that Drum?

A truck is picking up waste at different buildings on your company's site. The truck gets to your location and as the driver opens the door a cloud of smoke comes out of the back. You send in a team to investigate (with self-contained breathing apparatus and protective clothing). The drums inside are not well labeled, but the team did get some information: two NFPA labels, a DOT label and a manifest that was with the driver. The labels are below and the manifest is attached.

- Label #1 – Three of the drums display this NFPA label. One of these drums appeared to have smoke coming out of the open bung.

- Label #2 – This NFPA label appeared on one drum.



- Label #3 – This DOT label appeared on one drum.

What's in that Drum? Worksheet

Answer the following questions using the preceding labels and manifest, along with the NIOSH Pocket Guide, and the Emergency Response Guidebook

1. Match the drums with the chemicals on the attached manifest.

   Label #1: ______________________________

   Label #2: ______________________________

   Label #3: ______________________________

2. What is the health hazard of the three drums with the same NFPA label?

3. What does the ~~W~~ with the slash through it, mean?

4. What is the hazard characteristic of the single drum with the NFPA label?

5. What does the number three at the top portion of the NFPA label indicate?

6. What is the DOT hazard class of the material in the other drum?

7. What is the UN I.D. number for this chemical?

8. Should the waste phosphorus trichloride be in this load? Why?

9. Who would you contact about the chemicals on the truck? What is that person's phone number?

ENVIRONMENTAL
MANAGEMENT
INCORPORATED

Course Evaluation

Class Name: **Student Name:**

Course #:

Date: Instructor:

1. Where did you hear about this course?

________________Newspaper _____________EMI Reminder

________________Friend _____________EMI Staff (Who)____________

________________Employer _____________Other

2. What is your overall evaluation of this course?

___________Excellent

___________Good

___________Fair

___________Poor

3. Do you feel the course material was:

__________About right

__________Too complicated

__________Was better than my expectations

__________Met my expectations

__________Too elementary

4. This course:

_____Was better than my expectations

_____Met my expectations

_____Was less than I expected

5. Please rate your satisfaction with the instructor:

_________Very Satisfied

_________Satisfied

_________Dissatisfied

6. We at EMI would appreciate your comments on the following:

   a. Instructors and their presentations:

   b. What would improve the course?

   c. Are there other classes you would like us to provide?

   d. Do you have any other suggestions or comments?