

# WELCOME TO...

## ***Health Hazards in Construction***

*Construction workers are exposed to a variety of health hazards every day. These men and women have the potential for becoming sick, ill and disabled for life.*

*Learn the health hazards on your job and know how to protect yourself...*

*Sadly, these health hazards (e.g., dangerous dust and other chemicals) can be unexpectedly brought home...*



*Learn how to protect your family!*

This publication contains:

1. The purpose for the Occupational Safety and Health Administration (OSHA) and its enforcement duty under law.
2. Common health hazards found in construction.
3. An explanation of Industrial Hygiene and toxicology.
4. Important terms and definitions used in health standards and toxicology.
5. Procedures for how to anticipate, recognize, evaluate and control health hazards in construction.
6. Hazard communication program for contractors & the Globally Harmonized System for Hazard Communication.
7. Respiratory protection program for contractors.
8. Hearing conservation program for contractors.

This program is dedicated to all the workers who have sustained a life threatening or disabling illness as a result of an occupational exposure.

This publication was produced by:

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The Construction Safety Council will like to thank the following for their contributions and support:

- The Occupational Safety and Health Administration (OSHA)
- The National Institute for Occupational Safety and Health (NIOSH)
- The United States Environmental Protection Agency (EPA)
- Chicago Area Laborers – Employer Cooperation and Education Trust (LECET)
- United Union of Roofers, Waterproofers and Allied Workers
- elcoshimages.org
- LeBlanc Building Co., Inc.
- Milton R. Chicas
- David Allie (4-Safety.com)
- John Dimos, MS, CIH

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## OVERVIEW

**Employers have the responsibility to protect the safety and health of the worker. This course will help prepare an employer or its designated representative (job-site competent person) to understand and react to occupational health hazards in construction.**

Course participants will learn how to *anticipate, recognize, evaluate* and *control* occupational health hazards; these hazards include, but are not limited to: **chemical, physical, biological** hazards. Special consideration will be given to occupational **noise** exposure in construction.

In addition, the participant will learn how and when to make managerial decisions, such as how to implement a **job-site hazard communication program**, how to select appropriate **engineering & administrative controls** and how to properly implement a **personal protective equipment (PPE) program**. Also, participants will gain insight as to when to consult the expertise of an Industrial Hygienist and/or other qualified person.

The goal of this course (*Health Hazards in Construction*) is to enhance communication of health hazards between employers & employees, to prepare an individual to make competent decisions on matters of occupational health exposures in construction and to equip this person with the knowledge and skills necessary to perform frequent and regular inspections of the job-site. At the conclusion, each course participant will possess the confidence to recognize and avoid unsafe conditions and will be able to identify regulations applicable to health hazards in construction.

## INTENDED AUDIENCE

The target audience is the private sector construction employer, manager, employee or employee representative who, as part of a safety and health program, would either be acting to fulfill the requirements of a competent person (to conduct frequent and regular inspections of a job-site) or performing safety and health evaluations for their member employees and performing training as described in OSHA's construction safety & health standard 29 CFR 1926.



## RESPONSIBILITY TO SELF & FAMILY!

A worker's exposure to hazardous materials on the job can be unknowingly brought back to a person's home; heavy metals such as lead dust, concrete crusted clothing and variety of oils, greases and solvents can all be unintentionally poisoning your family!

As a worker who might be exposed to these hazards, you have a responsibility to wear personal protective equipment (PPE), practice good hygiene and take advantage of training programs like this. Learn of the hazards associated with your job and protect your family.



***Occupational health hazards can unexpectedly be brought home; wear personal protective equipment (PPE) on the job and do not bring home health hazards that can harm your family!***

# INDUSTRIAL HYGIENE

## ***Learning Goals:***

- Define industrial hygiene.
- Recognize industrial hygiene's relationship to OSHA.
- Identify and define job hazard analysis
- Be able to apply the classic industrial hygiene approach (*anticipate, recognize, evaluate & control*) to hazard abatement.

## ***Important Terms:***

- Industrial Hygiene
  - *Anticipate (hazards)*
  - *Recognize (hazards)*
  - *Evaluate (hazards)*
  - *Control (hazards)*
- Toxicology
- Job Hazard Analysis
- Hazard Abatement

## Industrial Hygiene

Industrial hygiene is the art and science of ***anticipating, recognizing, evaluating, and controlling*** workplace conditions that may cause workers' injury or illness. Industrial hygienists use personal and environmental monitoring and analytical methods to detect the extent of worker exposure and employ engineering, work practice controls, and other methods to control potential health hazards.

## ***The History of Industrial Hygiene***



4<sup>th</sup> Century B.C.

Hippocrates -  
Noted lead toxicity in  
the mining industry.



1<sup>st</sup> Century A.D.

Pliny the Elder -  
Devised a face mask  
made from an animal  
bladder.



1556 A.D.

Georgius Agricola -  
Publishes *De Re Metallica* -  
diseases associated with  
mining occupations.



1700 A.D.

Bernardo Ramazzini -  
"Father of Industrial  
Medicine" publishes *De  
Morbis Artificum Diatriba*  
(*The Diseases of Workmen*).

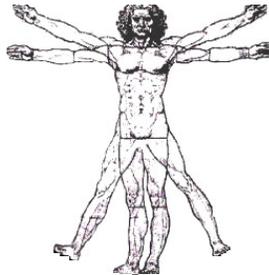
***There has been an awareness of industrial hygiene since the ancient times!***

# Health Hazards in Construction



## Chemical

- Gases
- Vapors
- Fumes
- Dusts
- Fibers
- Mists



## Physical

- Temperature
- Noise
- Repetitive Motion & Awkward Postures
- Ionizing & Non-Ionizing Radiation



## Biological

- Fungi (Mold)
- Bloodborne Pathogens
- Bacteria
- Poisonous Plants
- Poisonous & Infectious Animals

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## Toxicology

Toxicology is the science that studies the poisonous or toxic properties of a substance. The basic assumption of toxicology is that there is a relationship among the dose (amount), the concentration at the affected site, and the resulting effects. As part of your job as a construction worker, study and learn the hazardous effects of the substances that you work with; study the dangers associated with the above *health hazards in construction*.

## Anticipation of Health Hazards

Health hazards can be anticipated by knowing the history of the work involved as well as through worker experience and education; learn all the hazards associated with your job and be better prepared to make good decisions regarding your health and safety.

Generally, hazards associated with a particular job are either inherent (present before the worker shows up); or hazards can be created by the work (e.g., welding & cutting, use of fuel powered equipment, etc.).



**What hazards can you anticipate in this picture?  
Old fuel storage tank be excavated – site being prepared for rebuild (fueling station).**

### **To anticipate hazards:**

- Survey job-site conditions.
- Be aware of the actions and behaviors of workers.

### **Hazardous conditions that can be anticipated on construction job-sites include:**

- Confined or enclosed spaces (hazardous atmospheres).
- Contaminated soil conditions (hazardous atmospheres).
- Unsanitary conditions (poor housekeeping, poorly kept toilet facilities, etc.).
- Presence of hazardous materials (dangerous coatings on structures & metal containing alloys, concrete & silica).
- The use of hazardous chemicals (gases, solvents & glues).
- The presence of residues left by degreasing agents, usually chlorinated hydrocarbons (chloroform and carbon tetrachloride).
- Older buildings and structures; unoccupied dwellings (fungi/mold, asbestos & lead).
- Extreme temperatures (hot & cold environments; working outside or in attics, boiler rooms, etc.).
- Radiological exposures (nuclear power plants, antennas, hospitals, laboratories and the sun).
- Loud noise (use of tools and equipment).
- Hot work (welding and cutting).
- The presence of plant and/or animal wildlife (poisonous venom, feces, rabies...).

### **Group Discussion...**

**What health hazards can you anticipate on your job?**

## Recognition of Health Hazards

### What do you see?

- **Visible material in the air** – If you see visible clouds of vapor or particles, there may be a serious exposure problem. Remember, however, that most gases and vapors are invisible, and that often the most dangerous particles are too small to see.
- **Settled dust** – If there is chemical dust on the ground or other surfaces, it probably got there by settling out of the air. If disturbed, settled dust can become airborne again.
- **Warning signs, labels & decals** – As required by OSHA's Hazard Communication Standard (29 CFR 1910.1200) and other applicable standards.



**Concrete cutting with saw creates obvious dust exposure.**

#### **Group Discussion...**

**What health hazards do you see on your job?**

### Do you smell or taste anything?

- **Odor** – If you smell a chemical, you are inhaling it. However, some chemicals can be smelled at levels well below those that are harmful. The *odor threshold* is the lowest level of a chemical that can be smelled by most people. If a chemical's odor threshold is lower than the amount that is hazardous, the chemical is said to have good warning properties. It is important to remember that for most chemicals, the odor thresholds vary widely from person to person. In addition, some chemicals, like hydrogen sulfide, cause you to rapidly lose your ability to smell them; this is called olfactory fatigue. With these cautions in mind, knowing a chemical's odor threshold may serve as a rough guide to your exposure level.
- **Taste** – Never taste something that might be a hazardous chemical. However, if you inhale a chemical or accidentally get some in your mouth, it may have a particular taste that warns you're being exposed (e.g., metal fumes).



**Smell or taste could cause you to recognize a health hazard.**

#### **Group Discussion...**

**What health hazards do you smell on your job?**

## Recognition of Health Hazards

### *Do you hear anything?*

**Loud noise can severely damage your hearing!**

#### **Sources of loud noise in construction:**

- Hand tools (e.g., metal hammers)
- Power tools (e.g., jackhammers, grinders, saws, powder actuated tools)
- Equipment (e.g., generators, excavators, cranes, trucks)
- Blasting



#### **Group Discussion...**

**What sources of loud noise are on your job?**

### *Do you feel immediate symptoms?*

- **Particles in you respiratory system** – Your nose and airways have mucous which traps particles and removes them when you cough or blow your nose.
- **Narcotic effect** – When solvents are breathed in, they enter the blood stream and travel to other parts of the body, particularly the nervous system causing dizziness, headache, feelings of “drunkenness”, and tiredness. One result of these symptoms may be poor coordination which can contribute to falls and other accidents.



**Feeling sick, dizzy or nauseous could mean you are being exposed to a health hazard.**

#### **Group Discussion...**

**Have you ever felt sick or nauseous on the job (resulting from an on the job exposure)?**

## Recognition of Health Hazards

### **Not following safety procedures?**

***Learn to recognize unsafe conditions and unsafe behaviors...***

- **Not** implementing engineering and/or administrative controls (e.g., wet methods, ventilation, and dust collection systems).
- **Not** wearing appropriate Personal Protective Equipment (e.g., gloves, respirators, chemical suites, hearing protectors, etc.).
- **Not** practicing good housekeeping.
- **Not** following good hygiene practices.
- **Not** performing a hazard analysis (e.g., air monitoring, dust sampling, noise metering, and biological monitoring & medical surveillance).

***Know the safety procedures on your job and learn to recognize safety violations – report them and get them corrected!***



***Never eat, drink, smoke or apply cosmetics in the areas where hazardous work is performed; employers must train their employees on how to recognize and avoid unsafe conditions and unsafe behaviors!***

## Evaluation of Health Hazards

### *Environmental & Personal Air Monitoring*

Environmental and personal air monitoring is one way to determine exposure to most chemicals. There are instruments to measure contaminants in the air – chemical hazards, such as hazardous gases, vapors, fumes, dust/fibers & mists; also physical hazards, such as noise, heat stress and radiation.

#### ***Environmental & Personal Air Monitoring:***

- Air monitoring does not measure you or what you are doing, but rather what you are exposed to on the job.
- Air monitoring must be done by a trained health professional (industrial hygienist or technician).
- Monitoring can be done by measuring the air in a fixed location in the work area (***area monitoring***) or by placing the monitoring equipment on individual workers and measuring the amount they are exposed to (***personal monitoring***).

NIOSH/John Rekus/elcoshimages.org



***Trained health professional wearing personal protective equipment; evaluating job-site conditions.***

### ***Personal Monitoring***

Personal monitoring is done to determine individual worker exposure and area monitoring may be done to estimate possible exposure of a group of workers in a particular area. Monitoring is usually done during a specific time period, often as an 8-hour shift or 15 minute period to ensure compliance with OSHA standards.

Air monitoring may be done in a number of ways. Some toxins are measured by placing a small pump on your belt and a filter cassette or tube clipped on your collar with a flexible tube running between them. The filter or tube should be located as close as possible to your breathing zone (the air in front of your nose and mouth which you breathe).

The pump pulls air through the filter or tube, which traps the dust or toxin. After the sample has been taken, the filter or tube is sent to a laboratory. The laboratory uses scientific methods to measure the amount of contaminant on the filter or tube. It may take several days or longer before the results are ready from the laboratory.



## Evaluation of Health Hazards

### ***Biological Monitoring & Medical Surveillance***

For chemicals that are absorbed by routes other than inhalation, such as through the skin and by ingestion, air monitoring may underestimate the amount of chemical absorbed into the body; to ensure accurate employee exposure, medical surveillance is sometimes necessary. The levels of the chemical (or its breakdown products) in the body can also be measured in the blood, urine, or exhaled air. Such testing is called biological monitoring. For several substances, biological monitoring is required by law when air monitoring results are above a certain level; employers must maintain the results of these tests as employee records.

#### ***Medical surveillance records include:***

- Employee exposure records (results from personal air monitoring).
- Employee medical records (results from biological monitoring).

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### ***Employee Exposure and Medical Records***

Workers with possible exposure to or uses toxic substances or harmful physical agents on job-sites have rights to access exposure records. These rights and responsibilities can be found in OSHA's standard 29 CFR 1926.33 (see 29 CFR 1910.1020 – Access to Employee Exposure and Medical Records).

#### ***Retention of Medical Records...***

- Employee medical records must be retained for at least the duration of the employee's employment plus 30 years.
- Employee exposure records for at least 30 years (personal air monitoring results).
- Background data related to environmental, or workplace, monitoring or measuring—such as laboratory reports and worksheets—must only be retained for 1 year, so long as you preserve certain interpretive documents relevant to the interpretation of the data for 30 years.



***Employee exposure and medical records must be retained by the employer.***

## Environmental & Personal Air Monitoring Devices

Hazard	Device	Description
<p><b>Gases &amp; Vapors</b></p> <p>Examples:</p> <ul style="list-style-type: none"> <li>○ Carbon Monoxide</li> <li>○ Hydrogen Sulfide</li> <li>○ Methane</li> <li>○ Ammonia</li> <li>○ Chlorine</li> </ul>	<p><b>Detector Tubes</b></p> 	<p>Detects different gases and vapors; often used as a survey tool to determine if a substance is present or not – does not determine exact quantity or employee exposure.</p> <p>Easy to use and gives instant color change results; uses either a hand or a battery operated pump.</p> <p>Often non-specific and has a high standard of error (<math>\pm 25\%</math>).</p> <p>Low cost.</p>
	<p><b>Sampling Tubes</b></p> 	<p>Easy to use and can sample for more than one chemical on a single tube.</p> <p>Tubes must be specific for type of gas or vapor.</p> <p>Not real time measurement – delay in results.</p> <p>Highly accurate in determining exposure.</p> <p>Low cost.</p>
	<p><b>Multi or single gas/vapor detector</b></p> 	<p>Real time measurement device that provides instant results; can be used as personal alarm monitors.</p> <p>Detects a variety of toxic gases and explosive environments.</p> <p>Easy to use, but requires calibration to be accurate; requires on-going maintenance.</p> <p>Sensors wear out (need replacement).</p> <p>Moderate to high cost.</p>
	<p><b>Passive badge gas/vapor sampler</b></p> 	<p>Device worn to passively measure exposure.</p> <p>Simple to use; just put it on and go to work.</p> <p>Accurate device, but limited to the number of chemicals measured.</p> <p>Not real time measurement – delay in results.</p> <p>Low cost.</p>
<p><b>Fumes, Dusts, Mists &amp; Fibers</b></p> <p>Examples:</p> <ul style="list-style-type: none"> <li>○ Lead</li> <li>○ Silica</li> <li>○ Asbestos</li> <li>○ Paints</li> </ul>	<p><b>Instant Swab Wipes</b></p> 	<p>Detects the presence of lead in paint or metals.</p> <p>Does not give detail as to amount, only if substance is present.</p> <p>May show false positive results; perform second wipe to confirm.</p> <p>Low cost.</p>
	<p><b>Filter Cassette</b></p> 	<p>Used to determine an average exposure over a period of time (<i>time weighted average</i>).</p> <p>Samples taken in the “breathing zone” of the employee.</p> <p>Not real time measurement – delay in results.</p> <p>Specific filters required for different substances.</p> <p>Moderate cost.</p>

## Environmental & Personal Air Monitoring Devices

<b>Hazard</b>	<b>Device</b>	<b>Description</b>
<p><b>Noise</b></p> <ul style="list-style-type: none"> <li>○ Decibels (dB)</li> </ul>	<p><b>Sound Level Meter</b></p> 	<p>Measures ambient noise levels and is used as a surveying instrument; provides real time instant reading.</p> <p>Easy to use.</p> <p>Accurate device.</p> <p>Calibration required.</p> <p>Varies in cost.</p>
	<p><b>Personal Dosimeter</b></p> 	<p>Measures personal exposures to noise and determines exposure over a period of time (<i>time weighted average</i>).</p> <p>Requires training to use.</p> <p>Accurate device.</p> <p>Calibration required.</p> <p>High cost.</p>
	<p><b>Noise badge</b></p> 	<p>Indicates that user is being exposed to high levels of noise.</p> <p>Simple to use.</p> <p>No calibration required.</p> <p>Real time instant reading; used as a personal alarm.</p> <p>Low cost.</p>
<p><b>Radiation</b></p> <ul style="list-style-type: none"> <li>○ Ionizing</li> <li>○ Non-ionizing</li> </ul>	<p><b>Film Badge Dosimeters</b></p> 	<p>Measures personal exposure to ionizing radiation.</p> <p>Simple to use.</p> <p>Passive reading.</p> <p>Not real time measurement – delay in results.</p> <p>Low cost.</p>
	<p><b>Survey Instruments (Geiger Counter)</b></p> 	<p>Survey instrument to determine levels of ionizing radiation.</p> <p>Easy to use.</p> <p>Real time measurement.</p> <p>High cost.</p>
	<p><b>Personal Alarm Monitors (RF)</b></p> 	<p>Measures personal exposures and provides instant results; used as a personal alarm.</p> <p>Specific to type of radiation.</p> <p>Easy to use.</p> <p>Moderate to high cost.</p>

## Environmental & Personal Air Monitoring Devices

<b>Hazard</b>	<b>Device</b>	<b>Description</b>
<p><b>Temperature</b></p> <ul style="list-style-type: none"> <li>○ Heat/Humidity</li> <li>○ Cold/Wind</li> </ul>	<p><b>Thermometer</b></p> 	<p>Measures air temperature.</p> <p>Simple to use.</p> <p>Accurate device.</p> <p>Survey instrument.</p> <p>Real time measurement.</p> <p>Varies in cost.</p>
	<p><b>Wet Bulb Globe Temperature (WBGT)</b></p> 	<p>Estimates the effect of temperature, humidity, and solar radiation.</p> <p>Requires training to use.</p> <p>Accurate device.</p> <p>Calibration required.</p> <p>Measures personal exposures.</p> <p>High cost.</p>
	<p><b>Thermo-Anemometer</b></p> 	<p>A measure wind speed and calculates wind chill temperature.</p> <p>Simple to use.</p> <p>No calibration required.</p> <p>Real time instant reading.</p> <p>Moderate to high cost.</p>

### Wet Bulb Globe Temperature (WBGT)

The Wet Bulb Globe Temperature (WBGT) is a composite temperature used to estimate the effect of temperature, humidity, and solar radiation on humans.

Portable heat stress meters or monitors are used to measure heat conditions. These instruments can calculate both the indoor and outdoor WBGT index. With this information and information on the type of work being performed, heat stress meters can determine how long a person can safely work or remain in a particular hot environment.



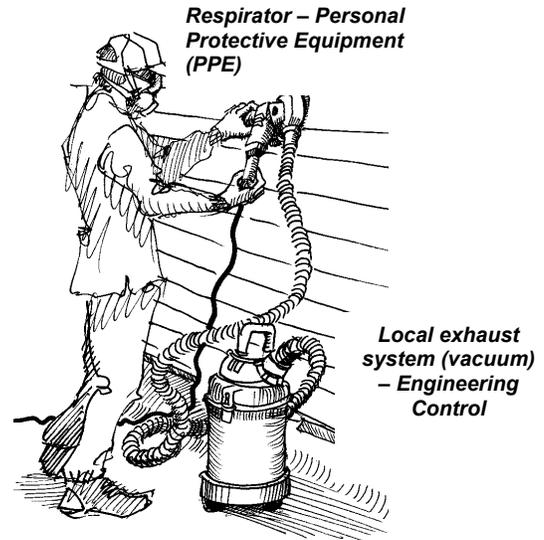
**Quest Technologies  
Wet Bulb Globe Temperature  
(WBGT) Device**

## Control of Health Hazards

### **Hazard Abatement**

To abate a hazard means to eliminate its effects; this would cause a worker who might otherwise be exposed to a hazard not be exposed by means of one or more control strategy. These control strategies are chosen by preference according to the *hierarchy of controls*.

***Implementing control strategies, such as engineering controls, safe work practices and wearing personal protective equipment will stop health hazards on your job!***



### **Hierarchy of Controls**

(See *Hierarchy of Controls*, page 32)

Controlling exposures to occupational hazards is the fundamental method of protecting workers. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective controls.

***OSHA requires that employers use the hierarchy of controls in order of preference for protecting the worker.***

#### ***Hierarchy of controls in order of preference:***

1. ***Elimination of hazard;*** Substitution with safe alternative.
2. ***Engineering;*** Ventilation & wet methods.
3. ***Administrative;*** Work practices, scheduling workers to minimize exposure, extended breaks, etc.
4. ***Personal Protective Equipment (PPE);*** Respiratory and hearing protection, protection of face, hand, feet, eyes & whole body.

## Job Hazard Analysis

A job hazard analysis (JHA) is a technique that focuses on the relationship between the worker, the task, the tools, and the work environment; it's an essential first step that helps an industrial hygienist determine the sources of potential problems.

During a **job hazard analysis**, a competent industrial hygienist will examine all **materials & equipment** being used; look at the **process** in which work is being performed and assess the **people** performing the work.

**Questions that are asked during a job hazard analysis are...**

### What is it?

**Materials & Equipment** – What building materials, chemicals, tools and equipment are being used; what is the likelihood that these things will cause a potential health hazard (gases, vapors, fumes, dusts/fibers, noise, vibration, radiation, etc.)?



### How does it?

**Process** – How & where is the work being performed; potential health hazards can turn into toxic exposures if the process is not controlled.



### Who are exposed?

**People** – Who are exposed to the hazards; are these workers properly trained, qualified and wearing appropriate personal protective equipment (PPE)?



## Job Hazard Analysis Example

**Look at the pictures and complete the analysis...**

Job/Task:

---

---

---

What are the hazards?

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How & who are exposed?

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What controls are being implemented?

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What (if any) further controls need to be implemented?

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## The Value of a Job Hazard Analysis

Supervisors can use the findings of a job hazard analysis to eliminate and prevent hazards in their workplaces. This is likely to result in fewer worker injuries and illnesses; safer, more effective work methods; reduced workers' compensation costs; and increased worker productivity.

The analysis also can be a valuable tool for training new employees in the steps required to perform their jobs safely.

Determining whether a health hazard exists at your worksite is based on a combination of factors including observation, interviews, and measurements of the level of air contaminants arising from the work processes as well as an evaluation of the effectiveness of control measures in the workplace. These environmental measurements are then compared to acceptable exposure levels, such as OSHA standards or other guidelines.

## Use of Professionals & Consultants

If the work involves many different or complex processes, a professional may be needed to help conduct job-site evaluation and personal exposure monitoring. Sources of help include insurance companies, contractor associations, trade unions, and private consultants with safety and health expertise.

OSHA offers assistance through its regional and area offices and consultation services. Contact your local OSHA office for more information.

Even when outside help is received, it is important that all employees remain involved in the process of identifying and correcting hazards because job-site conditions change every day. New circumstances and a recombination of existing circumstances may cause old hazards to reappear and new hazards to appear. In addition, employees must be ready and able to implement whatever hazard elimination or control measures a professional consultant recommends.

### ***Occupational Health Teams***

The goal of a multidisciplinary occupational health and safety team is to design, implement, and evaluate a comprehensive health and safety program that will maintain and enhance health, improve safety, and increase productivity. Such programs often provide similar results for the families of workers, with resultant financial and other benefits for the corporation. Occupational health and safety professionals include occupational and environmental health nurses, occupational medicine physicians, industrial hygienists, safety professionals, and occupational health psychologists. Other related members of the multidisciplinary team are ergonomists, toxicologists, epidemiologists, human resource specialists, and industrial/organizational psychologists.



***The most important member of the health team is you!***

## Review

*Match the letter to correct acronym, word or phrase...*

\_\_\_\_\_ **Industrial Hygiene**  
\_\_\_\_\_ **Job Hazard Analysis**  
\_\_\_\_\_ **Hazard Abatement**  
\_\_\_\_\_ **Toxicology**

- a. A technique that focuses on the relationship between the worker, the task, the tools, and the work environment; it's an essential first step that helps an industrial hygienist determine the sources of potential problems.
- b. The art and the science of **anticipating**, **recognizing**, **evaluating**, and **controlling** workplace conditions that may cause workers' injury or illness.
- c. An action taken that would cause a worker who might otherwise be exposed to a hazard not be exposed by means of one or more control strategy.
- d. The science that studies the poisonous or toxic properties of a substance.

# OCCUPATIONAL SAFETY & HEALTH ADMINISTRATION (OSHA)

## ***Learning Goals:***

- Identify the Occupational Safety and Health Administration (OSHA) as being the authority for protecting worker's health and safety on the job.
- Recognize both employer and employee rights and responsibilities under OSHA law.

## ***Important Terms:***

- OSHA
- OSHA's General Duty Clause
- Worker rights under OSHA Law

## **You Have A Right!**

The Occupational Safety and Health Act of 1970 (OSHAct) was passed by the United States Congress to prevent workers from being killed or seriously harmed at work. The law requires that employers provide their employees with working conditions that are free of known dangers. The Act created the Occupational Safety and Health Administration (OSHA), which sets and enforces protective workplace safety and health standards.



## **Occupational Safety & Health Act of 1970**

### ***OSHA Duties...***

To assure safe and healthful working conditions for working men and women; by authorizing enforcement of the standards developed under the OSHAct; by assisting and encouraging the States in their efforts to assure safe and healthful working conditions; and by providing research, information, education, and conducting training in the field of occupational safety and health.

An important section of the OSHA Act is the General Duty Clause.

## General Duty Clause

### 5. Duties

#### (a) Each employer

- (1) Shall furnish to 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 his employee;
- (2) Shall comply with occupational safety and health standards promulgated under this Act.

(b) Each employee shall comply with occupational safety and health standards and all rules, regulations, and orders issued pursuant to this Act which are applicable to his own actions and conduct.

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### ***What is OSHA's General Duty Clause?***

Section 5(a)(1) of the Occupational Safety and Health Act of 1970 has become known as the “**General Duty Clause**”. It is a catch all for citations if OSHA identifies unsafe conditions to which a regulation does not exist.

If the following elements are present, a “General Duty Clause” citation may be issued:

- (1) An employer failed to keep the workplace free of a hazard to which employees of that employer were exposed.
- (2) The hazard was recognized. (Examples might include: through job-site safety personnel, employees, trade unions and other associations/organizations.)
- (3) The hazard was causing or was likely to cause death or serious physical harm.
- (4) There was a feasible and useful method to correct the hazard.

***OSHA believes there is always a feasible and useful method to correct any and all health hazards!***

## Health Hazards are Recognized by OSHA

A number of health related hazards in construction have been well documented over the years. We all heard of asbestos and the deadly lung disease asbestosis; because of the risks associated with working with and around asbestos, an OSHA standard was established.

Other health hazards are regulated as well, e.g., lead fumes and dusts, noise and standards relating to specific chemicals have been put into effect to protect the worker. It is not possible to address all potential health related issues in regulations; however, OSHA does have policies on how to hold employers accountable to exposing their employees to harmful substances that are not otherwise addressed in its standards to protect health (*see OSHA Enforcement Policy, page 217*).

With a general understanding of how to anticipate, recognize and control exposures to occupational health hazards, and by knowing where to obtain information about a particular substance (chemical); a contractor will be better prepared to make good decisions that will have a positive affect on their workers' health.

*To learn more about OSHA standards and the health hazards associated with your job, go to [www.osha.gov](http://www.osha.gov)*

***Learn all there is to know about the health hazards on your job!***

***Stop health hazards before they stop you!***

- Lung Disease
- Skin Irritation & Rashes
- Hearing Loss
- Cumulative Trauma Disorders
- Cancer
- Death!



**Job Safety and Health  
IT'S THE LAW!**

**OSHA**  
Occupational Safety  
and Health Administration  
U.S. Department of Labor

**EMPLOYEES:**

- You have the right to notify your employer or OSHA about workplace hazards. You may ask OSHA to keep your name confidential.
- You have the right to request an OSHA inspection if you believe that there are unsafe and unhealthful conditions in your workplace. You or your representative may participate in that inspection.
- You can file a complaint with OSHA within 30 days of retaliation or discrimination by your employer for making safety and health complaints or for exercising your rights under the OSH Act.
- You have a right to see OSHA citations issued to your employer. Your employer must post the citations at or near the place of the alleged violation.
- Your employer must correct workplace hazards by the date indicated on the citation and must certify that these hazards have been reduced or eliminated.
- You have the right to copies of your medical records or records of your exposure to toxic and harmful substances or conditions.
- Your employer must post this notice (OSHA 3165-12-06R) in your workplace.
- You must comply with all occupational safety and health standards issued under the *OSH Act* that apply to your own actions and conduct on the job.

**EMPLOYERS:**

- You must furnish your employees a place of employment free from recognized hazards.
- You must comply with the occupational safety and health standards issued under the *OSH Act*.

**This free poster available from OSHA - *the Best Resource for Safety and Health***

Free assistance in identifying and correcting hazards or complying with standards is available to employers, without citation or penalty, through OSHA-supported consultation programs in each state.

1-800-321-OSHA  
[www.osha.gov](http://www.osha.gov)

OSHA 3165-12-06R

## Refusing to Work because Conditions are Dangerous

Workers have the right to refuse to do a job if they believe in good faith that they are exposed to an *imminent danger*. "Good faith" means that even if an imminent danger is not found to exist, the worker had reasonable grounds to believe that it did exist.

### ***Refusing work is protected if...***

***Your right to refuse to do a task is protected if all of the following conditions are met:***

- Where possible, you have asked the employer to eliminate the danger, and the employer failed to do so; and
- You refused to work in "good faith." This means that you must genuinely believe that an imminent danger exists. Your refusal cannot be a disguised attempt to harass your employer or disrupt business; and
- A reasonable person would agree that there is a real danger of death or serious injury (illness); and
- There isn't enough time, due to the urgency of the hazard, to get it corrected through regular enforcement channels, such as requesting an OSHA inspection.

***When all of these conditions are met, you take the following steps:***

- Ask your employer to correct the hazard;
- Ask your employer for other work;
- Tell your employer that you won't perform the work unless and until the hazard is corrected; and
- Remain at the worksite until ordered to leave by your employer.

IF	THEN
You believe working conditions are unsafe or unhealthful.	Call your employer's attention to the problem.
Your employer does not correct the hazard or disagrees with you about the extent of the hazard.	You may file a complaint with OSHA.
Your employer discriminates against you for refusing to perform the dangerous work.	Contact OSHA immediately. (800) 321-OSHA

## Review

*Match the letter to correct acronym, word or phrase...*

_____	<b>OSHA (acronym)</b>
_____	<b>Employer responsibilities under OSHA law.</b>
_____	<b>Worker responsibilities under OSHA law.</b>
_____	<b>Your employer discriminates against you for refusing to perform dangerous work.</b>

- a.** Employer must post employee rights notice (OSHA 3165-12-06R) in the workplace.
- b.** Occupational Safety & Health Administration
- c.** Contact OSHA immediately!
- d.** You must comply with all occupational safety and health standards.

# HEALTH STANDARDS IN CONSTRUCTION

## ***Learning Goals:***

- Overview OSHA's health standards in construction.
- Be introduced to the American Conference of Governmental Industrial Hygienists (ACGIH)®
- Be introduced to the National Institute for Occupational Safety and Health (NIOSH).
- Become familiar with the terms and definitions used to describe occupational limits relating to health hazards.
- Identify OSHA's special emphasis programs and compliance directives for enforcing health standards in construction.

## ***Important Terms:***

- Hierarchy of Controls
- Permissible Exposure Limit (PEL)
- Action Level (AL)
- Ceiling (C)
- American Conference of Governmental Industrial Hygienists (ACGIH)®
- Threshold Limit Value (TLV)®
- National Institute for Occupational Safety & Health (NIOSH)
- Recommended Exposure Limit (REL)
- Short Term Exposure Limit (STEL)
- OSHA Special Emphasis Programs for Health

## Health Standards in Construction Overview

OSHA's health standards in construction addresses issues such as; the ***availability of medical services and first aid, sanitation of the job-site*** (toilet facilities), the ***availability of water*** (potable and non-potable), ***eating and drinking areas*** and ***vermin control***.

Health standards also cover exposures to air contaminants and other materials that can lead to illness and disability. These standards regulate ***chemicals*** in the forms of ***gases, vapors, fumes, dusts, fibers and mists; noise and radiation***.

***OSHA currently regulates exposure to approximately 400 substances!***

## **Medical Services & First Aid** (29 CFR 1926.50)

- The employer must insure the availability of medical personnel for advice and consultation on matters of occupational health.
- Provisions must be made prior to commencement of the project for prompt medical attention in case of serious injury.
- In the absence of an infirmary, clinic, hospital, or physician, that is reasonably accessible in terms of time and distance to the worksite, which is available for the treatment of injured employees, a person who has a valid certificate in first-aid training must be available at the worksite to render first aid.
- First aid supplies must be easily accessible when required.

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### **First Aid Kits...**

***First aid kits must be available on all job-sites where a hospital, clinic or physician is not available in terms of time and distance. Persons must be trained to use these supplies and be willing to give care.***

***An automated electronic defibrillator (AED) is highly recommended.***



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## **Medical Services & First Aid** (29 CFR 1926.50)

- The contents of the first aid kit must be placed in a weatherproof container with individual sealed packages for each type of item, and shall be checked by the employer before being sent out on each job and at least weekly on each job to ensure that the expended items are replaced.
- Proper equipment for prompt transportation of the injured person to a physician or hospital, or a communication system for contacting necessary ambulance service, must be provided.
- In areas where 911 is not available, the telephone numbers of the physicians, hospitals, or ambulances must be conspicuously posted.
- Where the eyes or body of any person may be exposed to injurious corrosive materials, suitable facilities for quick drenching or flushing of the eyes and body must be provided within the work area for immediate emergency use.

## First Aid Kits

### Appendix A to § 1926.50 -- First aid Kits

Minimal contents of a generic first aid kit as described in American National Standard (ANSI) Z308.1 "Minimum Requirements for Industrial Unit-Type First-aid Kits".

<i>Item</i>	<i>Minimum Size or Volume</i>	<i>Quantity per Package</i>	<i>Unit Package Size</i>
Absorbent compress	32 sq. in.	1	1
Adhesive bandage	1" x 3"	16	1
Adhesive tape	5 yd. (total)	1 or 2	1 or 2
Antibiotic treatment	1/32 oz.	6	1
Antiseptic swab	0.14 fl. oz.	10	1
Antiseptic towelette	24 sq. in.	10	1
Bandage compress (2 in.)	2" x 36"	4	1
Bandage compress (3 in.)	3" x 60"	2	1
Bandage compress (4 in.)	4" x 72"	1	1
Burn dressing	4" x 4"	1	1 or 2
Burn treatment*	1/32 oz.	6	1
CPR barrier		1	1 or 2
Cold pack (4" x 5")	4" x 5"	1	2
Eye covering, with means of attachment	2.9 sq. in.	2	1
Eye wash	1 fl. oz. total	1	2
Gloves		2 pair	1 or 2
Roller bandage (4 in.)	4" x 6 yd.	1	1
Roller bandage (2 in.)	2" x 6 yd.	1	1
Sterile pad	3" x 3"	2	1
Triangular bandage	40" x 40" x 56"	4	1

\* **Do not** put ointment on a burn unless a healthcare provider tells you to do so.

## **Sanitation of Job-Sites** (29 CFR 1926.51)

- An adequate supply of potable water (drinking water) must be provided in all places of employment.
- Portable containers used to dispense drinking water must be capable of being tightly closed, and equipped with a tap. Water must not be dipped from containers.
- Any container used to distribute drinking water must be clearly marked as to the nature of its contents and not used for any other purpose.
- The common drinking cup is prohibited.
- Toilets must be provided for employees and cleaned regularly.



**Potable water (drinking water) must be made available on all job-sites. To ensure freshness, seal the container with tape – record date and time.**

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## **Washing Facilities** [29 CFR 1926.51(f)]

### **Good health starts with good hygiene!**

- The employer must provide adequate washing facilities for employees engaged in the application of paints, coatings, herbicides, or insecticides, or in other operations where contaminants may be harmful to the employees. Such facilities must be in near proximity to the worksite and must be so equipped as to enable employees to remove such substances.
- Washing facilities must be maintained in a sanitary condition.



**Portable washing facilities on construction job-sites will help to ensure proper hygiene and worker health.**

## ***Eating and Drinking Areas*** [29 CFR 1926.51(g)]

- No employee shall be allowed to consume food or beverages neither in a toilet room nor in any area exposed to a toxic material.



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## ***Vermin Control*** [29 CFR 1926.51(h)]

- Every enclosed workplace must be so constructed, equipped, and maintained, so far as reasonably practicable, as to prevent the entrance or harborage of rodents, insects, and other vermin. A continuing and effective extermination program must be instituted where their presence is detected.



## OSHA – Permissible Exposure Limit (PEL)

### *What is a Permissible Exposure Limit?*

Health standards relating to exposure to gases, vapors, fumes, dusts/fibers and mists; noise and radiation, require some extra explanation. These standards limit the amount or concentration of a material (chemical, noise or radiation) that can be present in the workplace. To describe the limits, or amounts of these exposures, the term **Permissible Exposure Limit (PEL)** is used.

**Permissible Exposure Limit (PEL);** a legal standard set by OSHA for the maximum concentration of a chemical or substance in the air.

**IMPORTANT!** *To comply with OSHA’s health standards related to environmental exposures to harmful gases, vapors, fumes, dust/fibers & mists; noise and radiation, employers must first attempt to eliminate or reduce exposure through **administrative or engineering controls.***

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### **Complying with OSHA Health Standards**

#### **To achieve compliance with OSHA’s health standards:**

- **Administrative or engineering controls** must first be implemented whenever feasible.
- When administrative or engineering controls are not feasible to achieve full compliance, protective equipment or other protective measures must be used to keep the exposure of employees to air contaminants within the limits prescribed.
- Any equipment and technical measures used for this purpose must first be approved for each particular use by a competent industrial hygienist or other technically qualified person.
- Whenever respirators are used, their use must comply with OSHA’s respiratory protection standard (29 CFR 1910.134).

## ACGIH–Threshold Limit Value (TLV) ®

When OSHA started, it was given the task of enforcing safety and health regulations; in the beginning however, OSHA had no reference as to what is considered unhealthy or a health related violation. So, in an effort to put in place health standards, OSHA incorporated by reference the existing Threshold Limit Values (TLVs)® of Airborne Contaminants for 1970 of the American Conference of Governmental Industrial Hygienists (ACGIH).

(See OSHA Standard, 29 CFR 1926.55)

### *The American Conference of Governmental Industrial Hygienists (ACGIH)*

Since the early 1900's, the ACGIH has been investigating, recommending, and annually reviewing exposure limits for chemical substances. The best known efforts by the ACGIH is the creation of the *Threshold Limit Values of Airborne Contaminants*; this publication contains a list of contaminants and their respected Threshold Limit Values (TLVs)®. Today's list of TLVs® includes 642 chemical substances and physical agents, as well as 47 Biological Exposure Indices (BEIs)® for selected chemicals.

For more information on the ACGIH, visit their website at [www.acgih.org](http://www.acgih.org)

### **OSHA Standard:**

#### **29 CFR 1926.55 Gases, Vapors, Fumes, Dusts (Fibers) & Mists...**

*Exposure of employees to inhalation, ingestion, skin absorption, or contact with any material or substance at a concentration above those specified in the "Threshold Limit Values of Airborne Contaminants for 1970" of the American Conference of Governmental Industrial Hygienists, shall be avoided!*

**Threshold Limit Value (TLV)®;** Levels of contaminants established by the American Conference of Governmental Industrial Hygienists (ACGIH) to which it is believed that workers can be exposed to with minimal adverse health effects.

**NOTE:** When OSHA started in the early 1970's, the Administration (OSHA) incorporated the ACGIH TLVs® into their construction safety and health regulations (29 CFR 1926). The standard reference is 29 CFR 1926.55; this makes any exposure above any listed 1970 ACGIH TLV® a violation of OSHA rule. (See 29 CFR 1926.55 Appendix A, page 219). Any new standards established by OSHA through its rule making process are issued Permissible Exposure Limits (PELs); the TLVs of these substances are then removed from 29 CFR 1926.55 Appendix A and are given their own standard number.

## NIOSH – Recommended Exposure Limit (REL)

The Occupational Safety and Health Act of 1970 created both NIOSH (National Institute for Occupational Safety & Health) and the Occupational Safety and Health Administration (OSHA). OSHA is in the U.S. Department of



[www.cdc.gov/niosh](http://www.cdc.gov/niosh)

Labor and is responsible for developing and enforcing workplace safety and health regulations. NIOSH is part of the Centers for Disease Control and Prevention (CDC) in the Department of Health and Human Services. NIOSH is an agency established to help assure safe and healthful working conditions for working men and women by providing research, information, education, and training in the field of occupational safety and health.

A Recommended Exposure Limit (REL) is an occupational exposure limit that has been recommended by NIOSH to the Occupational Safety and Health Administration (OSHA).

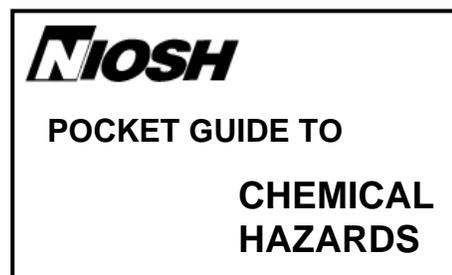
**Recommended Exposure Limit (REL);** Levels that NIOSH believes would be protective of worker safety and health over a working lifetime if used in combination with engineering and work practice controls, worker training and personal protective equipment.

 **RELs are usually highly protective to health and are often used as best practices in industry.**

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## NIOSH Pocket Guide to Chemical Hazards

The NIOSH Pocket Guide to Chemical Hazards is a publication of NIOSH and is intended as a source of general industrial hygiene information on several hundred chemicals/classes for workers, employers, and occupational health professionals. The information found in the NIOSH Pocket Guide should help users recognize and control occupational chemical hazards.



*For more information on NIOSH and to access the Pocket Guide to Chemical Hazards, go to [www.cdc.gov/niosh](http://www.cdc.gov/niosh)*

## ***Time Weighted Average (TWA)***

**The 8-Hour Time Weighted Average (TWA)** is the average employee exposure over an 8-hour period, based on chemical measurements close to the worker. The measured level may sometimes go above the TWA value, as long as the 8-hour average stays below it. Most chemicals with PELs have a TWA value. Some chemicals have **Ceiling** or **Short Term Exposure Limits** in addition to – or instead of – TWA values.

## ***Action Level (AL)***

The exposure level (concentration in air) at which some OSHA regulations set to protect employees takes effect; for example, workplace air analysis, employee training, medical monitoring, and recordkeeping. Exposure at or above action level is termed occupational exposure. Exposure below this level can also be harmful. This **Action Level (AL)** is generally half the PEL.

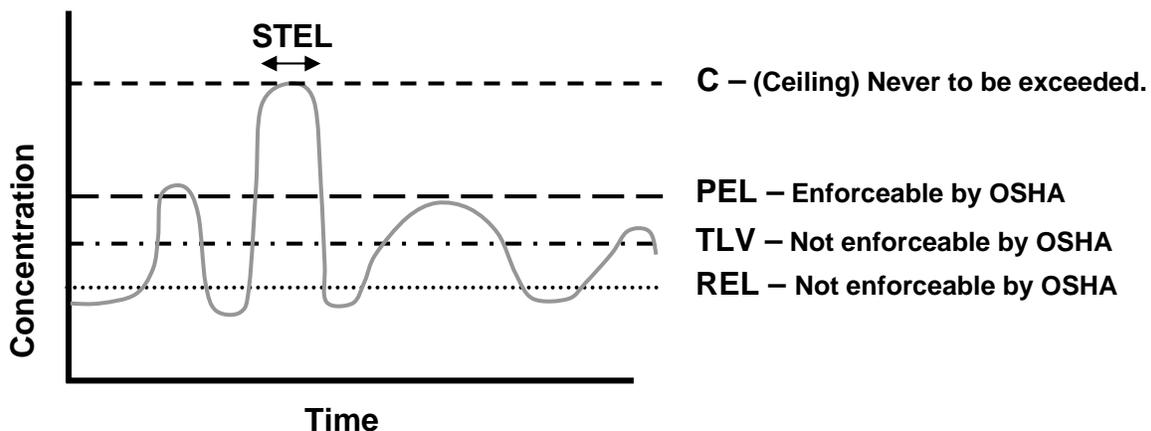
## ***Ceiling Limit (C)***

The **Ceiling Limit (C)** is the maximum allowable level. It must never be exceeded, even for an instant.

## ***Short Term Exposure Limit (STEL)***

The **Short Term Exposure Limit (STEL)** is a level that must not be exceeded when averaged over a specified short period of time (usually 15 minutes). When there is an STEL for a substance, exposure still must never exceed the Ceiling Limit, and the 8-hour average still must remain at or below the TWA.

## ***Exposure Limit Comparison Chart***



## Hierarchy of Controls

Controlling exposures to occupational hazards is the fundamental method of protecting workers. Traditionally, a hierarchy of controls has been used as a means of determining how to implement feasible and effective controls.

***OSHA requires that employers use the hierarchy of controls in order of preference for protecting the worker.***

### ***Hierarchy of controls in order of preference:***

1. ***Elimination of hazard;*** Substitution with safe alternative.
2. ***Engineering;*** Ventilation & wet methods.
3. ***Administrative;*** Work practices, scheduling workers to minimize exposure, extended breaks, etc.
4. ***Personal Protective Equipment (PPE);*** Respiratory and hearing protection, protection of face, hand, feet, eyes & whole body.

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The idea behind this hierarchy is that the control methods at the top of the list are potentially more effective and protective than those at the bottom. Following the hierarchy normally leads to the implementation of inherently safer job-sites, ones where the risk of illness or injury has been substantially reduced.

**Elimination & Substitution**  
**Engineering**  
**Administration**  
**PPE**

## Elimination & Substitution

**Elimination** and **substitution**, while most effective at reducing hazards, also tend to be the most difficult to implement in an existing process or job-site. If the project is still at the design or development stage, elimination and substitution of hazards may be inexpensive and simple to implement. For an existing process, major changes in equipment and procedures may be required to eliminate or substitute for a hazard.

### **Elimination & Substitution include:**

- Automate the process by using equipment; remove or isolate the worker.
- Select and use a less toxic chemical; in an effort to reduce occupational illness, chemical manufacturers' have created less harmful substitutes.
- Sub-contract out jobs to more qualified people; know the limitations of your workers and be prepared to solicit the services of specially trained and equipped contractors. Some work may require a special license, i.e. lead & asbestos.

NIOSH/John Rekus/elcoshimages.org



**Elimination & Substitution Example...  
Skid steer loader with pneumatic hammer.**

### **Elimination & Substitution Example...**

**Demolition of structure using mechanical shears; combined with the safe work practice of spraying water will significantly reduce worker exposure to harmful dust.**



## Engineering Controls

**Engineering controls** are used to remove a hazard or place a barrier between the worker and the hazard. This barrier can be placed at the source of the hazard, between the source and the worker, or at the worker. Well-designed engineering controls can be highly effective in protecting workers and will typically be independent of worker interactions to provide this high level of protection. The initial cost of engineering controls can be higher than the cost of administrative controls or personal protective equipment, but over the longer term, operating costs are frequently lower, and in some instances, can provide a cost savings in other areas of the process. Examples of engineering controls include, **wet methods**, **mechanical ventilation** and **dust collection systems**.

**Engineering controls include:**

- Using dust suppression (**wet methods**) and/or dust collection systems.

OR

- Installing and using **mechanical ventilation**; general (dilution) and local (exhaust) ventilation systems.



**Engineering Control Example...**  
**Water suppression system on concrete saw.**

NIOSH/John Rekus/elcoshimages.org

**Engineering Control Example...**

**Dust suppression system on concrete saw using supplied water.**



## Dust Suppression & Collection Systems

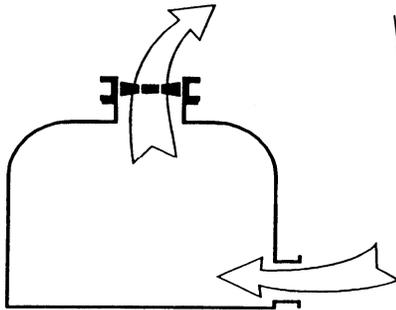
Some studies have shown that wet cutting methods can reduce average respirable dust levels by up to 94 percent. However, if an employer determines that the use of a wet saw in a particular circumstance is not feasible, and the brick, concrete block or masonry must be cut dry, then the employer would be required to explore other engineering control options. Dust collection systems can be used, but they are typically not sufficient to reduce exposures below permissible limits and employees will usually need to be protected with appropriate respirators as well; monitoring the air will confirm exposure.



**Engineering Control Example...**  
Dust collection system in use while worker is wearing respirator.

## Mechanical Ventilation

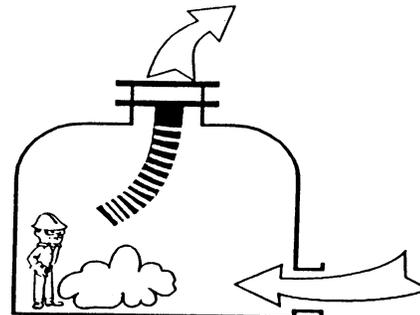
Mechanical ventilation consists of either **general (dilution)** ventilation systems or **local (exhaust)** systems.



### General (Dilution) Ventilation...

**Forces fresh air into an area and dilutes contaminants; this allows air to move through a space which ensures a fresh continual supply.**

**WARNING! Pure oxygen must never be used for ventilation purposes.**



### Local (Exhaust) Ventilation...

**Removes contaminated air at its source; this prevents harmful dust, fumes & mists from contaminating the breathing air of the worker.**

**WARNING! Contaminated air exhausted from a working space must be discharged into the open air or otherwise clear of the source of intake air.**

## General (Dilution) Ventilation

**General (dilution)** ventilation must be of sufficient capacity and so arranged as to produce the number of air changes necessary to maintain breathing air to safe limits, as defined by OSHA permissible exposure limits (PELs).

**General (dilution) ventilation works best when:**

- Air contaminants are widely dispersed throughout the area.
- Toxicity levels and concentrations are low.

General (dilution) ventilation can be applied to most jobs by simply opening a window or door and blowing fresh air into a space using a fan. *Turn the fan around to blow air out and it becomes an exhaust ventilation system.*



**Ventilation Systems Examples...**  
*Air moving equipment can be set up to either blow (dilute) or suck (exhaust).*



## Local (Exhaust) Ventilation

**Local (exhaust)** ventilation consists of freely movable hoods intended to be placed by the welder or burner as close as practicable to the work. This system must be of sufficient capacity and so arranged as to remove fumes and smoke at the source and keep the concentration of them in the breathing zone within safe limits as defined by OSHA permissible exposure limits (PELs).

**Local (exhaust) ventilation works best when:**

- Air contaminants are generated at a single source.
- There's a need to remove high levels and concentrations of a toxic material.



*Courtesy of Sentry Air Systems, Inc.  
Houston, TX USA  
Model 300 Welding Fume Extractor  
[www.sentryair.com](http://www.sentryair.com)*

## Administrative Controls

**Administrative controls** are changes in work procedures such as written safety policies, rules, supervision, schedules, and training with the goal of reducing the duration, frequency, and severity of exposure to hazardous chemicals or situations.

### Administrative controls include:

- Gathering all specialty equipment, including, ventilators, warning signs, personal protective equipment, etc. before starting work.
- Performing operations that involve toxic substances at times when other workers are not present.
- Isolate the work to a few employees.
- Rotating workers through various job assignments.
- Prohibiting workers from working around hazardous substances once they have reached a predetermined level of exposure.
- Requiring workers in hot environments to take breaks in cool rest areas and providing fluids for rehydration.
- Prohibiting worker access to areas involving hazards such as lasers, toxic materials, or excessive noise.



**Administrative Control Example... Posting signs is often required under certain regulations.**

## Isolate the Work

Isolation is a method of limiting exposure to only those employees directly working with a particular substance. It may be as simple as erecting signs and barricades to keep non-essential personnel away from potential exposure areas. The area inside the barricades is known as a regulated area.



## Work Practice Controls

Safe work practices include your company's general workplace rules and other operation-specific rules. For example, even when a hazard is controlled, exposure can occur if the worker is not familiar with such controls.

### Train employee on...

- Proper housekeeping & good personal hygiene.
- The proper procedures that minimize exposures.
- How to inspect and maintain process and equipment on a regular basis.
- No eating, drinking, smoking, chewing tobacco or gum, and applying cosmetics in hazardous areas.



**Frequent hand washing will help to prevent sickness and disease.**

## **Work Practice Control Example – Dust Control**

Sweeping and the blowing of dust creates an inhalation hazard; consider the use of a vacuum to clean up job-sites.

**Take precautions while sweeping!**

### **Safe work practices while sweeping:**

- Use a sweeping compound to reduce airborne dust.
- Wear personal protective equipment (respirator).
- Schedule clean-up operations appropriately.
- Warn others and clear the area of those who are affected by the dust and are not protected.



**Sweeping hazard!**

## **How to Use a HEPA Vacuum**

A preferred method of controlling dust on a job-site is to use a vacuum; using a high efficiency particulate air (HEPA) vacuum will keep exposure levels down and minimize worker exposure to harmful dust.

### **To use a HEPA vacuum:**

- Lightly mist area with water to keep dust levels down. Some HEPA vacuums can combine a wet wash with the vacuum. Read the manufacturer's instructions on how to use it.
- Begin with high areas first. Clean ceilings and walls working downward. Vacuum all surfaces in the room. Work in the direction furthest from the entry door toward it.
- Move slowly.
- Remember, dust can stick to surfaces. Vacuum slowly so the HEPA vacuum can pick up all the dust.



**Using vacuum technology will greatly reduce exposure to the inhalation of dust and potential toxins.**

## Personal Protective Equipment (PPE)

Controlling a hazard at its source is the best way to protect workers. However, when engineering, work practices and administrative controls are not feasible or do not provide sufficient protection, employers must provide **personal protective equipment (PPE)** to the employee and ensure its proper use.

***Personal protective equipment (PPE) can only be used as a last resort!***

***Consideration and use of PPE is only allowed when:***

- Engineering controls and/or work practices are not **feasible**;
- Engineering controls or work practices are being implemented;
- Engineering controls or work practices do not effectively reduce exposure to acceptable limits, or;
- In cases of emergency (e.g., confined space rescue, area evacuation, etc.)



***Personal Protective Equipment Example...  
Chemical resistant suit, gloves, safety glasses and face shield.***

### ***Feasible (Definition)***

There are two key factors that would determine whether a control is feasible or not: **technological feasibility** and **economic feasibility**.

**Technologically feasible**; this is fairly straight forward, as long as all engineering and administrative controls are being implemented and yet levels still remain above permissible exposure limits (PELs), then in respect to the work being done; it is technologically not feasible to reduce exposures any lower. PPE may be worn in addition to engineering controls and administrative controls.

**Economic feasible**; OSHA would consider administrative or engineering controls economically feasible when the cost of implementing such controls will not threaten the employer's ability to remain in business, or if such a threat to viability results from the employer's failure to meet industry safety and health standards.

**OSHA interprets the term "feasible" to conform to its ordinary meaning... "Capable of being done"; if a recognized and accepted engineering or administrative control exists, it must be implemented before allowing the use of personal protective equipment, such as respirators and hearing protectors.**

## ***Important Concerns Regarding PPE***

The purpose of protective clothing and equipment is to shield or isolate individuals from the chemical, physical, and biological hazards that may be encountered; PPE does not eliminate any hazard. During some operations, it is not always apparent when exposure occurs. Some hazards are invisible and offer no warning.

### ***Important considerations for PPE:***

- No one piece of protective equipment and clothing is capable of protecting against all hazards.
- The use of protective clothing can itself create significant wearer hazards, such as heat stress, physical and psychological stress, in addition to impaired vision, mobility and communication.

*NIOSH/Pam Sussi/elcoshimages.org*



***Worker protected with a powered air purifying respirator (PAPR) while using a grinder.***

In general, the greater the level of protective clothing, the greater the associated risks, and for any given situation, equipment and clothing should be selected that provides an adequate level of protection. Overprotection as well as underprotection can be hazardous and should be avoided.

### ***Questions regarding personal protective equipment (PPE):***

- Is the device approved?
- Is the device appropriate for the type of hazard?
- Is the worker wearing the device properly trained to understand the use, limitations and care instructions of the device?
- Does the material have sufficient strength to withstand the physical stress of the tasks at hand?
- Will the material withstand repeated use after contamination and decontamination?
- Is the material flexible or pliable enough to allow end users to perform needed tasks?
- Will the material maintain its protective integrity and flexibility under hot and cold extremes?

**HMIS (Hazardous Materials Identification System)**, developed by the National Paint and Coatings Association (NPCA), is a numerical hazard rating that incorporates the use of labels with color-coded bars. A special code identifying appropriate personal protective equipment (PPE) is also listed.

**NOTE:** Safety glasses must conform to the American National Standards Institute (ANSI Z 87.1 – Practice for Occupational & Educational Eye and Face Protection).

**NOTE:** Gloves must be selected based on type of chemical being used (see Chemical Glove Selection Chart, page 197).

Chemical Name	
<b>HEALTH</b>	0
<b>FLAMMABILITY</b>	0
<b>PHYSICAL HAZARD</b>	0
<b>PERSONAL PROTECTION</b>	0

## HAZARDOUS MATERIALS IDENTIFICATION SYSTEM

HAZARD INDEX	
4 = SEVERE HAZARD	An asterisk (*) or other designation corresponds to additional information on a data sheet or separate chronic effects notification.
3 = SERIOUS HAZARD	
2 = MODERATE HAZARD	
1 = SLIGHT HAZARD	
0 = MINIMAL HAZARD	
Additional Information	

PERSONAL PROTECTION INDEX					
A					
B		+			
C		+		+	
D		+		+	
E		+		+	
F		+		+	
G		+		+	
H		+		+	
I		+		+	
J		+		+	
K		+		+	
X	Consult your supervisor for special handling instructions.				

A  Safety Glasses	n  Splash Goggles	o  Face Shield	p  Gloves
q  Boots	r  Synthetic Apron	s  Full Suit	t  Dust Respirator
u  Vapor Respirator	w  Dust & Vapor Respirator	y  Full Face Respirator	z  Airline Hood or Mask

Employers must provide and pay for **personal protective equipment (PPE)**.

### Personal Protective Equipment (PPE)

PPE is equipment worn to minimize exposure to a variety of hazards. Examples include items such as gloves, foot and eye protection, hearing protection, hard hats and respirators.

Employer Obligations	Worker Responsibility:
<ul style="list-style-type: none"> <li><input type="checkbox"/> Perform a “hazard assessment” of the workplace to identify and control physical and health hazards.</li> <li><input type="checkbox"/> Identify and provide appropriate PPE for employees.</li> <li><input type="checkbox"/> Train employees in the use and care of the PPE.</li> <li><input type="checkbox"/> Maintain PPE, including replacing worn or damaged PPE.</li> <li><input type="checkbox"/> Periodically review, update and evaluate the effectiveness of the PPE program.</li> </ul>	<ul style="list-style-type: none"> <li><input type="checkbox"/> Properly wear PPE.</li> <li><input type="checkbox"/> Attend training sessions on PPE.</li> <li><input type="checkbox"/> Care for, clean and maintain PPE.</li> <li><input type="checkbox"/> Inform a supervisor of the need to repair or replace PPE.</li> </ul> <p><i>Note: The employer must pay for replacement PPE, except when the employee has lost or intentionally damaged the PPE.</i></p>

### Employers Must Pay for Personal Protective Equipment (PPE)

With few exceptions, OSHA requires employers to pay for personal protective equipment used to comply with OSHA standards; employers cannot require workers to provide their own PPE. Even when a worker provides his or her own PPE, the employer must ensure that the equipment is adequate to protect the worker from hazards at the workplace.

#### **Employers are not required to pay for:**

- **Everyday clothing;** such as long-sleeve shirts, long pants and normal work boots (including protective toe).
- **Ordinary clothing;** such as winter coats, jackets and gloves.

## ***Limitations & Use of Respirators***

Engineering and work practice controls are generally regarded as the most effective methods to control exposures to airborne hazardous substances. OSHA considers the use of respirators to be the *least* satisfactory approach to exposure control because...

- All respirators leak!
- Respirators provide adequate protection only if employers ensure, on a constant basis, that they are properly fitted and worn.
- Respirators protect only the employees who are wearing them from a hazard, rather than reducing or eliminating the hazard from the workplace as a whole (which is what engineering and work practice controls do).
- Respirators are uncomfortable to wear, cumbersome to use, and interfere with communication in the workplace, which can often be critical to maintaining safety and health.

***The costs of operating a functional respiratory protection program are substantial — including regular medical examinations, fit testing, training, and the purchasing and maintenance of equipment.***

## ***Use Only NIOSH Approved Respirators!***

*Respirator examples...*



***Half-Mask Negative Pressure Air Purifying (Elastomeric Type)***



***Half-Mask Negative Pressure Air Purifying Filtering Facepiece (Disposable)***

***Prioritize your efforts*** — justify your actions using the hierarchy of controls; ensure compliance with applicable OSHA standards and adequately protect and inform employees of potential health hazards.

## Respirator Types

The appropriate respirator will depend on the contaminant(s) to which you are exposed and the protection factor (PF) required. Required respirators must be NIOSH-approved and medical evaluation, fit testing and training must be provided before use.

<p><b>Approved filtering facepieces</b> – can be used for dust, mists, welding fumes, mold, etc. They do not provide protection from gases or vapors. <b>DO NOT USE FOR ASBESTOS.</b></p>	<p>Disposable &amp; easy to breathe through – easier to use under welding hoods/helmets and with face shields.</p> <p>Least protection (rated the same as elastomeric half-face).</p> <p>Not allowed for use in atmospheres with less than 19.5% oxygen.</p>	 <p><b>Filtering Facepiece</b></p>
<p><b>Half-face respirators (elastomeric)</b> – can be used for protection against most vapors, acid gases, dust or welding fumes, mold. Cartridges/filters must match contaminant(s) and be changed periodically.</p>	<p>Can be used with a variety of cartridges/filters.</p> <p>Hard to get a good fit with some people.</p> <p>Requires regular cleaning and periodic disinfecting, requires maintenance and replacement of parts.</p> <p>Not allowed for use in atmospheres with less than 19.5% oxygen.</p>	 <p><b>Half-Face (Elastomeric)</b></p>
<p><b>Full-face respirators (elastomeric)</b> – are more protective than half-face respirators. They can also be used for protection against most vapors, acid gases, dust or welding fumes and mold. The face-shield protects face and eyes from irritants and contaminants. Cartridges/filters must match contaminant(s) and be changed periodically.</p>	<p>Can be used with a variety of cartridges/filters.</p> <p>Built in safety eye protection (ANSI Z87).</p> <p>Requires regular cleaning and periodic disinfecting, requires maintenance and replacement of parts.</p> <p>Not allowed for use in atmospheres with less than 19.5% oxygen.</p>	 <p><b>Full-Face (Elastomeric)</b></p>
<p><b>Powered-air-purifying respirators (PAPR)</b> – offers breathing comfort from a battery powered fan which pulls air through filters and blows air into the facepiece or hood. Hooded PAPR's may be worn by workers who have beards under certain circumstances. Cartridges/filters must match contaminant(s) and be changed periodically.</p>	<p>May be loose-fitting or tight-fitting.</p> <p>Can be used with a variety of cartridges/filters.</p> <p>Built in safety eye protection (ANSI Z87).</p> <p>Easier to fit, easier on heart and lungs.</p> <p>Requires regular cleaning and periodic disinfecting, requires maintenance and replacement of parts.</p> <p>Not allowed for use in atmospheres with less than 19.5% oxygen.</p>	 <p><b>Loose Fitting PAPR</b></p>
<p><b>Self-Contained Breathing Apparatus (SCBA)</b> – is used for entry and escape from atmospheres that are considered immediately dangerous to life and health (IDLH) or oxygen deficient. They use their own air tank.</p>	<p>Built in safety eye protection (ANSI Z87).</p> <p>Easier to fit.</p> <p>Requires regular cleaning and periodic disinfecting, requires maintenance and replacement of parts.</p> <p>Requires Compressed Gas Association (CGA) Grade D breathing air.</p> <p>Can be used in Oxygen deficient atmospheres (less than 19.5% oxygen).</p>	 <p><b>SCBA</b></p>

**Table 1. (29 CFR 1910.134) -- Assigned Protection Factors<sup>5</sup>**

Type of respirator <sup>1, 2</sup>	Quarter mask	Half mask	Full facepiece	Helmet/ hood	Loose-fitting facepiece
Air-Purifying Respirator	5	<sup>3</sup> 10	50	.....	.....
Powered Air-Purifying Respirator (PAPR)	.....	50	1,000	<sup>4</sup> 25/1,000	25
Supplied-Air Respirator (SAR) or Airline Respirator					
• Demand mode	.....	10	50	.....	.....
• Continuous flow mode	.....	50	1,000	<sup>4</sup> 25/1,000	25
• Pressure-demand or other positive-pressure mode	.....	50	1,000	.....	.....
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:

<sup>1</sup> 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.

<sup>2</sup> 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.

<sup>3</sup> This APF category includes filtering facepieces, and half masks with elastomeric facepieces.

<sup>4</sup> 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 WPF or 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.

<sup>5</sup> 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).

**Facial Hair**

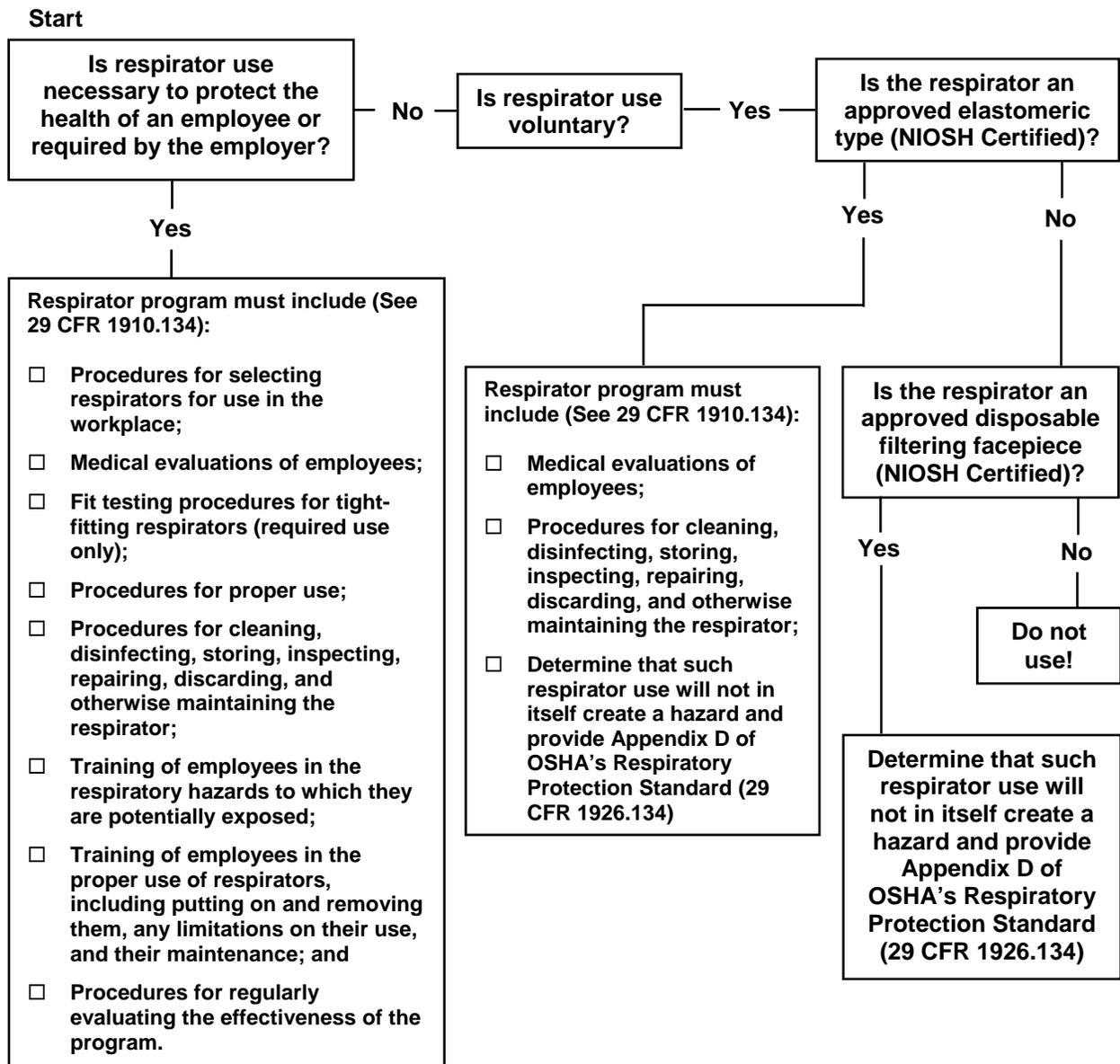
**Facial hair is not allowed while wearing a tight fitting facepiece respirator; it interferes with the fit and will allow more hazardous substances to leak into the facepiece. However, some mustaches, sideburns, and small goatees that are trimmed so that no hair underlies the seal of the respirator present no hazard and may be worn – only a properly performed fit test will ensure this.**



## Respiratory Protection Decision Flow Chart

The allowable use of a respirator depends on certain circumstances; two scenarios in which an employee may wear a respirator are:

1. **Employee must wear a respirator due to job-site conditions;** if concentrations of airborne contaminants cannot be effectively minimized to below permissible exposure limits through engineering or administrative controls then respiratory protection must be worn.
2. **Voluntary use by employee;** an employee may choose to wear a respirator under voluntary conditions when concentrations of airborne contaminants are below legal permissible exposure limits.



OSHA considers health hazards to be a priority; a team of health experts (industrial hygienists) conduct workplace inspections focusing on health related issues. Health standards and ***Special Emphasis Programs*** are written to protect the worker and to give OSHA the authority to stop unsafe work.

## OSHA's Special Emphasis Programs

***National Emphasis Programs specifically targeting health hazards in construction:***

- National Emphasis Program – Crystalline Silica (CPL 03-00-007)
- National Emphasis Program on Lead (CPL 03-00-009)
- National Emphasis Program – Hexavalent Chromium (CPL 02-02-076)

In addition to these National Emphasis Programs, OSHA provides standards and compliance guides for the following health related topics...

- Inspection Procedures for the Hazard Communication Standard – OSHA Instruction CPL 02-02-038.
- Inspection Procedures for the Respiratory Protection Standard – OSHA Instruction CPL 02-00-120.
- Inspection Procedures for Hexavalent Chromium Standard – OSHA Instruction CPL 02-02-074
- Inspection Procedures for Occupational Exposure to Asbestos – OSHA Instruction CPL 02-02-063.

***For a complete listing of health standards and OSHA Special Emphasis Programs, go to [www.osha.gov](http://www.osha.gov)***

***WARNING!*** *A cloud of dust surrounding a worker's face is a serious health hazard. This condition will not go unnoticed and is considered to be immediately dangerous to life and health!*



**Review**

*Match the letter to correct acronym, word or phrase...*

- \_\_\_\_\_ **Elimination & Substitution**
- \_\_\_\_\_ **Engineering Controls**
- \_\_\_\_\_ **Administrative Controls**
- \_\_\_\_\_ **Personal Protective Equipment**
- \_\_\_\_\_ **OSHA Special Emphasis Programs for Health**
- \_\_\_\_\_ **PEL (acronym)**
- \_\_\_\_\_ **AL (acronym)**
- \_\_\_\_\_ **C (acronym)**
- \_\_\_\_\_ **ACGIH® (acronym)**
- \_\_\_\_\_ **TLV® (acronym)**
- \_\_\_\_\_ **NIOSH (acronym)**
- \_\_\_\_\_ **REL (acronym)**
- \_\_\_\_\_ **STEL (acronym)**

- a.** Dust suppression systems and mechanical ventilation.
- b.** Good housekeeping, proper hygiene, worker rotation and effective scheduling of work.
- c.** Respirators, chemical resistant suits and gloves, hearing protection and safety glasses.
- d.** Redesigning work stations, using different tools and equipment to do a task, selecting less hazardous substances to perform a job.
- e.** Crystalline Silica (CPL 03-00-007), Lead (CPL 03-00-009) & Hexavalent Chromium (CPL 02-02-076)
- f.** Action Limit
- g.** Short Term Exposure Limit
- h.** Ceiling
- i.** National Institute for Occupational Safety & Health
- j.** Permissible Exposure Limit
- k.** American Conference of Governmental Industrial Hygienists
- l.** Threshold Limit Value
- m.** Recommended Exposure Limit

# COMPETENT PERSON

## ***Learning Goals:***

- Be able to identify the definition of competent person and know how to apply its meaning to construction job-sites.
- Identify the specific competent person requirements in OSHA's health standards.
- Learn an employer's responsibilities towards injury and illness prevention and be able to explain OSHA's employee training requirements.

## ***Important Terms:***

- Competent person**
- Qualified person**
- Industrial Hygienist**
- Program administrator**

To ensure a safe and healthful workplace, employers must designate a **competent person** to each job-site. This person has the responsibility to conduct frequent and regular inspections of the job-site, materials and equipment; this includes health related exposures. In addition to the inspection duties, a competent person will also perform regular and on-going safety training; this includes new hire worker orientation.

***Health hazard communication is an important part of a competent person's job!***

**COMPETENT PERSON** means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.



**29 CFR 1926.32(f)**

The term "**Competent**" (or similar meaning) is used in the following OSHA health related topics.

## Occupational Health and Environmental Controls

### *Ionizing radiation*

Any activity which involves the use of radioactive materials or X-rays, whether or not under license from the Nuclear Regulatory Commission, must be performed by **competent persons** specially trained in the proper and safe operation of such equipment. In the case of materials used under Commission license, only persons actually licensed, or **competent persons** under direction and supervision of the licensee, must perform such work.

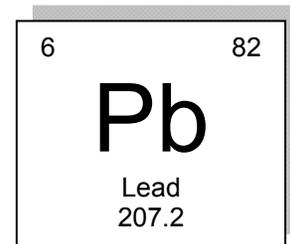


29 CFR 1926.53

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### *Lead*

The compliance (lead) program must provide for frequent and regular inspections of job sites, materials, and equipment to be made by a **competent person**.



29 CFR 1926.62

*Exposure to lead is a recognized health hazard in construction and is a leading cause of workplace illness.*



The term "**Competent**" (or similar meaning) is used in the following OSHA health related topics.

## Occupational Health and Environmental Controls

### *Gases, Vapors, Fumes, Dusts, and Mists*

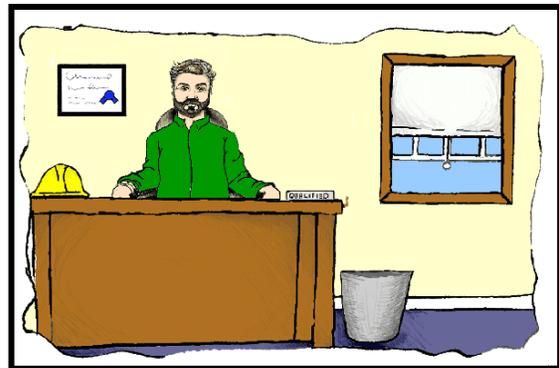
Exposure of employees to inhalation, ingestion, skin absorption, or contact with any materials or substance at a concentration above those specified in [OSHA regulations], must be avoided!

To achieve compliance with [OSHA health standards] administrative or engineering controls must first be implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or other protective measures must be used to keep the exposure of employees to air contaminants within the limits prescribed [by OSHA]. Any equipment and technical measures used for this purpose must first be approved for each particular use by a **competent industrial hygienist** or other technically **qualified person**.

29 CFR 1926.55

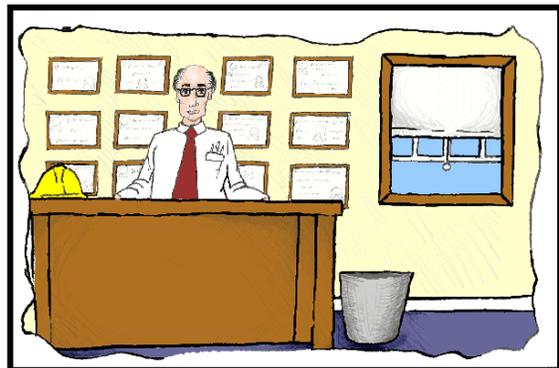
**QUALIFIED PERSON** means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

29 CFR 1926.32(m)



**INDUSTRIAL HYGIENIST** - A professional devoted to the anticipation, recognition, evaluation, prevention, and control of those environmental factors or stresses arising in or from the workplace which may cause sickness, impaired health and well-being, or significant discomfort among workers.

*American Industrial Hygiene Association*



The term "**Competent**" (or similar meaning) is used in the following OSHA health related topics.

## Personal Protective and Life Saving Equipment

### *Hearing protection*

Ear protective devices inserted in the ear must be fitted or determined individually by **competent persons**.



29 CFR 1926.101

### *Respiratory protection*

A respiratory protection program, when used, must be administered by a suitably trained **program administrator (competent person)**.

29 CFR 1926.103 (see 29 CFR 1910.134)

**NOTE:** In OSHA's Respiratory Protection Standard, the term "**Program Administrator**" is used to describe the person who has authority for ensuring compliance with the rule and administering the program.



### **A comprehensive respiratory protection program will include:**

- Procedures for selecting respirators for use in particular jobs.
- Medical evaluations of employees.
- Fit testing procedures for tight-fitting respirators (elastomeric facepieces).
- Procedures for proper use of respirators.
- Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators.
- Training of employees in the respiratory hazards to which they are potentially exposed.
- Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance.
- Review of the program.

The term "**Competent**" (or similar meaning) is used in the following OSHA health related topics.

## Welding and Cutting

### ***Welding, Cutting & Heating in way of Preservative Coatings***

Before welding, cutting, or heating is commenced on any surface covered by a preservative coating whose flammability is not known, a test must be made by a **competent person** to determine its flammability.

*29 CFR 1926.354*

**NOTE:** *A competent person must determine the presence of any toxic exposure during all welding, cutting and heating activities.*



## Demolition

### ***Preparatory Operations***

Prior to permitting employees to start demolition operations, an engineering survey must be made, by a **competent person**...

*29 CFR 1926.850*

**NOTE:** *An engineering survey includes determining the presence of any hazardous materials used on the property. When the presence of any such substances is apparent or suspected, testing must be performed and the hazard eliminated before demolition is started.*



The term "**Competent**" (or similar meaning) is used in the following OSHA health related topics.

## Toxic and Hazardous Substances

### Asbestos

The employer must ensure that all asbestos work performed within regulated areas is supervised by a **competent person**...

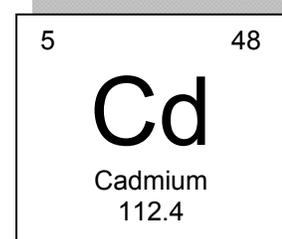
29 CFR 1926.1101



### Cadmium

Prior to the performance of any construction work where employees may be potentially exposed to cadmium, the employer must establish the applicability of this standard by determining whether cadmium is present in the workplace and whether there is the possibility that employee exposures will be at or above the action level. The employer must designate a **competent person** who must make this determination.

29 CFR 1926.1127



*Cadmium is an extremely toxic metal; it can be released into the air during welding, cutting and brazing operations; several deaths from exposure have occurred among welders who have unsuspectingly welded on cadmium-containing alloys.*



The term "**Competent**" (or similar meaning) is used in the following OSHA health related topics.

## Accident Prevention Responsibilities

### **Safety & Health Programs**

[Safety & Health] programs must provide for frequent and regular inspections of the job sites, materials, and equipment to be made by **competent persons** designated by the employers.

29 CFR 1926.20(b)



### **Elements of an Effective Safety & Health Program...**

**Management Commitment and Employee Involvement** – Establish clear policies for safe work and assign competent persons to the job-site to ensure that these safe work policies are being implemented and enforced. Communicate safety goals and provide visible top management commitment to show that the company is serious about safety.

**Worksite Analysis** – Conduct comprehensive baseline worksite surveys for safety and health hazards, perform regular inspections of the job-site and complete routine job hazard analyses.

**Hazard Prevention and Control** – Implement effective engineering, work practice (administrative) controls and provide personal protective equipment.

**Medical Management** – Ensure the availability of medical personnel for advice and consultation on matters of occupational health.

**Safety and Health Training** – Ensure that all employees understand the hazards to which they may be exposed and how to prevent harm to themselves and others from exposure to these hazards.

**Program Evaluation** – Review program to ensure that the existing policies, procedures and hazard prevention & control strategies are working and effective.

## Employee Training Requirements

### *29 CFR 1926.21(b)*

- (1) The employer should avail himself of the safety and health training programs the Secretary (OSHA) provides.
- (2) The employer must instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury.
- (3) Employees required to handle or use poisons, caustics, and other harmful substances must be instructed regarding the safe handling and use, and be made aware of the potential hazards, personal hygiene, and personal protective measures required.
- (4) In job site areas where harmful plants or animals are present, employees who may be exposed must be instructed regarding the potential hazards, and how to avoid injury, and the first aid procedures to be used in the event of injury.
- (5) Employees required to handle or use flammable liquids, gases, or toxic materials must be instructed in the safe handling and use of these materials and made aware of the specific requirements contained in OSHA's 29 CFR 1926 Subparts D, F, and other applicable subparts.



**Respirator Training**  
**Construction Safety Council**



**HAZWOPER Training**  
**Construction Safety Council**



**HAZWOPER Training**  
**Construction Safety Council**

## Employee Training Requirements

*29 CFR 1926.21(b)*

- (6) All employees required to enter into confined or enclosed spaces must be instructed as to the nature of the hazards involved, the necessary precautions to be taken, and in the use of protective and emergency equipment required. The employer must comply with any specific regulations that apply to work in dangerous or potentially dangerous areas.



*Worker in confined space wearing full-facepiece (elastomeric) – air purifying respirator.*

***In addition to the general safety education and training requirements established by OSHA, additional rules may also apply to specific standards.***

***OSHA has specific training requirements for each of the following health related topics:***

- Employee Emergency Action Plans
- Medical Services and First-aid
- Ionizing Radiation
- Non-ionizing Radiation
- Gases, Vapors, Fumes, Dusts (Silica), and Mists
- Hazard Communication
- Methylenedianiline
- Lead in Construction
- Hexavalent Chromium
- Process Safety Management of Highly Hazardous Chemicals
- Hazardous Waste Operations and Emergency Response
- Hearing Protection
- Respiratory Protection
- Welding and Cutting
- Site Clearing
- Underground Construction
- Preparatory Operations in Demolition
- Asbestos
- Use of Carcinogens
- Vinyl Chloride
- Inorganic Arsenic
- Cadmium

## Review

*Match the letter to correct acronym, word or phrase...*

\_\_\_\_\_ **Competent Person**

\_\_\_\_\_ **Qualified Person**

\_\_\_\_\_ **Industrial Hygienist**

\_\_\_\_\_ **Program Administrator**

- a.** One who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.
- b.** A professional devoted to the anticipation, recognition, evaluation, prevention, and control of environmental factors or stresses arising in or from the workplace which may cause sickness, impaired health and well being, or significant discomfort among workers.
- c.** One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.
- d.** The person who is responsible for administering a respiratory protection program for an employer.

# HEALTH HAZARDS IN CONSTRUCTION

## ***Learning Goals:***

- Be able to explain what a hazard is and how workers might be exposed to occupational health hazards in construction.
- List the three categories of health hazards found in construction.
- Overview the health effects of these hazards on the human body.
- Define important terms used to describe dangerous & hazardous environments.

## ***Important Terms:***

- Health Hazard
- Acute Effects
- Chronic Effects
- Local Effects
- Systemic Effects
- Immediately Dangerous to Life & Health (IDLH)
- Hazardous Atmosphere
- Flammable & Explosive Environments
- Oxygen Deficiency Hazard

## **What is a Hazard?**

A hazard is the potential for harm. In practical terms, a hazard often is associated with a condition or activity that, if left uncontrolled, can result in an injury or illness.

## ***What is a Health Hazard?***

There are many definitions of health, but simply stated...

***Health is the general condition of a person in all aspects, including, but not limited to: physical, mental and social well-being and not merely the absence of disease or infirmity.***

A health hazard is any condition or activity that threatens a person's well-being.



***Learn all the health hazards on your job...  
Anticipate, Recognize, Evaluate and Control these hazards.***

Health hazards in construction can be classified into three (3) categories...

## Health Hazards Categories...

1. **Chemical Hazards;** such as gases, vapors, fumes, dusts/fibers, mists and substances found in **OSHA PELs<sup>1</sup>**, **NIOSH RELs<sup>2</sup>**, and **ACGIH TLVs<sup>®3</sup>**
2. **Physical Hazards;** such as temperature, noise, repetitive motion & awkward postures, ionizing and non-ionizing radiation.
3. **Biological Hazards;** such as mold, bloodborne pathogens, bacteria, poisonous plants and animals, animal, bird and rodent feces.

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*Some health hazards are obvious, like working with chemicals...*



*Some health hazards are not so obvious, like awkward postures and noise exposure...*



<sup>1</sup> **Occupational Safety & Health Administration Permissible Exposure Limits**

<sup>2</sup> **National Institute of Occupational Safety & Health Recommended Exposure Limits**

<sup>3</sup> **American Conference of Governmental Industrial Hygienists Threshold Limit Values**

## Health Effects and the Human Body

Health hazards may cause measurable changes in the body - such as decreased pulmonary function, hearing loss and/or muscle fatigue and stiffness. These changes are generally indicated by the occurrence of signs and symptoms in the exposed employees - such as shortness of breath.

The following are example of health hazards and their effects on the human body.

Health Hazard		Health Effect
<b>Chemical</b>	Gas	<ul style="list-style-type: none"> <li>▪ Asphyxiation</li> <li>▪ Reduced pulmonary function</li> <li>▪ Damage to body tissue and organs</li> <li>▪ Metal fume fever (inhalation of fine particles of zinc, magnesium and copper)</li> <li>▪ Silicosis</li> <li>▪ Asbestosis</li> <li>▪ Mesothelioma</li> <li>▪ Dermatitis</li> <li>▪ Cancer</li> </ul>
	Vapor	
	Fume	
	Dust/Fiber	
	Mist	
<b>Physical</b>	Temperature	<ul style="list-style-type: none"> <li>▪ Heat exhaustion and heat stroke</li> <li>▪ Hypothermia and frost bite</li> <li>▪ Hearing loss</li> <li>▪ Cumulative trauma disorder</li> <li>▪ Sunburn</li> <li>▪ Tissue heating and burning</li> <li>▪ Cancer</li> </ul>
	Noise	
	Repetitive Motion & Awkward Postures	
	Ionizing Radiation	
	Non-Ionizing Radiation	
<b>Biological</b>	Mold	<ul style="list-style-type: none"> <li>▪ Allergic reaction</li> <li>▪ Asthmatic reaction (constriction of bronchial tubes)</li> <li>▪ Hepatitis</li> <li>▪ HIV</li> <li>▪ Histoplasmosis</li> <li>▪ Infections</li> </ul>
	Bloodborne Pathogens	
	Bacteria & Viruses	
	Poisonous Plants & Animals	
	Animal, Bird & Rodent Feces	

The toxic action of a health hazard can be divided into **acute (short-term)** effects and chronic (long-term) effects.

## Acute Health Effects

**Acute health effects** are quickly seen, usually after exposures to fairly high levels or concentrations of hazardous substances. For example, fiberglass can immediately cause itchiness and skin irritation; an extremely loud noise can result in temporary or even permanent hearing loss.

A lethal concentration of carbon monoxide, CO (1200 ppm) is considered to be **Immediately Dangerous to Life and Health (IDLH)**; a worker exposed to this acute amount of CO can lose consciousness and die.

### **Acute effects referred to most frequently are:**

- Irritation; rashes & dry skin
- Dermatitis (acute)
- Corrosivity; burns or dissolves skin tissue
- Sensitization; allergic reactions (anaphylactic shock)
- Metal fume fever
- Lethal Concentration (LC)

***Skin rashes, red dry skin and dermatitis are examples of acute health effects.***



**Acute Toxicity** - refers to those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.

**Lethal Concentration (LC)** - An indication of the lethality of a given substance or type of radiation.

**LC<sub>50</sub>** - Is the concentration of a material, which causes the death of 50% (one half) of a group of test animals. The LC<sub>50</sub> is one way to measure the short-term poisoning potential (acute toxicity) of a material.



***Skull & cross-bone symbol is used to warn of an acute toxicity hazard; Globally Harmonized System.***

The toxic action of a health hazard can be divided into acute (short-term) effects and **chronic (long-term)** effects.

## Chronic Health Effects

**Chronic effects** usually develop slowly. For example, if you breathe small amounts of asbestos fibers, you won't even notice them. There are no acute effects. But if you inhale asbestos month after month, year after year, you greatly increase your chances of getting asbestos disease, such as lung cancer. This is a chronic effect.

Other examples of chronic health effects include hearing loss and cumulative trauma disorders; these are examples of physical health hazards.

**Chronic effects referred to most frequently are:**

- **Cancer**
- **Asbestosis**
- **Mesothelioma**
- **Silicosis**
- **Occupational Hearing Loss**
- **Cumulative Trauma Disorder**

## Chronic Health Effects and Long-Term Disability

Most health effects experienced in construction are typically chronic; this makes it difficult to associate where the exposure occurred. For example, a worker in their later years presents with a chronic health effect. The exposures that may have caused the damage could have occurred very early in his working life.



**Chronic health hazard symbol;  
Globally Harmonized System.**



**Worker with chronic health problems; he needs oxygen.**

Health hazards to the body may be subjected to a small area of which a chemical or other substance makes direct contact; these are called **local health effects**.

## Local Health Effects

A **local health effect** refers to an adverse health effect that takes place at the point or area of contact. The site may be skin, mucous membranes, the respiratory tract, gastrointestinal system, eyes, etc. Absorption does not necessarily occur.

An example of a local health effect is an exposure to strong acids or alkalis resulting in skin damage.

### Examples of local health effects (corrosives, irritants & sensitizers):

- Concrete burns
- Skin & eye irritation
- Dermatitis
- Poison Ivy
- Tissue damage
- Acid burn
- Sunburn

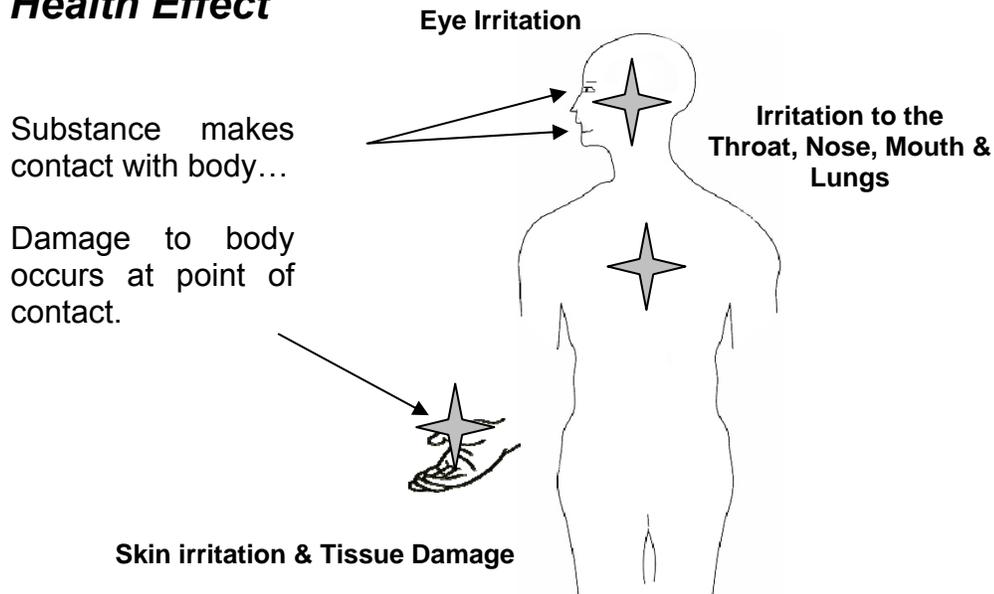


Pictogram for Corrosive  
Globally Harmonized System



Pictogram for Irritant & Sensitizer  
Globally Harmonized System

## Local Health Effect



Other chemicals when exposed to the worker can be absorbed into the body and affect the whole body; these are called **systemic health effects**.

## Systemic Health Effects

A **systemic health effect** refers to an adverse health effect that takes place at a location distant from the body's initial point of contact, for example, a chemical is inhaled into the lungs or absorbed through the skin, yet it affects the person's kidney, liver or other part of the body.

Substances with systemic effects often have "Target Organs" in which they accumulate and exert their toxic effect. Often these effects are not seen until a critical body burden is reached.

### Examples of systemic health effects (carcinogens, toxins and sensitizers):

- Asbestosis & Mesothelioma
- Silicosis
- Metal fume fever
- Kidney damage
- Allergic reactions
- Infections
- Radiation sickness
- Nervous system failure
- Reproductive system damage



Pictogram for Carcinogen  
Globally Harmonized System



Pictogram for Toxin  
Globally Harmonized System

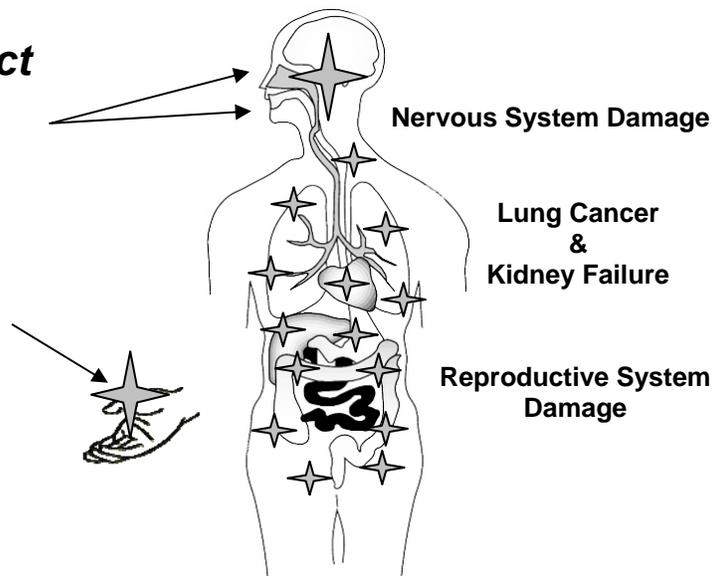


Pictogram for Sensitizer  
Globally Harmonized System

## Systemic Health Effect

Substance enters the body (see *Routes of Entry*) and is deposited throughout the system.

Damage to body occurs at locations remote from initial point of contact.



A work environment that poses an immediate threat to an employee's life and health are called ***Immediately Dangerous to Life & Health (IDLH)***.

## Immediately Dangerous to Life & Health (IDLH)

An IDLH condition is one that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual's ability to escape unaided from a space.

**NOTE:** *Some materials may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12-72 hours after exposure. The victim "feels normal" from recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health.*

### ***Potential IDLH Environments in Construction***

Because of their potential to contain hazardous atmospheres, confined or enclosed spaces are suspect IDLH environments.

#### ***Confined & Enclosed Spaces:***

- Storage Tanks
- Process Vessels
- Bins
- Boilers
- Ventilation or Exhaust Ducts
- Sewers & Manholes
- Underground Utility Vaults
- Tunnels
- Pipelines
- Open top spaces more than 4 feet in depth
- Temporary Enclosures (heating enclosures for break)
- Dumpsters
- Stair-wells
- Elevator Shafts
- Basements
- Attics
- Trenches & Excavations



***Hazardous atmospheres may exist in trenches. When a trench reaches a depth of 4 feet, they must be evaluated for IDLH conditions by a competent person.***

## Confined & Enclosed Spaces

**"Confined or enclosed space"** means any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than 4 feet in depth such as pits, tubs, vaults, and vessels.

***All confined or enclosed spaces must be evaluated for IDLH conditions!***

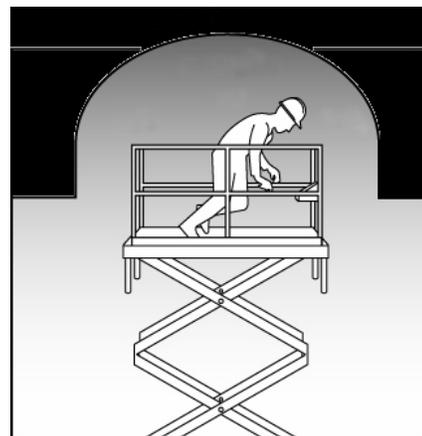
***Contractors must coordinate work in confined or enclosed spaces...***

- ***Identify the hazards;*** oxygen deficiency, flammable and/or toxic.
- ***Classify the space;*** enclosed space, confined space (hazards isolated), or permit required confined space.
- ***Eliminate and/or control the hazards;*** engineering controls (ventilation) and/or personal protective equipment (PPE).
- ***Coordinate entry operations;*** entrant & attendant responsibilities, ensure proper communication.
- ***Ensure prompt rescue;*** team readily available, properly equipped & trained!

### ***Enclosed space example...***

Confined and enclosed spaces can exist where you least expect them; always survey the job-site for potential hazardous atmospheres.

***Working in elevated lifts (locations) could cause you to be exposed to unexpected hazardous atmospheres.***



## Confined & Enclosed Spaces

**Entry into a confined space;** means the action by which a person passes through an opening into a space and is considered to have occurred as soon as any part of the body breaks the plane of the space.

***Confined space entry is serious and dangerous work; always follow approved confined space entry procedures!***

***This is not an approved entry →***



## Confined Space Entry Procedures

***Each employee who enters or is involved in the entry must:***

- Understand the procedures for confined space entry;
- Know the hazards of the specific space;
- Review the specific procedures for each entry; and
- Understand how to use entry and rescue equipment (picture).



***Confined Space Training Facility  
(Construction Safety Council)***

## Confined Space Entry Permits

Confined Space Entry Permits must be completed before any employee enters a Permit-Required Confined Space. The "Permit" must be completed and signed by the **entry supervisor** before entry. Permits must be maintained on file for 12 months and an annual review of the confined space program must be conducted.

***See Sample Confined Space Entry Permit, page 215.***



***Test all confined spaces before you enter!***

- ⊗ Oxygen Content
- ⊗ Flammable Environments
- ⊗ Toxic Substances

Employees shall not be permitted to work in hazardous and/or toxic atmospheres!

## Hazardous Atmospheres

A *hazardous atmosphere* means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue, injury, or acute and/or chronic illness from one or more of the following causes:

- Flammable gas, vapor, or mist in excess of 10 percent of its *lower flammable limit (LFL)*.
- Airborne combustible dust at a concentration that meets or exceeds its LFL (*dust obscures vision at a distance of 5 feet or less*).
- Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent.
- Atmospheric concentration of any substance for which a permissible exposure limit (PEL) is published in OSHA's standards.

### **Hazardous Atmosphere:**

- Oxygen concentration below 19.5% or above 23.5%
- Flammable gas, vapor, mist in excess of 10% of its lower flammable limit (LFL).
- Airborne combustible dust at high concentrations.
- Exposure to any substance above OSHA's Permissible Exposure Limit (PEL).

***Inside containment preparing for abrasive blasting, blaster dressed in blasting hood with bib and protective clothing. Hazards include: Dust, Lead, Heat, Noise, and Stress.***



NIOSH/Mount Sinai/CHEP/elcoshimages.org

## Group Discussion – Hazardous Atmosphere

***Discuss potential hazardous atmospheres in your workplace.***

- Discuss how these spaces can cause illness, injury or death. What are the potential health effects?

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- Using the hierarchy of controls, how can these hazards be eliminated and/or controlled?

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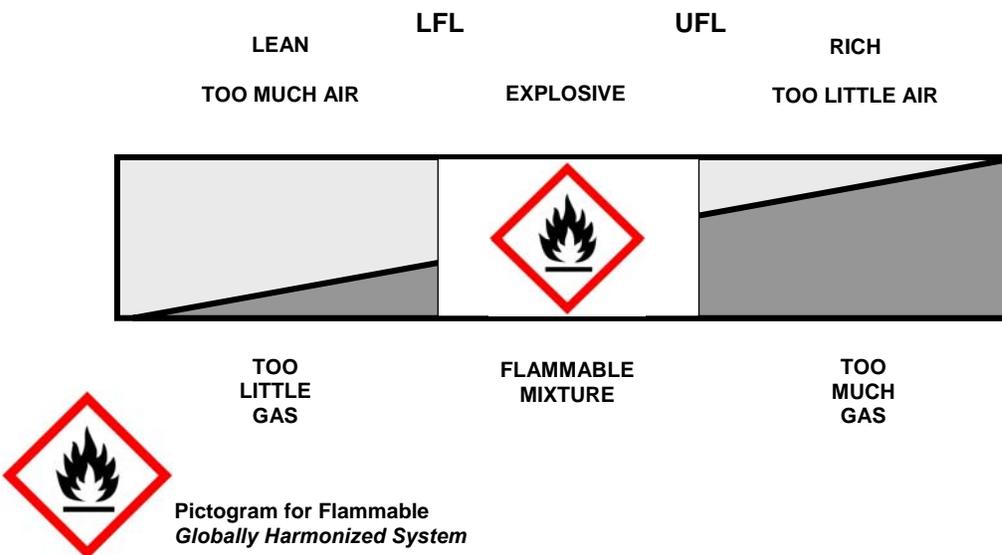


***Workers unprotected; this is a serious health risk. Behaviors like this must be avoided!***

## Flammable & Explosive Hazards

Flammable limits are defined as the concentration range in which a flammable substance can produce a fire or explosion when an ignition source (such as a spark or open flame) is present. The concentration is generally expressed as percent fuel by volume.

For example, Methane (CH<sub>4</sub>) has a Lower Flammable Limit (LFL) = 5.3%, and an Upper Flammable Limit (UFL) = 15.0%; if the air contains between 5.3% and 15% volume of air of methane (under normal atmospheric conditions), then a flammable environment exists.



**WARNING!** Atmospheres that are rich in flammable gas (above the UFL) must be ventilated thoroughly, with powerfull blowers to completely bring the atmosphere down below the LFL.

<b>Examples of LFL &amp; UFL</b>		
<i>Substance</i>	<i>Lower Flammable Limit (LFL)</i>	<i>Upper Flammable Limit (UFL)</i>
<b>Acetylene</b>	<b>2.5%</b>	<b>100%</b>
<b>Propane</b>	<b>2.1%</b>	<b>9.5%</b>
<b>Gasoline</b>	<b>1.4%</b>	<b>7.6%</b>

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals

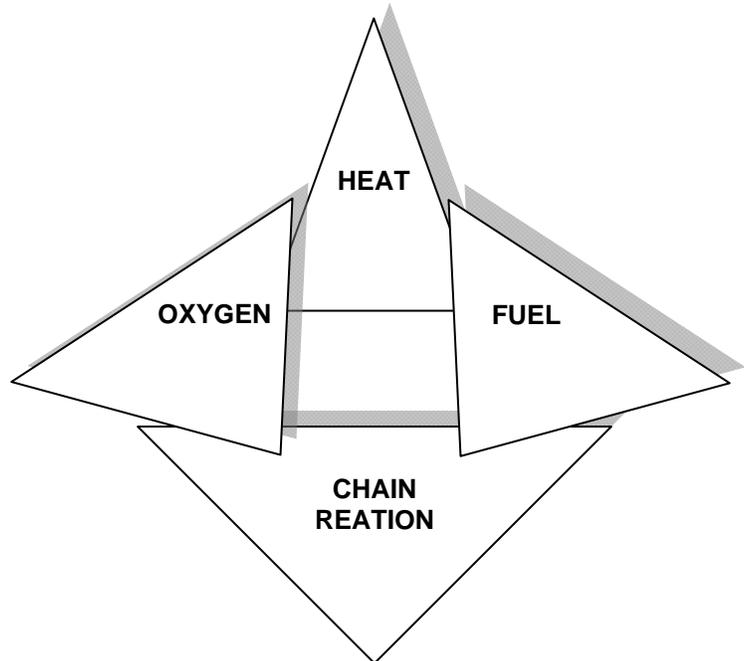
## Flammable & Explosive Hazards

To prevent fire and explosion, ensure that sources of fuel, heat and oxygen are controlled and that the storage and use of these substances are monitored by a competent person.

***Keep fuel, heat & oxygen separated!***

### ***Fire Tetrahedron***

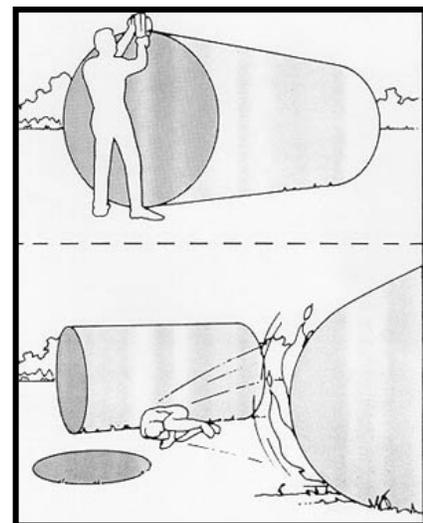
For a fire or explosion to occur, ***fuel, heat, oxygen,*** and a ***chemical chain reaction*** must be present. Removal of any one of these essential elements will result in the fire being extinguished or have never started.



### **ACCIDENT REPORT** **FATAL FACTS**

A laborer was killed when a gasoline storage tank he was cutting with a portable power saw exploded.

Although he had experienced working with the saw and scrap materials, the worker did not adequately purge the tank and test for vapors before beginning to cut. The tank had been used recently for underground storage at a service station. At the time of the explosion, the mechanic was cutting on the tank with a gasoline powered portable saw equipped with an abrasive epoxy disk for cutting metal. The explosion propelled the worker 10 to 15 feet from the tank into another tank.



To see complete OSHA Fatal Fact #3, go to [www.osha.gov](http://www.osha.gov)

## Flammable Materials (Storage & Use)

### Flammable Liquid (Storage & Use):

- No more than 25 gallons of flammable or combustible liquids may be stored in a room outside of an approved storage cabinet. 29 CFR 1926.152(b)(1)
- Not more than 60 gallons of flammable or 120 gallons of combustible liquids may be stored in any one storage cabinet. Not more than three such cabinets may be located in a single storage area. 29 CFR 1926.152(b)(3)
- Storage of liquid petroleum gas (LPG) within buildings is prohibited. 29 CFR 1926.153(j)
- Only approved containers and portable tanks shall be used for storage and handling of flammable and combustible liquids. 29 CFR 1926.152(a)(1)

### Propane - LPG (C<sub>3</sub>H<sub>8</sub>)

- Flammable liquid gas under pressure and can form explosive mixtures with air (LFL = 2.1%).
- May cause frostbite if exposed to skin.
- Simple Asphyxiant; can displace oxygen and cause suffocation.
- Gas density of LPG is 1.55 (air = 1)

**NOTE:** Before suffocation could occur, the lower flammability limit (LFL) of propane in air would be exceeded; possibly causing both an oxygen deficient and explosive atmosphere.



**Propane tanks connected to lift trucks are considered to be “in use” and may be left attached when truck is stored inside a building.**

**NOTE:** Containers in use means connected for use.

#### When exchanging out propane (LPG) tanks:

- Be sure area is well ventilated.
- Turn off gas on tank.
- Let truck run gas out of line.
- Remove hose from tank (wear protective gloves).
- No Smoking!

## Hazard Recognition

No more than 25 gallons of a flammable or combustible liquid may be stored in a room outside of an approved storage cabinet.

**Violation** →

*Picture (right) shows more than 25 gallons of a flammable and combustible liquid stored in a room outside of an approved storage cabinet.*

**Good** ↓



*Photo courtesy of Justrite Mfg. Co.*



**Improper storage of flammable & combustible liquids and gases; creates a potential fire hazard as well as a toxic atmosphere. Notice the enclosed space hazard.**

## Hazard Control

An approved “Safety Can” for storage and handling of flammable or combustible liquids:

- A closed container of not more than 5 gallons capacity.
- Has a flash-arresting screen.
- Spring-closing lid and spout cover.

Safety cans are designed so that when subjected to heat, it will safely relieve internal pressure.

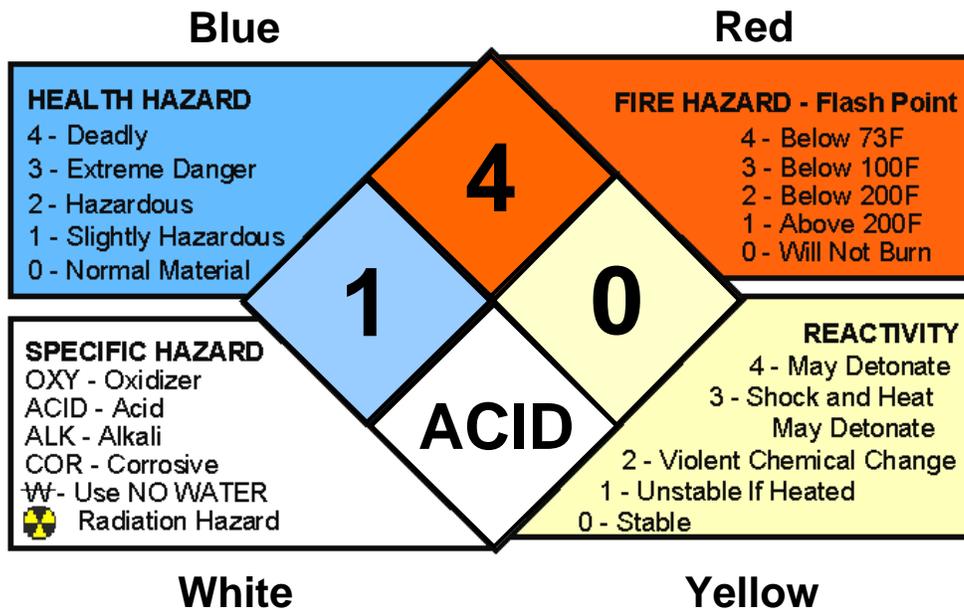


**“Safety Can”**

*Photo courtesy of Justrite Mfg. Co.*

## National Fire Protection Association (NFPA 704M)

The *NFPA 704M Diamond* is a means of disseminating hazard information for a material. The diamond is divided into four sections. Each of the first three colored sections (blue, red & yellow) has a number in it associated with a particular hazard. The higher the number is, the more hazardous a material is for that characteristic. The fourth section (white) includes special hazard information.



The NFPA 704M standard provides a readily recognized, easily understood system for identifying specific hazards. It addresses the health, flammability, instability, and related hazards that may be presented as short-term, acute exposures that are most likely to occur as a result of fire, spill, or similar emergency.

### **The objectives of NFPA 704M are:**

- To provide an appropriate signal or alert for the protection of both public and private emergency response personnel.
- To assist in planning for effective fire and emergency control operations, including clean-up.
- To assist all designated personnel, engineers, job-site, and safety personnel in evaluating hazards.

## The Globally Harmonized System of Classification & Labeling of Chemicals

The Globally Harmonized System of Classification and Labeling of Chemicals is a system for standardizing and harmonizing the classification and labeling of chemicals. It is a logical and comprehensive approach to defining health, physical and environmental hazards of chemicals and to communicate hazard information, as well as protective measures, on labels and Safety Data Sheets (SDSs).

<b>Globally Harmonized System Pictograms</b>		
	<b>Gas</b>	This is the symbol that will appear on chemicals that are; gases under pressure, compressed gases, liquefied gases, refrigerated liquefied gases, dissolved gases.
	<b>Aquatic Hazard</b>	This is the symbol that will appear on chemicals which are acutely hazardous to fish, crustacea, or aquatic plants.
	<b>Explosive</b>	This is the symbol that will appear on chemicals which are; unstable explosives, self-reactive substances and mixtures, and organic peroxides.
	<b>Flammable</b>	This is the symbol that will appear on chemicals that are flammable. Depending on the properties of the chemical(s); flammable gas, flammable aerosol, flammable liquid and vapor, flammable solid.
	<b>Corrosive</b>	This is the symbol that will appear on chemicals that have corrosive properties. Depending on the properties of the chemical(s); may be corrosive to metal, causes severe skin burns and eye damage, will cause serious eye damage.
	<b>Oxidizer</b>	This is the symbol that will appear on chemical that will release oxygen or behave like oxygen in a chemical reaction; causing a greater fire and explosion.
	<b>Irritant &amp; Sensitizer</b>	This is the symbol that will appear on chemicals with less severe toxicity; harmful if swallowed, harmful in contact with skin, harmful if inhaled, causes skin and eye irritation, may cause allergic skin reaction.
	<b>Acute Toxicity</b>	This is the symbol that will appear on the most severely toxic chemicals. Depending on the toxicity of the chemical, the skull and crossbones indicate that the chemical may be toxic or fatal; inhaled, swallowed, and/or contact with skin.
	<b>Chronic Health Hazard</b>	This is the symbol that will appear on chemicals that poses chronic health hazards; respiratory sensitization, germ cell mutagenicity, carcinogenicity, reproductive toxicity, specific target organ toxicity, and/or aspiration hazard.

## Hazard Symbols & Classes

**Hazard Class** is the nature of the physical or health hazard, e.g., flammable solid, carcinogen, oral acute toxicity.

Flame	Flame Over Circle	Exclamation Mark	Exploding Bomb
 <p>Flammables Self Reactives Pyrophorics Self-Heating Emits Flammable Gas Organic Peroxides</p>	 <p>Oxidizers</p>	 <p>Irritant Dermal Sensitizer Acute Toxicity (Harmful) Narcotic Effects Respiratory Tract Irritation</p>	 <p>Explosives Self Reactives Organic Peroxides</p>
Corrosion	Gas Cylinder	Health Hazard	Skull & Crossbones
 <p>Corrosives</p>	 <p>Gases Under Pressure</p>	 <p>Carcinogen Respiratory Sensitizer Reproductive Toxicity Target Organ Toxicity Mutagenicity Aspiration Toxicity</p>	 <p>Acute Toxicity (Severe)</p>



**Aquatic Toxicity**

## Physical Hazards Classification

**Hazard Category** is the division of criteria within each hazard class. These categories compare hazard severity within a hazard class and should not be taken as a comparison of hazard categories more generally.

Hazard Class	Hazard Category						
	Unstable Explosive	Div 1.1	Div 1.2	Div 1.3	Div 1.4	Div 1.5	Div 1.6
<b>Explosive</b>	Unstable Explosive						
<b>Flammable Gases</b>	1	2					
<b>Flammable Aerosols</b>	1	2					
<b>Oxidizing Gases</b>	1						
<b>Gases under Pressure</b> Compressed Gases Liquefied Gases Refrigerated Liquefied Gases Dissolved Gases	1						
<b>Flammable Liquids</b>	1	2	3	4			
<b>Self-Reactive Chemicals</b>	Type A	Type B	Type C	Type D	Type E	Type F	Type G
<b>Pyrophoric Liquids</b>	1						
<b>Pyrophoric Solid</b>	1						
<b>Pyrophoric Gases</b>	Single Category						
<b>Self-Heating Chemicals</b>	1	2					
<b>Chemicals, which in contact with water, emit flammable gases</b>	1	2	3				
<b>Oxidizing Liquids</b>	1	2	3				
<b>Oxidizing Solids</b>	1	2	3				
<b>Organic Peroxides</b>	Type A	Type B	Type C	Type D	Type E	Type F	Type G
<b>Corrosive to Metals</b>	1						
<b>Combustible Dust</b>	Single Category						

## Health Hazards Classifications

Hazard Class	Hazard Category			
	1	2	3	4
Acute Toxicity	1	2	3	4
Skin Corrosion/Irritation	1A	2A	1C	2
Serious Eye Damage/Eye Irritation	1	2A	2B	
Respiratory or Skin Sensitization	1			
Germ Cell Mutagenicity	1A	1B	2	
Carcinogenicity	1A	1B	2	
Reproductive Toxicity	1A	1B	2	Lactation
STOT* – Single Exposure	1	2	3	
STOT* – Repeated	1	2		
Aspiration	1			
<i>Simple Asphyxiants</i>	Single Category			

\* STOT - Specific Target Organ Toxicity

## Environmental Hazards

**Acute Aquatic Toxicity** means the intrinsic property of a material to cause injury to an aquatic organism in a short-term exposure.

**Chronic Aquatic Toxicity** means the potential or actual properties of a material to cause adverse effects to aquatic organisms during exposures that are determined in relation to the lifecycle of the organism.



## Group Discussion – Propane (LPG)

**Physical Description:** Colorless, odorless gas. [Note: A foul-smelling odorant is often added when used for fuel purposes.]

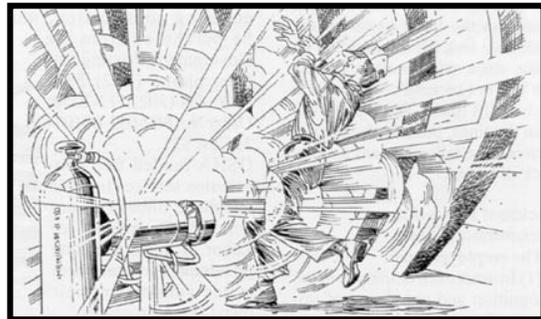
<b>Propane – Physical Properties</b>			
<b>Gas Density: 1.55</b> (air = 1)	<b>LFL: 2.1%</b>	<b>NFPA Fire Rating: 4</b> <b>NFPA Health Rating: 1</b> <b>NFPA Reactivity Rating: 0</b> <b>NFPA Special Instruction: N/A</b>	
<b>Flash Point: -156°F</b>	<b>UFL: 9.5%</b>		
<b>Globally Harmonized System Label:</b>			

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals

### ACCIDENT REPORT FATAL FACTS

Propane gas was being used to fuel a portable heater (blow torch). The torch flamed out, allowing gas to gather in the bilge area of a construction barge. The accumulated gas exploded with great force, killing the worker.

To see complete OSHA Fatal Fact #72, go to [www.osha.gov](http://www.osha.gov)



### Lessons Learned (Propane)

**Propane** – LPG (density = 1.55); a heavy gas in respect to air; it is also highly flammable with a NFPA rating of 4.

If not carefully monitored, LPG gas can migrate and collect into enclosed spaces where it mixes with air. If the volume of propane gas gets to 2.1% of the volume of the air, an explosive environment exists!



**Store LPG outside in well ventilated areas and protect against accident damage.**

## Group Discussion – Gasoline

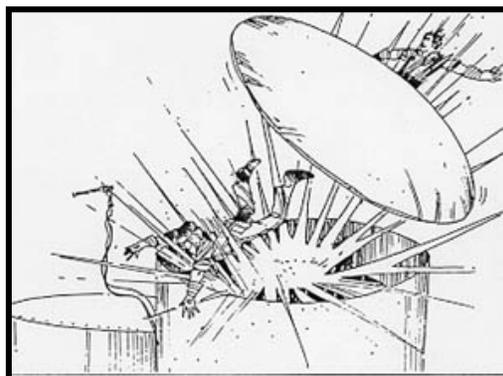
**Physical Description:** Clear liquid with a characteristic odor.

<b>Gasoline – Physical Properties</b>			
Vapor Density: 3 – 4 (air = 1)	LFL: 1.4%	NFPA Fire Rating: 3 NFPA Health Rating: 1 NFPA Reactivity Rating: 0 NFPA Special Instruction: N/A	
Flash Point: -45°F	UFL: 7.6%		
Globally Harmonized System Label:			

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals

### ACCIDENT REPORT FATAL FACTS

Two employees were welding brackets onto an oil storage tank (55,000 gallons). The tank, half full, contained explosive atmospheres of vapor from waste chemical and oil materials from automobile and truck service stations. One worker was killed and another injured when the tank exploded and the top was blown off.



To see complete OSHA Fatal Fact #53, go to [www.osha.gov](http://www.osha.gov)

## Lessons Learned (Gasoline)

**Gasoline** – must be stored in an approved “safety can” and kept away from sources of heat; no more than 25 gallons of gasoline can be stored in any one area outside of an approved flammable storage cabinet.

Photo courtesy of Justrite Mfg. Co.



## ***Compressed Gas Cylinders***

Dangerous gas can collect in confined, enclosed or poorly ventilated spaces. Misuse of compressed gas cylinders can result in death or serious injury. A competent person must instruct workers on the safe handling and use of compressed gas.

---

### ***Transporting, Moving & Storing Compressed Gas Cylinders***

- Valve protection caps must be in place and secured.
  - When cylinders are hoisted, they must be secured on a cradle, sling-board, or pallet. They must not be hoisted or transported by means of magnets or choker slings.
  - Cylinders can only be moved by tilting and rolling them on their bottom edges. They must never be intentionally dropped, struck, or permitted to strike each other violently.
  - When cylinders are transported by powered vehicles, they must be secured in a vertical position.
  - Valve protection caps must not be used for lifting cylinders from on vertical position to another.
  - Warm, not boiling, water can only be used to thaw cylinders loose.
  - Unless cylinders are firmly secured on a special carrier intended for transport, regulators must be removed and valve protection caps put in place before cylinders are moved.
- 

### ***Compressed Gas Cylinders – “In Use” vs. “Storage”***

Compressed gas cylinders are considered to be “in storage” if it is reasonably anticipated that gas will not be drawn from the cylinder within 24 hours (overnight hours included); compressed gas cylinders must be broken down with gages removed and oxygen separated from fuel gas.

If it is anticipated that gas will be drawn from the cylinders within this 24 hour period, then the cylinder is considered to be “in use”; compressed gas cylinders may remain on cart (secured & upright) with gages left on.



***Picture of compressed gas cylinders secured on special carrier, “in use”.***

## Compressed Gas Cylinders & Confined Spaces

**Compressed gas cylinders must be used with caution around confined and enclosed spaces!**

- Compressed gas cylinders must never be brought into confined spaces, this includes trenches.

*(Safe Work Practice)*

- Remove all hoses and leads from the enclosed/confined space when unoccupied and perform atmospheric testing to ensure air quality before returning to work.

*(Safe Work Practice)*

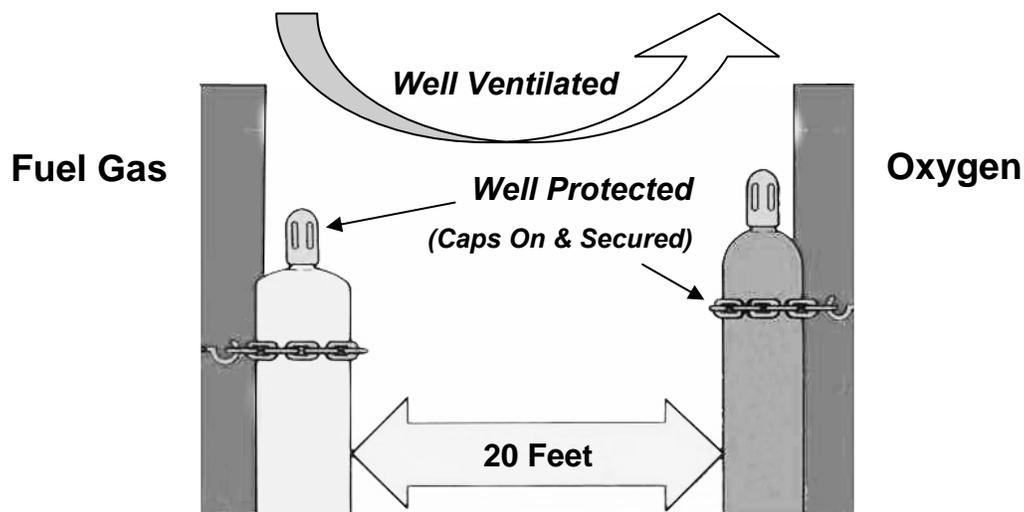


*Picture of compressed gas cylinders in use; close proximity of a trench.*

## Compressed Gas Cylinders – “In Storage”

Oxygen cylinders in storage must be separated from fuel-gas cylinders or combustible materials (especially oil or grease), a minimum distance of 20 feet or by a noncombustible barrier at least 5 feet high having a fire-resistance rating of at least one-half hour.

**29 CFR 1926.350(a)(10)**



## Compressed Gas Cylinders – “In Storage”

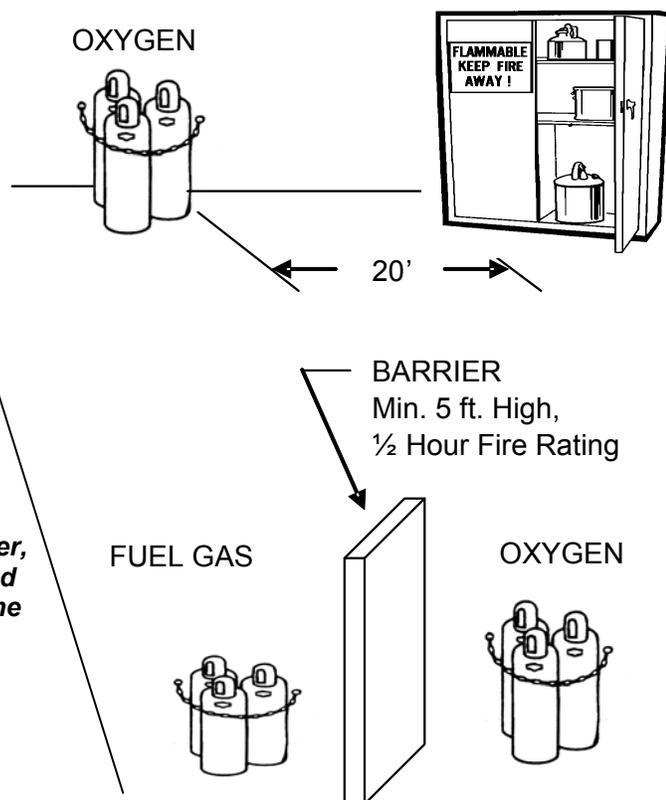
- Gas cylinders must be secured at all times to prevent tipping.
- Use appropriate material, such as chain, plastic coated wire cable, commercial straps, etc., to secure cylinders.
- Cylinders must be segregated in hazard classes while in storage. Oxidizers (oxygen) must be separated from flammable gases, and empty cylinders must be isolated from filled cylinders.
- Store out of direct sunlight and away from sources of heat and ignition; temperatures must not exceed 125 °F.
- Acetylene cylinders must never be stored on their sides.
- Always place valve protectors on gas cylinders when the cylinders are not connected for use.
- Cylinders must be stored where they are protected from the ground to prevent rusting.
- Storage areas must be well-ventilated, cool, dry, and free from corrosive materials.

### Proper Storage of Compressed Gas Cylinders



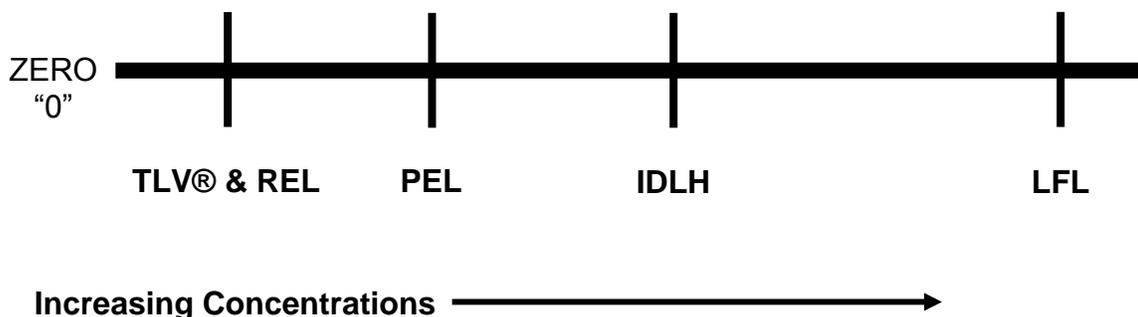
**Manufactured Carts with Barrier**

**Manufactured cart with 5 foot high barrier, (½-hour fire resistance rating); designed to prevent the spread of the fire from one cylinder to another.**



## Toxic vs. Flammable Environments

Concentrations of flammable substances that may ignite or explode are substantially *greater* than concentrations harmful to health, or toxic. Meaning, if an exposure to a substance that is both toxic and flammable is present, death may happen due to its toxicity before an explosion may occur.



<b>Toxic Substance</b>	<b>TLV® &amp; REL (ppm)</b>	<b>PEL (ppm)</b>	<b>IDLH (ppm)</b>	<b>LFL % (ppm)</b>	<b>NFPA 704M</b>
Carbon Monoxide, CO 	TLV – 25 REL – 35	50	1200	12.5% (125,000)	Fire: 4 Health: 3 Reactivity: 0 Specific Hz: NA 
Hydrogen Sulfide, H <sub>2</sub> S 	TLV – 10 REL (C) – 10	10	100	4 % (40,000)	Fire: 4 Health: 3 Reactivity: 0 Specific Hz: NA 
Benzene 	TLV – .5 REL – .1	1	500	1.2% (12,000)	Fire: 3 Health: 2 Reactivity: 0 Specific Hz: NA 

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals

### Concentrations of Gases and Vapors in Air by Volume...

1,000,000 ppm = 100%

100,000 ppm = 10%

10,000 ppm = 1%

Lowest LFL (Lower Flammable Limit) example: Toluene LFL = 1.1%

1,000 ppm = 0.1%

Highest PEL\* (Permissible Exposure Limit): example: Acetone (1000 ppm)

100 ppm = 0.01%

10 ppm = 0.001%

\* Exception of carbon dioxide (5000 ppm)

## Oxygen (O<sub>2</sub>) Deficiency Hazards

Normal breathing air contains around 20.9% oxygen...

***Oxygen deficient atmosphere is defined when the percent of oxygen in air drops below 19.5%***

### ***Oxygen Deficiency Hazards are caused by:***

- ***Displacement*** – The presence of any gas, such as carbon dioxide, nitrogen and/or argon gas; these gases are common industrial gases used to purposely remove (displace) oxygen.
- ***Consumption*** – The biological or chemical use of oxygen available in the environment. For example, workers consume oxygen through breathing; hot-work consumes oxygen around open flame and through oxidation of metal surfaces (e.g., iron oxide or rust).

<b>O<sub>2</sub> Content</b>	<b><i>Effects and Symptoms</i></b>
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, and judgment.
10 – 12%	Respiration further increases in rate and depth, poor judgment, lips blue.
8 – 10%	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea, and vomiting.
6 – 8%	8 min., 100% fatal; 6 min., 50% fatal; 4-5 min., recovery with treatment.
4 – 6%	Coma in 40 sec., convulsions, respiration ceases, death.

***NOTE:*** Exposure to atmospheres containing 12% or less oxygen will bring about unconsciousness without warning. Unconsciousness can occur so quickly that individuals cannot help or protect themselves.

## Review

*Match the letter to correct acronym, word or phrase...*

_____	<b>Health Hazard</b>
_____	<b>Acute Effects</b>
_____	<b>Chronic Effects</b>
_____	<b>Local Effects</b>
_____	<b>Systemic Effects</b>
_____	<b>IDLH (acronym)</b>
_____	<b>Hazardous Atmosphere</b>
_____	<b>LFL (acronym)</b>

- a.** Are quickly seen, usually after exposures to fairly high levels or concentrations of hazardous materials.
- b.** Oxygen concentration below 19.5% or above 23.5%, flammable gas, vapor, mist in excess of 10% of its lower flammable limit (LFL), exposure to any substance above OSHA's Permissible Exposure Limit (PEL).
- c.** Lower Flammable Limit
- d.** Any condition or activity that threatens a person's well-being.
- e.** An adverse health effect that takes place at the point or area of contact.
- f.** Usually develops slowly, over a long period of time.
- g.** Immediately Dangerous to Life & Health
- h.** An adverse health effect that takes place at a location distant from the body's initial point of contact.

# CHEMICAL HEALTH HAZARDS

## ***Learning Goals:***

- Be able to explain what a chemical health hazard is and how construction workers might be exposed to these hazards.
- Define important terms used to describe chemical hazards in the workplace.
- Overview the health effects of these hazards on the human body.



*Worker using corrosive and toxic chemicals while wearing proper personal protective equipment (PPE).*

## ***Important Terms:***

- Gases, vapors, fumes, dusts/fibers & mists
- Routes of entry
- Units of concentration
- Respirable
- Breathable Air
- Simple asphyxiant
- Chemical asphyxiant
- Gas & vapor density
- Carcinogens
- Toxic & highly toxic
- Reproductive toxins
- Irritants
- Corrosives
- Sensitizers
- Hepatotoxins (liver toxins)
- Nephrotoxins (kidney toxins)
- Neurotoxins (nerve toxins)
- Hematopoietic system (blood forming system)
- Synergistic Effect
- Your Right to Know
- Safety Data Sheet (SDS)

## ***Chemical Health Hazard***

A chemical health hazard means a chemical for which there is statistically significant evidence based on at least one study conducted in accordance with established scientific principles that acute or chronic health effects may occur in exposed employees. Chemical hazards may take the form of a gas, vapor, fume, dust/fiber and/or mist.

***Chemical hazards can damage the lungs, skin, eyes, mucous membranes, and target specific organs in the body!***

**Gases, Vapors, Fumes, Dust/Fibers & Mists**

Chemical health hazards can take the form of a **gas, vapor, fume, dust/fiber** and/or **mist**.

<b>Form</b>	<b>Description</b>	<b>Examples</b>
<b>Gases</b>	Gases are materials that exist as individual molecules in the air at room temperature; gases are measured as a percent volume of air, or parts per million (ppm).	<i>Welding gases (e.g., acetylene, nitrogen)</i>
		<i>Carbon Monoxide, CO</i>
		<i>Hydrogen Sulfide, H<sub>2</sub>S</i>
		<i>Methane, CH<sub>4</sub></i>
<b>Vapors</b>	Vapors are gaseous form of substances that are normally in a liquid state at room temperature and pressure. They are formed by evaporation; vapors are measured as a percent volume of air, or parts per million (ppm).	<i>Solvents (e.g., paint thinner, glue solvents, spot removers)</i>
		<i>Gasoline</i>
		<i>Paints &amp; coatings</i>
<b>Fumes</b>	Solid particles that are formed when a metal or other solid vaporizes and the molecules condense (or solidify) in cool air. This usually occurs during welding/cutting of metals, e.g., welding fumes. These are measured as a concentration of airborne particles in a given space. Fumes are measured in milligrams or micrograms per cubic meter of air (mg/m <sup>3</sup> ) or (µg/m <sup>3</sup> ).	<i>Lead (as a fume)</i>
		<i>Cadmium</i>
		<i>Hexavalent Chromium (CrVI) – Stainless steel</i>
		<i>Zinc (galvanized metals)</i>
<b>Dusts - Fibers</b>	Solid particles that are formed or generated from solid materials through mechanical processes such as crushing, grinding, sanding and drilling. Dusts are measured as a concentration of airborne particles in a given space in milligrams or micrograms per cubic meter of air (mg/m <sup>3</sup> ) or (µg/m <sup>3</sup> ). Fibers (asbestos) are measured in fibers per cubic centimeter (f/cc).	<i>Asbestos</i>
		<i>Silica (concrete)</i>
		<i>Lead (as a dust)</i>
<b>Mists</b>	Tiny droplets of liquid suspended in the air. Mists are measured in milligrams or micrograms per cubic meter of air (mg/m <sup>3</sup> ) or (µg/m <sup>3</sup> ).	<i>Lubricants</i>
		<i>Paints &amp; coatings</i>

Working with chemicals always involves the risk of exposure. The health risk is dependent upon the toxicity of the chemical, the types of effects and the various **routes of entry**.

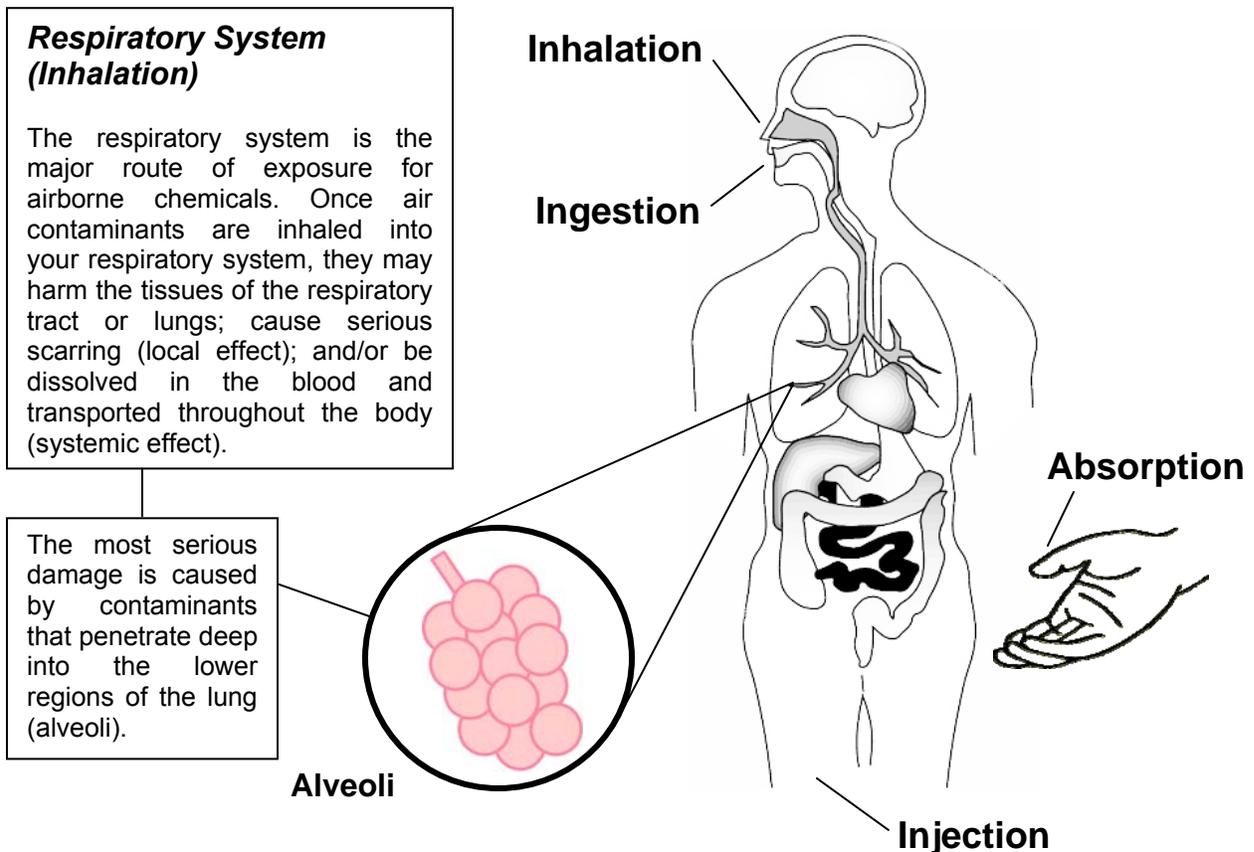
## Routes of Entry

**Inhalation** is the primary route of entry for hazardous chemicals in the work environment. Nearly all materials that are airborne can be inhaled.

**Absorption** through the skin is another route of entry. The skin is the largest organ of your body and a common exposure site for liquid and airborne chemicals. Absorption through the skin can occur quite rapidly if the skin is cut or abraded. Intact skin is an effective barrier to many hazardous materials.

**Ingestion** - toxic materials can be swallowed and enter the body through the gastrointestinal tract. In the workplace, people can unknowingly ingest harmful chemicals when you eat, drink, or smoke in a contaminated work areas.

**Injection** occurs when a sharp object punctures the skin, allowing a chemical or infectious agent to enter your body. For example, injection can occur when a contaminated object such as a rusty nail punctures the skin.

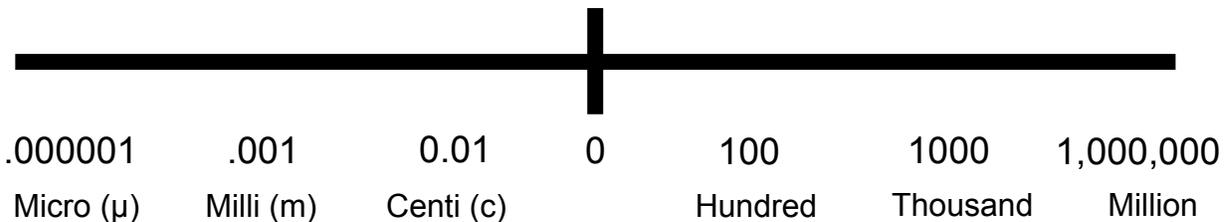


To describe the amount of a chemical, **units of concentration** such as parts per million (ppm), milligrams per cubic meter of air (mg/m<sup>3</sup>), micrograms per cubic meter of air (µg/m<sup>3</sup>) and fibers per cubic centimeter of air (f/cc) are most often used.

**Units of Concentration**

<b>(ppm)</b> Parts per Million	<b>(mg/m<sup>3</sup>)</b> Milligrams per Cubic Meter of Air	<b>(µg/m<sup>3</sup>)</b> Micrograms per Cubic Meter of Air	<b>(f/cc)</b> Fibers per Cubic Centimeter of Air
Used to express the amount of a gas or vapor; one part of a gas or vapor per million parts of air.	Used to express the amount of a toxic fume, dust or mist; the amount of a substance (mg) in a given amount of space (m <sup>3</sup> ).	Used to express the amount of a highly toxic fume, dust or mist; the amount of a substance (µg) in a given amount of space (m <sup>3</sup> ).	Fibers are any particle longer than 5 microns (µm), one millionth of a meter, and have an aspect ratio (length : width) greater than 3:1
<b>1 x 10<sup>-6</sup> or .000001</b>	<b>1 milligram (mg) = 1/1,000 gram = (0.001 gram)</b>	<b>1 microgram (µg) = 1/1,000,000 gram = (0.000001 gram)</b>	<b>1 micron (µm) = 1/1,000,000 meter</b>
<b>10,000 ppm = 1% volume of air</b>	<b>One cubic meter (m<sup>3</sup>) = 35.31 cubic feet (f<sup>3</sup>)</b>	<b>One cubic meter (m<sup>3</sup>) = 35.31 cubic feet (f<sup>3</sup>)</b>	<b>One cubic centimeter (cc) = 0.061 cubic inches</b>
<b>Example (PEL)... Carbon Monoxide (CO) (50 ppm)</b>	<b>Example (PEL)... Iron Oxide Fume (10 mg/m<sup>3</sup>)</b>	<b>Example (PEL)... Lead (50 µg/m<sup>3</sup>)</b>	<b>Example (PEL)... Asbestos (0.1 f/cc)</b>

**Scale of Numbers**



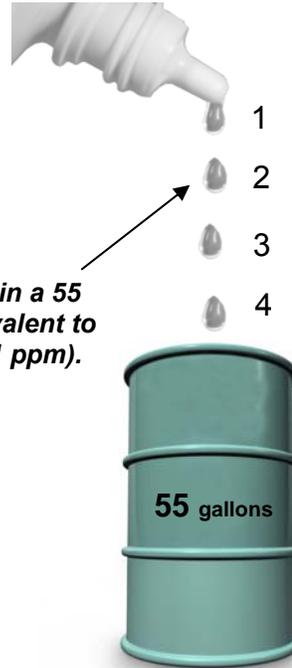
## Parts per Million (ppm)

*(Ratio: 1/1,000,000)*

### Example:

One part per million is equivalent to four (4) eye drops of liquid in a 55 gallon barrel.

*Four (4) eye drops in a 55 gallon drum is equivalent to 1 part per million (1 ppm).*



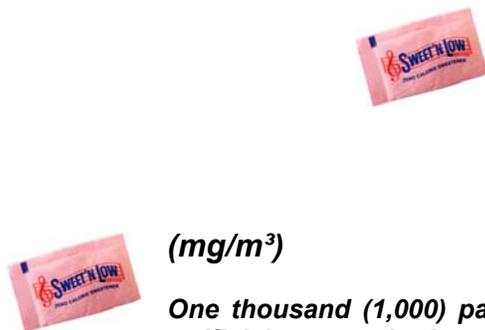
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## Milligrams per Cubic Meter of Air ( $\text{mg}/\text{m}^3$ ) & Micrograms per Cubic Meter of Air ( $\mu\text{g}/\text{m}^3$ )

### Weight / Volume

#### Example:

*[One (1) packet of artificial sweetener is 1 gram]*

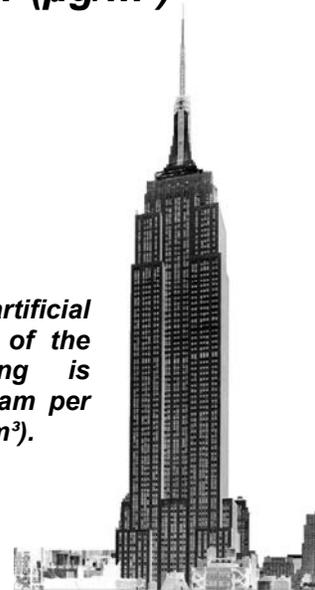


$(\mu\text{g}/\text{m}^3)$

*One (1) packet of artificial sweetener in the volume of the Empire State Building is equivalent to 1 microgram per cubic meter of air ( $1 \mu\text{g}/\text{m}^3$ ).*

$(\text{mg}/\text{m}^3)$

*One thousand (1,000) packets of artificial sweetener in the volume of the Empire State Building is equivalent to 1 milligram per cubic meter of air ( $1 \text{mg}/\text{m}^3$ ).*



*50 artificial sweetener packets in the volume of the Empire State Building is equivalent to  $50 \mu\text{g}/\text{m}^3$  (OSHA PEL for Lead).*

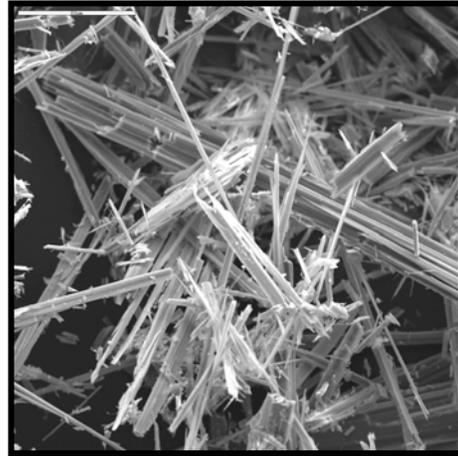
## ***Fibers per Cubic Centimeter (f/cc)***

***[Amount (Number of Fibers) / Volume]***

**Fiber** – Means a particulate form of asbestos, 5 micrometer ( $\mu\text{m}$ ) or longer, with a length-to-width ratio of at least 3 to 1.

### ***Why f/cc for Asbestos?***

The unit f/cc (Fibers per Cubic Centimeter) is used to describe limits for asbestos because it's the number of fibers, not the overall weight of the material that is of concern. Asbestos fibers that are in size and shape (5 $\mu\text{m}$  long and length to width ratio of 3:1) are needle sharp particles that damage the inner portions of the lungs. In contrast, asbestos fiber that is shorter or of a length-to-width ratio less than 3:1 does not cause significant damage.

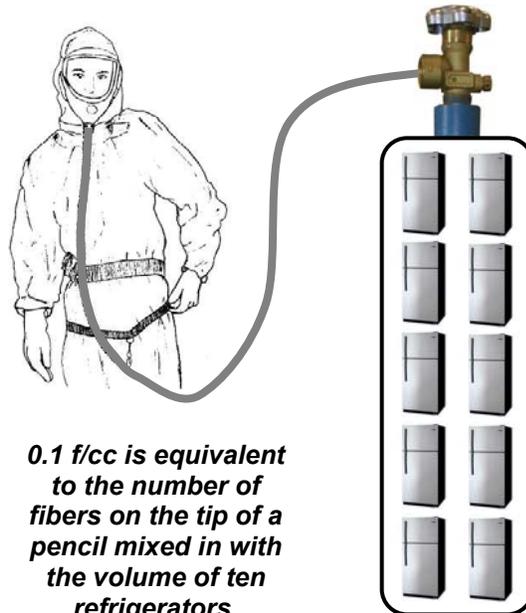


***Close-up photo of asbestos fiber; notice razor sharp particles.***

### ***OSHA PEL for Asbestos***

The Occupational Safety & Health Administration (OSHA) has established a Permissible Exposure Limit (PEL) for asbestos; **0.1 f/cc over a time weighted average (TWA) of 8 hours.**

On average, a worker will breathe 10,000,000 cubic centimeters (cc) of air in a typical work shift (8 hours); this is about the volume of 10 refrigerators. The number of asbestos fibers allowed by OSHA during this time period (0.1) can fit onto the tip of a pencil (about 1 million fibers).



***0.1 f/cc is equivalent to the number of fibers on the tip of a pencil mixed in with the volume of ten refrigerators.***



***Average amount of air a worker breathes during an 8-hour shift (ten refrigerators)***

## Respirable Particles

Dust, fibers, fumes and other particles that can go past the nose and mouth and enter deep into the respiratory system are considered to be respirable; these particles are less than 10 microns ( $\mu\text{m}$ ) in diameter.

***Respirable dust is less than 10 microns ( $\mu\text{m}$ ) in diameter!***

A micron is 1 millionth of a meter (1/96,000 of an inch).

Human hair is between 80 – 120 microns ( $\mu\text{m}$ ) in diameter.

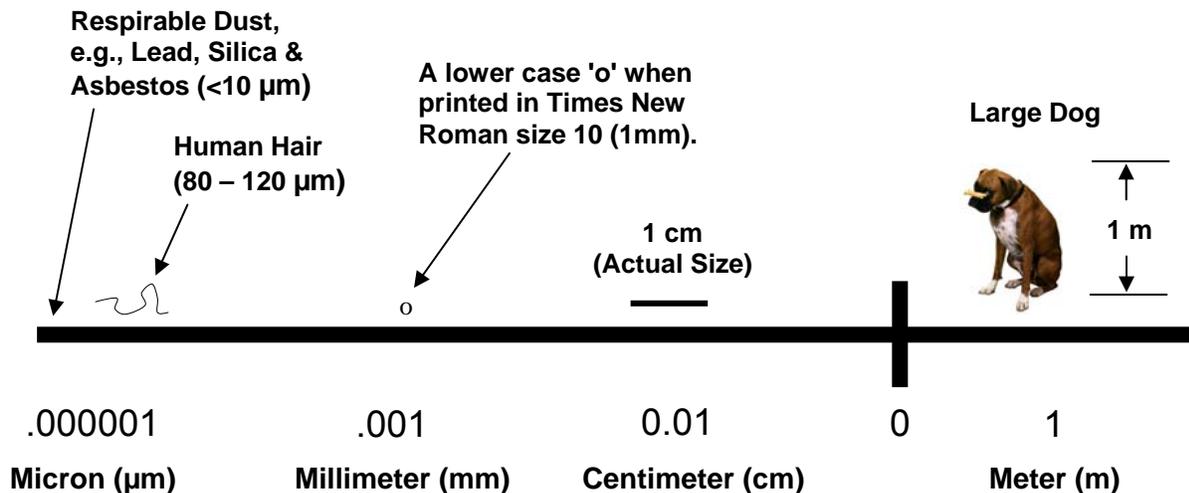
Some exposures in construction, such as toxic fumes, dusts and mists occur from particles that are less than 10 microns ( $\mu\text{m}$ ) in diameter; these exposures are invisible.



*Human hair is between 80 – 120 microns ( $\mu\text{m}$ ) in diameter.*

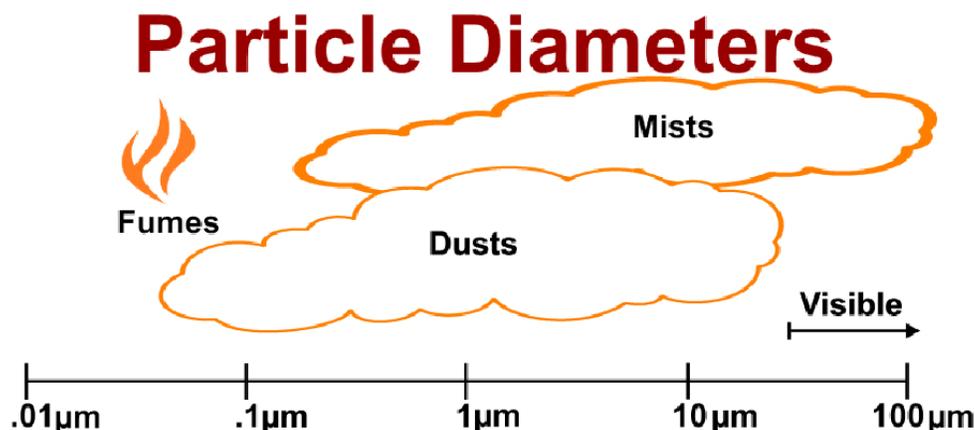
***Examples of respirable (invisible) fume or dust:***

- Silica
- Lead
- Asbestos
- Hexavalent Chromium



## Respirable Particles

Fumes, dusts and some mist particles are so small that they are invisible; these particles can enter deep into the lungs and cause serious health effects.



$$1 \text{ Micron} = 1\mu\text{m} = \frac{1}{1,000,000} \text{ Meter}$$

$$1 \text{ Red Blood Cell} = 7\mu\text{m}$$

### High Efficiency Particulate Air (HEPA)

High-efficiency particulate air filtration, or HEPA, is capable of filtering 0.3 micrometer particles with 99.97% efficiency, for use in contaminated environments.

Where airborne particles are less than 10 microns (μm) in diameter, a HEPA (100) rated respirator is highly recommended.

(See *Respiratory Protection Program*, page 201)



**Examples of respirators with high-efficiency particulate air (HEPA) filtration; these are recommended to be used where airborne particles are less than 10 μm in diameter.**

## Gases

Gases are materials that exist as individual molecules in the air at room temperature; gases are measured as a percent volume of air, or parts per million (ppm).

### REMEMBER...

**10,000 ppm = 1% volume of air**



Pictogram for Gas  
Globally Harmonized System

### How do Gases Affect the Body?

Toxic gases can directly irritate the skin, throat, eyes or lungs (*local health effect*); or they may pass from the lungs into the blood stream to damage other parts of the body (*systemic health effect*). Some gases such as carbon dioxide can cause you to suffocate by displacing oxygen in the air.

### Examples of gases found in construction:

- **Oxygen** – used for welding and cutting.
- **Acetylene** – used for welding and cutting.
- **Propane** – used for heating & fuel.
- **Carbon Dioxide** – used as an inert gas and can be found naturally in sewers.
- **Methane** – the principle component of natural gas and found in earth deposits.
- **Hydrogen Sulfide** – results from the break down of organic matter and can be found naturally in sewers.
- **Carbon Monoxide** – highly toxic and produced by the incomplete combustion of fuels.
- **Welding Gases** – The welding arc, burning process and action of ultraviolet radiation can produce ozone, phosgene and carbon monoxide gases.
- **Diesel Exhaust** – Nitrogen Dioxide.

### Who's at Risk?

Heavy equipment operators, welders and persons who enter into confined or enclosed spaces (plumbers & pipefitters, electricians and heating & air-conditioning workers) are the most at risk from chemicals in a gas form; laborers who enter into trenches are also at risk.

#### Group Discussion...

**What hazardous gases are present on your job?**



Engineering Control Example...  
Local Exhaust Ventilation System

## Gases

Gases used in construction are usually kept in compressed gas cylinders. The most common are oxygen and acetylene; these gases are used for hot work (e.g., cutting & welding of metals). However, some hazardous gases are found naturally in the earth and/or can be generated in sewer systems (e.g., carbon dioxide, methane & hydrogen sulfide).

Knowing the **gas density**, the **flammable range** and **toxicity** of the gas will help in understanding the hazards associated with the gas. Gases can also be classified as being either a **simple asphyxiant** or a **chemical asphyxiant**.

### Important questions concerning gases:

- What is the **gas density**?
- What is the flammable range (LFL) of the gas?
- How toxic is the gas (PEL, TLV, REL & IDLH)?
- Is the gas a **simple asphyxiant** or a **chemical asphyxiant**?

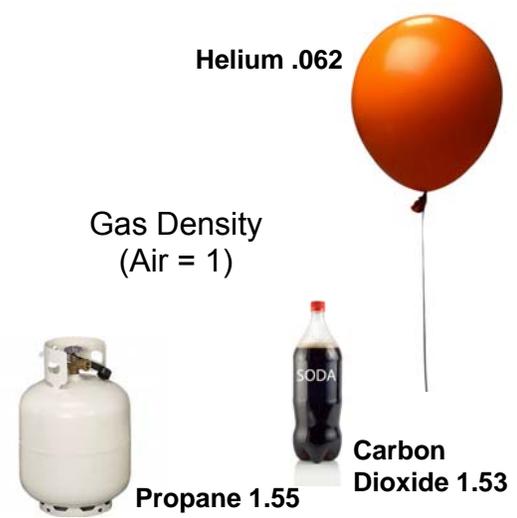


Compressed gas cylinders on cart (upright & secured)

## Gas Density

Gas density is defined as the relative weight of a gas compared to air, which has an arbitrary value of one (1). If a gas density is less than one it will generally rise in air. If the gas density is greater than one it will generally sink in air.

**WARNING!** Gases with densities greater than one (1) will sink in air and displace oxygen within confined or enclosed spaces.



## Breathable Air

The air around us is a mixture of gases, mainly nitrogen and oxygen. But air also contains a small amount of water vapor, argon, and carbon dioxide. Understanding the air we breathe will better prepare us to recognize potential hazardous atmospheres.

**Remember...**

**Oxygen Deficiency Hazard is when air contains less than 19.5% oxygen by volume.**



**The air we breathe is mostly made up of:**

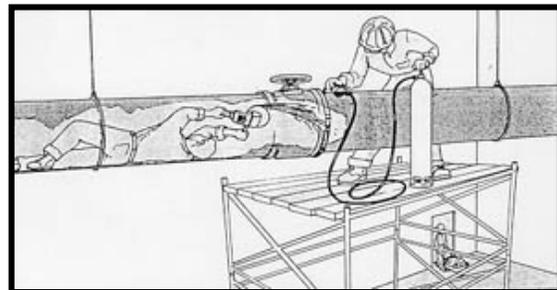
**Nitrogen, N<sub>2</sub> (78%)  
Oxygen, O<sub>2</sub> (20.9%)**

<b>Composition of Air</b>	
<b>Substance (Gas)</b>	<b>% by Volume (ppm)</b>
Nitrogen, N <sub>2</sub>	78% (780,000)
Oxygen, O <sub>2</sub>	20.9% (209,000)
Argon, Ar	0.9% (9,000)
Carbon Dioxide, CO <sub>2</sub>	0.1% (1,000)

**Too much oxygen (over 23.5%) is an unacceptable fire hazard!**

### ACCIDENT REPORT FATAL FACTS

A welder entered a steel pipe to grind a bad weld at a valve about 30 feet from the entry point. Before he entered, other crew members decided to add oxygen to the pipe near the bad weld. He had been grinding intermittently for about five minutes when a fire broke out enveloping his clothing. Another crew member pulled him 30 feet to the pipe entrance and extinguished the fire. However, the welder died the next day from his burns.



**Never use pure oxygen for ventilation, cooling or cleaning!**

To see complete OSHA Fatal Fact #25, go to [www.osha.gov](http://www.osha.gov)

Gases can displace oxygen; these gases are called...

### Simple Asphyxiants

## Simple Asphyxiant

A simple asphyxiant is a gas that displaces oxygen, thus lowers the overall amount of oxygen in the air. A simple asphyxiant by itself is not toxic but can be hazardous because of the oxygen deficient atmosphere that it may create. Simple asphyxiants are especially dangerous in confined and enclosed spaces because the gas gets trapped and has nowhere to go.

Non-flammable simple asphyxiants are considered to be a **hazard not otherwise classified (HNOC)**; meaning the substance has the potential to cause an adverse physical or health effect but does not meet the specified criteria for the physical and health hazard classes as listed by OSHA's Hazard Communication Standard.

**Oxygen deficient atmospheres contain less than 19.5% oxygen!**

Simple Asphyxiants						
Asphyxiant (Gas)	Gas Density	LFL	PEL <sup>1</sup> (ppm)	IDLH <sup>2</sup> (ppm)	NFPA 704M	
Carbon Dioxide, CO <sub>2</sub>	1.53	NA	5000	40,000	Fire: 0 Health: 0 Reactivity: 0 Specific Hz: NA	
Nitrogen, N	.97	NA	E <sup>3</sup>	NA	Fire: 0 Health: 0 Reactivity: 0 Specific Hz: NA	
Argon, Ar	1.38	NA	E <sup>3</sup>	NA	Fire: 0 Health: 0 Reactivity: 0 Specific Hz: NA	
Methane*, CH <sub>4</sub> 	.55	5.3%	E <sup>3</sup>	5300*	Fire: 4 Health: 1 Reactivity: 0 Specific Hz: NA	

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals

<sup>1</sup> Permissible Exposure Limit

<sup>2</sup> Immediate Dangerous to Life and Health

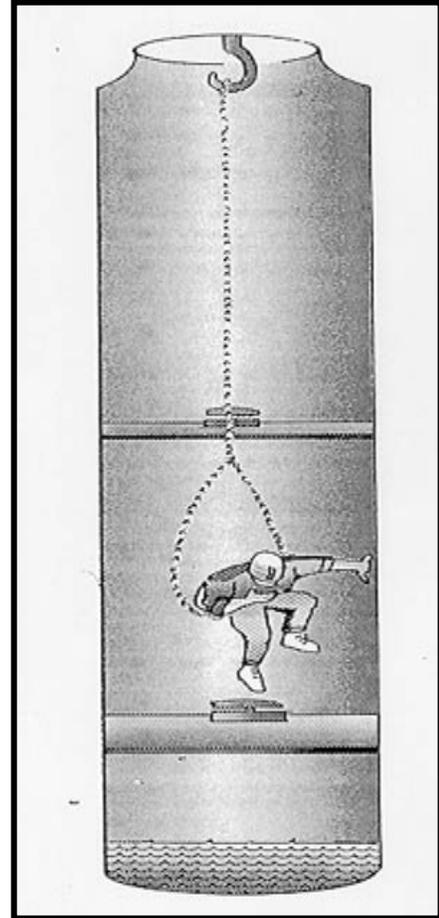
<sup>3</sup> Simple asphyxiants (E). The limiting factor is the available oxygen which shall be at least 19.5%.

\* Methane is non-toxic, but explosive; IDLH is based on 10% of the LFL.

## ACCIDENT REPORT FATAL FACTS

An employee sitting in a looped chain was lowered approximately 17 feet into a 21-foot deep manhole. Twenty seconds later he started gasping for air and fell from the chain seat face down into the accumulated water at the bottom of the manhole. An autopsy determined oxygen deficiency as the cause of death.

To see complete OSHA Fatal Fact #39, go to [www.osha.gov](http://www.osha.gov)



### **Sewer Entry**

Workers can be exposed to the following potential hazards:

- Engulfment
- Presence of toxic gases (e.g., hydrogen sulfide).
- Presence of explosive/flammable gases (e.g., methane).
- Oxygen deficiency; a concentration of oxygen in the atmosphere equal to or less than 19.5% by volume.

### **Before Entry into Confined Spaces:**

- Instruct employees to recognize and avoid unsafe conditions associated with their work environment.
- Instruct employees on hazards involved in entering confined or enclosed spaces.
- Evaluate the space for hazards and eliminate or protect against these hazards before entry.



**Confined Space Hazards...  
Always check for hazardous atmospheres!**

**ACCIDENT REPORT**  
**FATAL FACTS**

Three employees were sandblasting portions of a heat exchanger in a manufacturing plant, preparing the surface for paint. The job was almost finished except for some touch-up work. The air compressor used to supply breathing air to the sand-blasters' hoods was sent to another job. The workers hooked their supply hoses into the plant's air system without clearing it with the plant's management.

The plant operators, not knowing the plant air was being used for breathing air, shut down the compressor for scheduled maintenance. This caused the nitrogen back-up system to come on line to maintain air pressure.

One sandblaster was asphyxiated from the nitrogen being fed into his hood.

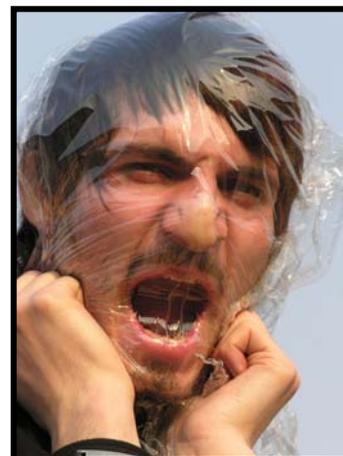


*To see complete OSHA Fatal Fact #67, go to [www.osha.gov](http://www.osha.gov)*

**Lessons Learned – Simple Asphyxiants**

Air is a mixture of different gases; oxygen is the most important element needed for human life. Because gases have different densities (air = 1), oxygen can be displaced. When this happens, oxygen levels drop and workers can become asphyxiated; oxygen deficiency is less than 19.5% O<sub>2</sub> by volume of air.

***Exposure to simple asphyxiants is like suffocating in a plastic bag.***



## ***Temporary Heating Devices & Asphyxiation***

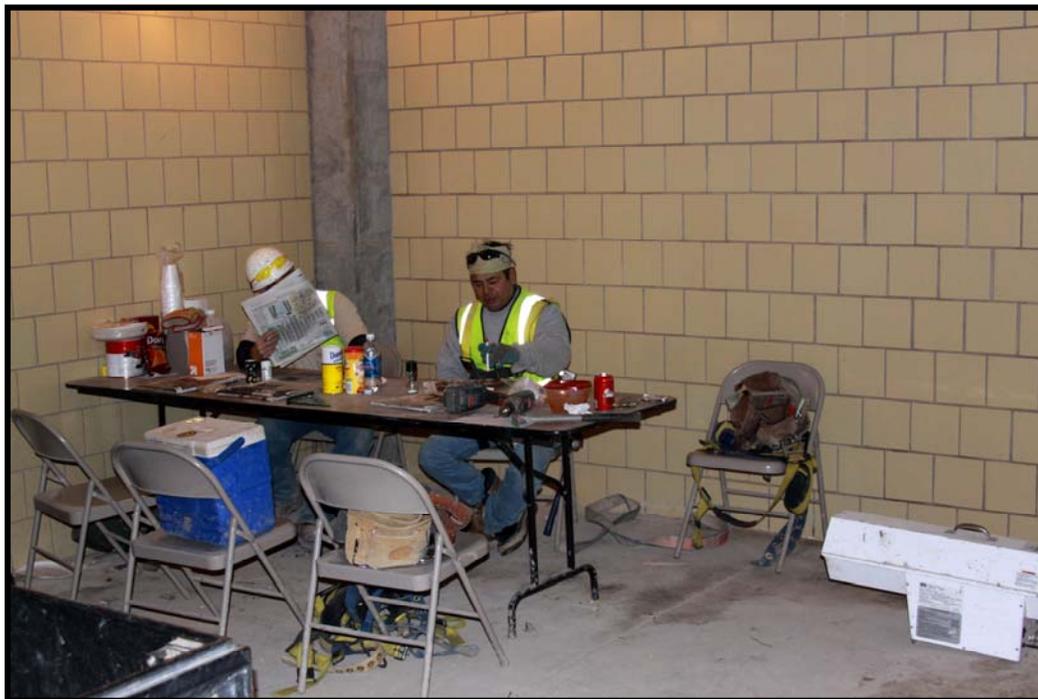
To avoid asphyxiation while using temporary heating devices, follow these OSHA rules:

- Fresh air must be supplied in sufficient quantities to maintain the health and safety of workers. Where natural means of fresh air supply is inadequate, mechanical ventilation must be provided.
- When heaters are used in confined spaces, special care must be taken to provide sufficient ventilation in order to ensure proper combustion, maintain the health and safety of workers and limit temperature rise in the area.

*OTI Southwest Education/elcoshimages.org*



***Portable heaters used inside could expose workers to hazardous gas.***



***When using portable heaters, special care must be taken to provide sufficient ventilation in order to ensure a safe and healthful environment.***

Gases, if inhaled, can be toxic; these are called...

**Chemical Asphyxiants**

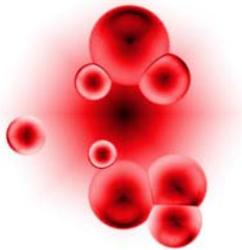
**Chemical Asphyxiant**

Chemical asphyxiants reduce the body's ability to absorb, transport, or utilize inhaled oxygen. They are often toxic at very low concentrations (a few ppm).

**Chemical asphyxiants include:**

**Carbon Monoxide** – “The Silent Killer”

**Hydrogen Sulfide** – Rotten Eggs



*Carbon monoxide prevents oxygen transport by combining with hemoglobin.*



*Hydrogen sulfide will cause a swelling of the air passage causing suffocation.*

Chemical Asphyxiants						
Asphyxiant (Gas)	Gas Density	LFL	PEL <sup>1</sup> (ppm)	IDLH <sup>2</sup> (ppm)	NFPA 704M	
Carbon Monoxide, CO 	.97	12.5%	50	1,200	Fire: 4 Health: 3 Reactivity: 0 Specific Hz: NA	
Hydrogen Sulfide, H <sub>2</sub> S 	1.19	4%	10	100	Fire: 4 Health: 3 Reactivity: 0 Specific Hz: NA	

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals

<sup>1</sup> Permissible Exposure Limit

<sup>2</sup> Immediate Dangerous to Life and Health

## Carbon Monoxide (CO)



Carbon monoxide is an odorless, colorless and toxic gas. Because it is impossible to see, taste or smell the toxic fumes, CO can kill you before you are aware of your exposure. At lower levels of exposure, CO causes mild effects that are often mistaken for the flu. These symptoms include headaches, dizziness, disorientation, nausea and fatigue. The effects of CO exposure can vary greatly from person to person depending on age, overall health and the concentration and length of exposure.

CO is found in combustion exhaust, such as those produced by cars, trucks and small gasoline engines (generators).



***Gasoline engine (water pump) being operated inside a trench box (enclosed space); this is a potential hazardous exposure to carbon monoxide!***

<b>Concentration of Carbon Monoxide (CO) &amp; Health Effects</b>		
<b>% Volume of Air</b>	<b>ppm</b>	<b>Health Effects</b>
<b>.02</b>	<b>200</b>	<b>Possibly headache, mild frontal in 2-3 hrs.</b>
<b>.04</b>	<b>400</b>	<b>Headache, frontal, and nausea after 1-2 hrs.</b>
<b>.08</b>	<b>800</b>	<b>Headache, dizziness and nausea in 3/4 hour, collapse and possible unconsciousness in 2 hrs.</b>
<b>.12</b>	<b>1200</b>	<b>Headache, dizziness and nausea in 20 min.; collapse, unconsciousness, possibly death in 2 hr.</b>

***Good example of generator exhausts being vented to the outside.***



## Hydrogen Sulfide ( $H_2S$ )



Hydrogen sulfide is a colorless, very poisonous, flammable gas with the characteristic foul odor of rotten eggs. It often results from the bacterial breakdown of organic matter in the absence of oxygen, such as in swamps and sewers (manholes).

Just a few breaths of air containing high levels of hydrogen sulfide gas can cause death. Lower, longer-term exposure can cause eye irritation, headache, and fatigue.



### Concentration of Hydrogen Sulfide ( $H_2S$ ) & Health Effects

% Volume of Air	ppm	Health Effects
.0002	.02	Odor detected by human nose.
.001	10	Irritation of the eyes, nose and throat.
.005	50	Headache, dizziness and nausea; coughing and breathing difficulty.
.01	100	Severe respiratory tract irritation, eye irritation, convulsions, coma & death in severe cases.

**WARNING:** When hydrogen sulfide is breathed in, it reacts with the moisture in the airways and forms an acid. This is highly irritating to skin tissue resulting in acute irritant health effects.

**$H_2S$**  is an acute poisoning!  
It can occur with no warning at all, since even the sense of smell may be overcome, and it can be fatal within a few seconds.

Decomposition, or break down of materials during welding, cutting and brazing could result in an exposure to hazardous gas.

## Welding, Cutting & Brazing Gases

A number of gases are produced as a normal part of the welding process. These gases may come from the welding arc (*ozone & nitrogen oxides*), or the burning process (*carbon dioxide, carbon monoxide, hydrogen fluoride and phosgene*).

***Gases generated during welding, cutting and brazing; these may be produced by the welding operation:***

- Carbon Dioxide
- Carbon Monoxide
- Nitrogen Dioxide
- Nitric Oxide
- Hydrogen Fluoride
- Ozone
- Phosgene



***Welders have potential exposure to hazardous gas.***

***Nitrogen Dioxide*** – Corrosive and irritating to the eyes, skin, and mucous membranes. Inhalation may result in chemical pneumonitis and pulmonary edema.

***Nitric Oxide*** – Corrosive and severely irritating to eyes and respiratory system. Effects may be delayed for several hours following exposure. Inhalation may result in chemical pneumonitis and pulmonary edema. This product accelerates the combustion of combustible material.

***Hydrogen Fluoride*** – Corrosive and irritating to the eyes, skin, and mucous membranes. Inhalation may result in chemical pneumonitis and pulmonary edema.

***Ozone*** – POISON GAS; lethal at relatively low concentrations and at short exposure periods. The primary toxic effect is lung injury characterized by pulmonary congestion, edema, and hemorrhage. Irritant; can cause eye, nose, throat, and respiratory irritation. Long-term exposure may result in chronic respiratory disease.

***Phosgene*** – Corrosive to exposed tissues. Inhalation may result in pulmonary edema and chemical pneumonitis. During welding operations, hot work can decompose chlorinated solvent vapors; example, trichloroethylene, which is often used as a metal cleaner.

Welding, Cutting & Brazing Gases						
Gas	Gas Density	LFL	PEL (ppm)	IDLH (ppm)	NFPA 704M	
Carbon Dioxide (Simple Asphyxiant)	1.53	NA	5000	40000	Fire: 0 Health: 0 Reactivity: 0 Specific Hz: NA	
Carbon Monoxide 	.97	12.5%	50	1,200	Fire: 4 Health: 3 Reactivity: 0 Specific Hz: NA	
Nitrogen Dioxide 	2.62	NA	5 (C <sup>1</sup> )	20	Fire: 0 Health: 3 Reactivity: 0 Specific Hz: NA	
Nitric Oxide 	1.04	NA	25	100	Fire: 0 Health: 3 Reactivity: 0 Specific Hz: OXY	
Hydrogen Fluoride 	1.86	NA	3	30	Fire: 0 Health: 4 Reactivity: 1 Specific Hz: NA	
Ozone 	1.66	NA	.1	5	Fire: 0 Health: 4 Reactivity: 3 Specific Hz: OXY	
Phosgene 	3.48	NA	.1	2	Fire: 0 Health: 4 Reactivity: 1 Specific Hz: NA	

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals

<sup>1</sup> Ceiling Limit (C); an exposure level for a chemical that must not be exceeded for any amount of time.



Flammable



Irritant



Corrosive



Toxic

## Diesel Exhaust

Diesel exhaust is a pervasive airborne contaminant in workplaces where diesel-powered equipment is used. Due to expanding use of diesel equipment, more and more workers are exposed to diesel exhaust. More than one million workers are exposed to diesel exhaust and face the risk of adverse health effects, ranging from headaches and nausea to cancer and respiratory disease.

### Diesel Fuel Hazard Information

Manufacturers and importers of diesel fuel are responsible for performing a hazard determination and transmitting the hazard information of diesel fuel to their downstream customers through Material Safety Data Sheets (MSDSs). As part of the evaluation, the manufacturer must anticipate the intended uses of the product, and consider the potential physical and health hazards to which employees may be exposed as a result of those uses. Any health or physical hazards associated with the exhaust must therefore be included on the MSDS.

### Group Discussion – Diesel Fuel

**Physical Description:** Liquid. Color varies, clear, yellow (pale to straw), red, blue, blue-green color - Petroleum odor.

<b>Diesel Fuel – Physical Properties</b>			
<b>Vapor Density:</b> >1 (air = 1)	<b>LFL:</b> 0.3 – 0.6%	<b>NFPA Fire Rating: 2</b> <b>NFPA Health Rating: 0</b> <b>NFPA Reactivity Rating: 0</b> <b>NFPA Special Instruction: N/A</b>	
<b>Flash Point:</b> >125°F	<b>UFL:</b> 7.5 – 10.0%		
<b>Globally Harmonized System Label:</b>			

**NOTE:** NIOSH regards whole diesel fuel exhaust particulates as a potential cause of occupational lung cancer based on animal studies and limited evidence in humans.

### Control of Diesel Exhaust

Equipment operators should be trained in the efficient use and care of the equipment.

- Ensure proper ventilation while equipment is operating in enclosed spaces.
- Do not idle engines excessively.
- Personnel working with diesel fuel in areas where diesel exhaust may be present should be advised of the potential hazards of exposure (see manufacturers MSDS).

## Respiratory Protection for Exposure to Gases

**NOTE:** Before using any respirator and filter combination, always check with the manufacturer to ensure that it is approved and appropriate for the hazard.

**Respiratory protection used to protect against gases include:**

- Acid gas cartridges [White]
- Organic vapor (OV) acid gas cartridges [Yellow]
- Multi vapor gas cartridges [Olive Green]



**3M™ Organic Vapor/Acid Gas Respirators 5000 Series**

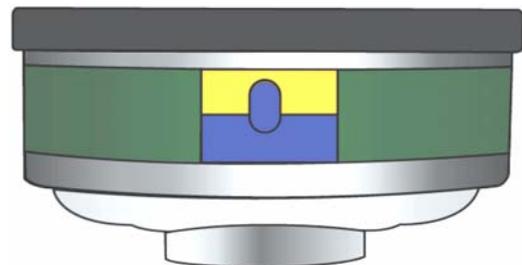
### End of Service Life Indicator (ESLI)

ESLI's help to eliminate the guesswork in determining when a respirator's cartridges should be replaced. ESLI's are indicators on the side of each filter cartridge that change color as the charcoal or other absorbent inside absorbs the chemicals. The color change progresses from one end of the indicator window to the other. The service life of the filter is expired when the indication color fills the indicator window.

Many gas cartridges require an **end of service life indicator (ESLI)** due to their poor warning properties (e.g., hydrogen sulfide). If the cartridge does not have an ESLI, then a regular respirator cartridge change out schedule must be instituted by the employer.



**The indicator background changes to a different color as the service life shortens.**



**The indicator completely changes color when the service life of the cartridge is expired.**

## Vapors

Vapors are gaseous form of substances that are normally in a liquid state at room temperature and pressure. They are formed by evaporation; vapors are measured as a percent volume of air, or parts per million (ppm).

### REMEMBER...

**10,000 ppm = 1% volume of air**

### Examples of vapors found in construction:

- **Gasoline** – used for fuel.
- **Organic Solvents** – used as paint thinners (toluene & turpentine) & glue solvents (acetone & methyl ethyl ketone)

### How are Vapors Formed?

Vapors may be formed when liquids are heated, for example, boiling water creates steam (a form of vapor); some solvents form vapors without being heated (these vapors are formed at or below room temperature). The temperature at which a liquid gives off vapor is called **flash point**. How much vapor is released into the air and how quickly the vapor will fill a space is based on a liquid's **vapor pressure**.



**Water needs to be heated (212°F) for vapors to be formed.**



**Some solvents give off vapor at or below room temperature (72°F).**

### Important questions concerning vapors:

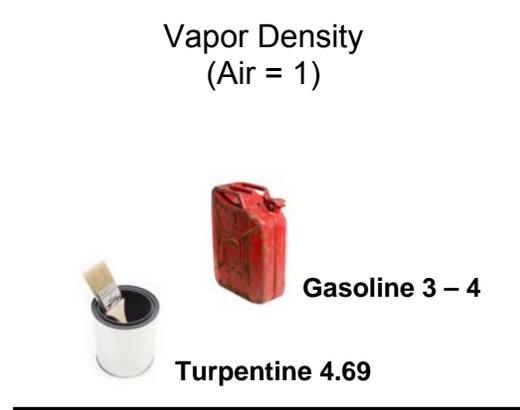
- What is the **vapor density**?
- What is the **flash point** of the liquid to which vapor is produced?
- What is the **vapor pressure**?
- What is the flammable range (LFL) of the vapor?
- How toxic is the vapor (PEL, TLV, REL & IDLH)?



**Nail polish remover, an organic solvent (usually acetone) has a distinctive vapor odor.**

## Vapor Density

Vapor density is defined as the relative weight of a vapor compared to air, which has an arbitrary value of one (1). If a vapor density is less than one it will generally rise in air. If the vapor density is greater than one it will generally sink in air. All vapor produced by solvents have densities greater than 1.



## Solvents

Most vapors produced on construction sites come from solvents. A solvent is a substance, most likely a liquid, which dissolves another substance. Common uses for organic solvents are in paint thinners (e.g., toluene & turpentine), and glue solvents [e.g., acetone & methyl ethyl ketone (butanone)]. An important physical property of solvents is **flash point**.



## Flash Point

**Flash Point** is the minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

A **Flammable Liquid** is a liquid with a flash point of not more than 93 °C. Substances and mixtures of this hazard class are assigned to one of four hazard categories on the basis of the flash point and boiling point.

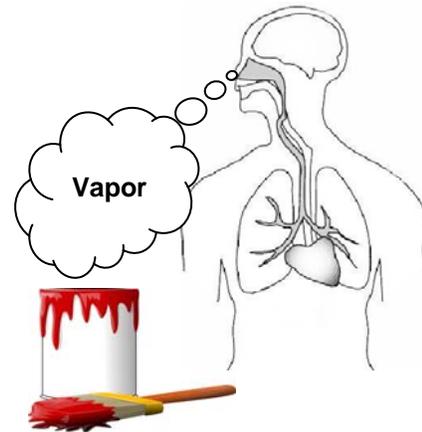
Flammable Liquids	
Category	Criteria
1	Flash point < 23°C (73°F) and initial boiling point ≤ 35°C (95°F)
2	Flash point < 23°C (73°F) and initial boiling point > 35°C (95°F)
3	Flash point ≥ 23°C (73°F) and ≤ 60°C (140°F)
4	Flash point ≥ 60°C (140°F) and ≤ 93°C (200° F)

## How do Solvents Affect the Body?

Solvents are valuable because they can dissolve other substances. But they can also dissolve skin fats and oils. Most of the solvents used in construction cause some form of dermatitis – skin dryness, cracking, redness, and blisters (*local health effect*).

Some solvents have high vapor pressure, meaning that the solvent evaporates at low temperatures and very quickly; this will result in more vapor being produced causing more of a hazard (more vapor being inhaled).

When breathed in, solvent vapors can enter the blood stream and travel to other parts of the body, particularly the nervous system, resulting in a toxic exposure (*systemic health effect*).

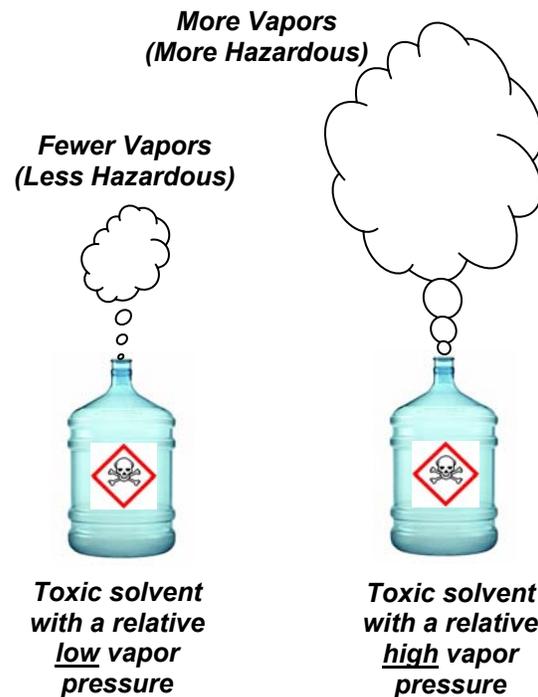


**Solvents have relatively low flash points and some have high vapor pressure values.**

## Vapor Pressure

Vapor pressure is the likelihood that a liquid will evaporate at room temperature. Chemicals with a high vapor pressure will evaporate more than chemicals with a low vapor pressure. If two chemicals are equally toxic to the body, the one with the higher vapor pressure is more hazardous because more of it will evaporate and be in the air to be inhaled.

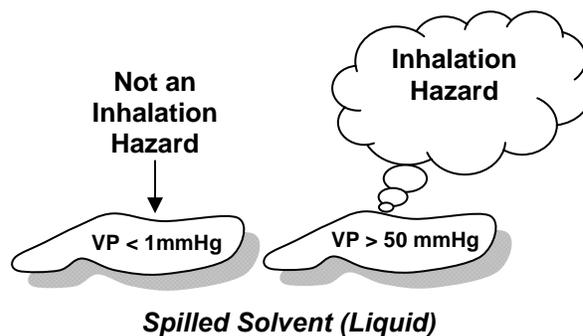
One unit of measurement to describe a substances relative vapor pressure is "mmHg" (millimeter of mercury); the unit of pressure equal to the pressure exerted by liquid mercury one-millimeter-high column at a standard temperature.



## Hazardous (Dangerous) Vapor Pressure

Toxic substances become more hazardous when a greater potential for entry into the body exists, inhalation is the greatest potential for chemicals to enter the body; *more airborne vapor, more hazardous the situation.*

- Vapor pressure is **less than 1mmHg**; it is not likely to evaporate (**not an inhalation hazard**).
- Vapor pressure **greater than 50 mmHg**; it is likely to evaporate (**is an inhalation hazard**).



### Group Discussion...

*What hazardous vapors are present on your job?*

## Respiratory Protection for Exposure to Vapors

**NOTE:** Before using any respirator and filter combination, always check with the manufacturer to ensure that it is approved and appropriate for the hazard.

**Respiratory protection used to protect against vapors include:**

- Organic vapor (OV) cartridge [Black]
- Organic vapor (OV) acid gas cartridges [Yellow]
- Multi vapor gas cartridges [Olive Green]

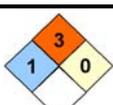
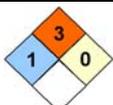


**North 7700 Series Half-Face Respirator equipped with organic vapor acid gas cartridge (yellow)**

<b>Solvents Commonly Used in Construction</b>	
<p><b>Alcohols</b></p> <p>All alcohols are flammable. Alcohols affect the body by irritating the skin, eyes, nose and throat. Commonly found in paints and varnishes.</p>	<p><b>Amyl</b> and <b>isopropyl (rubbing)</b> alcohol are irritating and can cause headache, nausea and drowsiness. High exposures to vapors in enclosed space can result in death.</p>
<p><b>Aromatic Hydrocarbons</b></p> <p>Derived from benzene, these flammable solvents are used to dissolve rubber, plastics, and paint. All members of this family can cause severe skin irritation and sleepiness.</p>	<p><b>Benzene</b> is very hazardous and should be completely avoided! Destroys the bone marrow's ability to produce red and white blood cells causing anemia (too few red blood cells). Can cause leukemia (cancer).</p> <p><b>Toluene</b> is found in paint and may be used as a substitute for benzene. However, it is often contaminated with benzene. Causes irritation to the skin. Vapors affect judgment and reflexes, exposure can contribute to accidents.</p> <p><b>Xylene</b> is most commonly found in paints and adhesives. It is a stronger irritant than toluene and less dangerous than benzene. But Xylene may also be contaminated with benzene.</p>
<p><b>Aliphatic Hydrocarbons</b></p> <p>Less harmful than the aromatic hydrocarbons. But they can still cause dermatitis and drowsiness.</p>	<p><b>Petroleum Naphtha</b>, found in coal tar and paints, is a mixture of chemicals, including benzene. Also called petroleum distillates.</p> <p><b>Ethylene Dichloride</b> is most commonly found in paint and varnish removers. Its vapors can irritate the eyes and throat, and cause nausea and vomiting.</p>
<p><b>Chlorinated Hydrocarbons</b></p> <p>Nonflammable materials that are used as degreasers and general-purpose solvents. All can cause dermatitis and drowsiness. Some can damage the liver and kidneys, and several are known or suspected cancer-causing agents.</p>	<p><b>Carbon Tetrachloride</b>; <i>completely avoid!</i> Even small concentrations of this material can damage the liver and kidneys.</p> <p><b>Methyl Chloroform</b> (1,1,1-trichloroethane) is considered safer than other chlorinated solvents. It can still damage the liver, though less severely than carbon tetrachloride.</p> <p><b>Trichloroethylene</b> is found in paints and is often used as a metal cleaner. It can damage the liver and kidneys; suspected to cause cancer. Can be broken down by heat from welding into harmful gases.</p> <p><b>Methylene Chloride</b> is found in paint strippers and can irritate the eyes and skin, and cause dizziness. When inhaled, it is changed by the body into carbon monoxide.</p> <p><b>Tetrachloroethane</b> is found in paint strippers and is extremely hazardous. Can cause severe liver and kidney damage as well as narcosis or drunkenness; can be absorbed directly through the skin.</p>

## Solvents Commonly Used in Construction

<p><b>Ketones</b></p> <p>These solvents can irritate the skin, eyes, nose and throat. Can cause mild drowsiness; high concentrations can cause dizziness. Long-term exposure can cause chronic lung irritation.</p>	<p><b>Acetone</b> is the substance you smell in nail polish remover, and is one of the most common industrial solvents. It is also one of the least harmful, causing only minor irritation or feelings of drunkenness at high concentrations. This material is found in paints, lacquers and paint removers.</p> <p><b>Methyl Ethyl Ketone (2, Butanone)</b> dissolves many substances and is used as a solvent in processes involving gums, resins, cellulose acetate and nitrocellulose coatings and in vinyl films; it is also used in dry erase markers as the solvent of the erasable dye. Butanone is an irritant.</p>
<p><b>Carbon Disulfide</b></p>	<p><b>Carbon Disulfide</b> is used as a solvent for some resins as well as some paints and paint removers. It can cause drowsiness and irritate the skin. Long-term exposure can lead to behavior changes, and possible heart and liver diseases. This material can also affect the human reproductive system.</p>
<p><b>Turpentine</b></p>	<p><b>Turpentine</b> is used to clean equipment or as paint thinner, can cause an allergic skin reaction. In concentrations, its vapors can irritate the eyes and nose, and cause headache. Exposure to high concentrations can also damage the kidneys.</p>
<p><b>Butadiene</b></p>	<p><b>Butadiene</b> is found in cements used to join plastic pipe and can irritate the eyes and mucous membranes. Inhalation of high concentrations can lead to coma or death. Contact with the skin can cause burns or frostbite because it vaporized quickly; be sure to wear appropriate protective clothing and gloves when working with this material.</p>
<p><b>Adhesives &amp; Resins</b></p> <p>Solvents are found in many adhesives and resins. These materials are used to glue down carpet, sheet goods, tile, roofing and wall materials, and join plastic pipe.</p>	<p><b>Epoxy Resins</b> are used in impermeable paints and as a primer on hard floor surfaces. They are also used as a surface coat and adhesive for concrete walls. Most common problem is dermatitis, but epoxies also irritate and sensitize the lungs. Once the skin is sensitized, any contact immediately causes an itching reaction or allergic dermatitis. The symptoms of lung sensitization are similar to asthma; the air passages tighten up, making breathing difficult and causes wheezing.</p> <p><b>Naphthalene</b> is the most abundant single component of coal tar. Exposure to large amounts of naphthalene may damage or destroy red blood cells. Symptoms of exposure include fatigue, lack of appetite, restlessness, and pale skin; high exposure may cause nausea, vomiting, diarrhea, blood in the urine, and jaundice.</p> <p><b>Polyurethanes</b> have wide uses in construction; they are found in seam sealers, polyurethane insulation and as coatings. Exposures results in becoming sensitized and causes allergic asthma-like lung reaction; dry cough, shortness of breath, breathing difficulties and sometimes choking.</p>

Solvents Commonly Used in Construction							
Solvent	PEL (ppm)	IDLH (ppm)	Flash Point	LFL	Vapor Pressure (mmHg)	NFPA 704M	
Isopropyl Alcohol 	400	2000	53 °F	2%	33	Fire: 3 Health: 1 Reactivity: 0 Specific Hz: NA	
Benzene 	1	500	12 °F	1.2%	75	Fire: 3 Health: 2 Reactivity: 0 Specific Hz: NA	
Toluene 	200	500	40 °F	1.1%	21	Fire: 3 Health: 2 Reactivity: 0 Specific Hz: NA	
m – Xylene 	100	900	82 °F	1.1%	9	Fire: 3 Health: 2 Reactivity: 0 Specific Hz: NA	
Ethylene Dichloride 	50	50	56 °F	6.2%	64	Fire: 3 Health: 2 Reactivity: 0 Specific Hz: NA	
Carbon Tetrachloride 	10	200	NA	NA	91	Fire: 0 Health: 3 Reactivity: 0 Specific Hz: NA	
Methyl Chloroform (1,1,1-trichloroethane) 	350	700	NA	7.5%	100	Fire: 1 Health: 2 Reactivity: 0 Specific Hz: NA	
Trichloroethylene 	100	1000	NA	8%	58	Fire: 2 Health: 2 Reactivity: 0 Specific Hz: NA	
Methylene Chloride 	25	2300	NA	13%	350	Fire: 1 Health: 2 Reactivity: 0 Specific Hz: NA	
Acetone 	1000	2500	0 °F	2.5%	180	Fire: 3 Health: 1 Reactivity: 0 Specific Hz: NA	
Methyl Ethyl Ketone (2-Butanone) 	200	3000	16 °F	1.4%	78	Fire: 3 Health: 1 Reactivity: 0 Specific Hz: NA	

OSHA/EPA Occupational Chemical Database & NIOSH Pocket Guide to Hazardous Chemicals



Flammable



Irritant



Toxic



Carcinogen

## Fumes

Fumes are solid particles that are formed when a metal or other solid vaporizes and the molecules condense (or solidify) in cool air. This usually occurs during welding/cutting of metals, e.g., **welding fumes**. Fumes are also produced by hot **asphalt** during hot tar roofing and paving. **Coal tar (naphtha)** and plastics also produce fumes when heated.

Fumes are measured as a concentration of airborne particles in a given space (weight/volume); and are measured in either milligrams or micrograms per cubic meter of air ( $\text{mg}/\text{m}^3$ ) or ( $\mu\text{g}/\text{m}^3$ ).

### Important questions concerning fumes:

- How is the fume generated?
- How toxic is the fume (PEL, TLV, REL & IDLH)?
- How does the fume affect the body?

### Examples of fumes found in construction:

- **Welding Fumes** – result from various welding operations. The primary components are oxides of the metals involved such as lead, zinc, iron, chromium, aluminum, or nickel.
- **Asphalt** – black, sticky material that comes from crude oil. It's used in paving, roofing, waterproofing, and some glues.
- **Naphtha** – “Coal Tar” a brown or black thick liquid that comes from coal; it's a skin irritant known to cause cancer.
- **Lead Fumes and the Plumbers Melting Pot** – melting of lead to make cast iron joints and fittings.
- **Hexavalent Chromium (CrVI)** – Stainless steel & chromium metals.

## Who's at Risk?

Building trades workers are exposed to fumes from a number of different sources: welding, cutting & soldering operations, plumbing, and hot asphalt & roofing.

In order to confirm that employees are protected from the hazards of toxic fumes, air sampling data is needed of workers.



**Welding fumes are some of the most hazardous exposures a construction worker may experience.**

### Group Discussion...

**What hazardous fumes are present on your job?**

## ***How are fumes generated?***

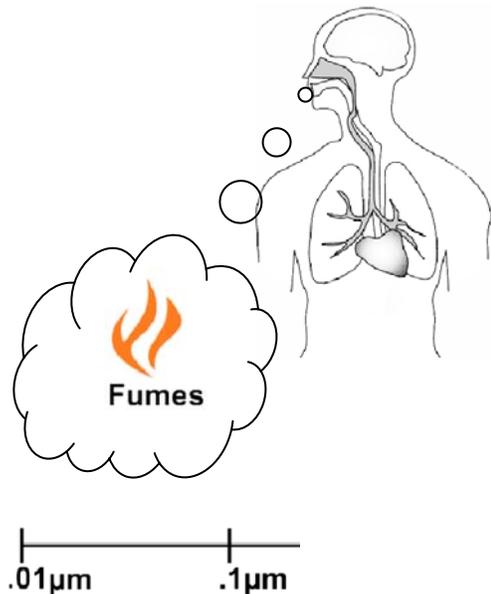
Fumes are generated by heat; either by burning, welding, cutting and heating. At a certain temperature, a solid is vaporized – then as it cools, it forms a small particle; these particles are respirable.

## ***How do fumes affect the body?***

Fumes can irritate the skin, eyes and nose; causing an immediate (*acute health effect*). These affects are local to the point of contact, such as mucous membranes, eyes and lungs.

For example, cadmium (welding fume), can cause the lungs to fill with fluid, causing pulmonary edema (fluid in the lungs).

Fumes are respirable in size [less than 10 microns ( $\mu\text{m}$ )] and primarily affect the body when they are breathed in. Because of their small size, fumes can easily pass from the lungs into the blood stream; resulting in a *systemic health effect*.



***Fumes are respirable size particles that are inhaled and can enter the blood stream.***

## ***Welding Fumes***

Welding fumes are the result from various welding operations. The primary components are oxides of the metals involved such as zinc, iron, chromium, aluminum, or nickel. Welding fumes typically have a metallic odor/taste, and their specific composition varies considerably.

***Hot work, such as welding, cutting and bracing creates fumes that may be hazardous to your health.***



## ***Metal Fume Fever [Zinc (Galvanized Metal)]***

According to the American Welding Society "...the symptoms of metal fume fever are headaches, fever, chills, muscle aches, thirst, nausea, vomiting, chest soreness, fatigue, gastrointestinal pain, weakness and tiredness. The symptoms usually start several hours after exposure and the attack may last between 6 and 24 hours. Complete recovery generally occurs without intervention after 24-48 hours. The respiratory effects are worse by those who smoke. There is an excess of infertility among welders that led to studies on sperm quality and welding exposures. There appears to be an increased frequency of abnormalities in semen quality associated with duration of exposure. Abnormalities were highest among stainless steel welders. Treatment of mild metal fume fever consists of bed-rest and symptomatic therapy (e.g., aspirin for headaches) as indicated. A traditional remedy is to consume large quantities of milk, either before or after exposure.

### ***Metal fume fever comes from welding on:***

- Galvanized metal with zinc coating.
- Cadmium, copper or magnesium.

Workers may experience sweating, shivering, nausea, fever, aching muscles, weakness, fatigue and a loss of energy and appetite.



## ***Siderosis [Iron, Iron Oxide (Rust)]***

A chronic respiratory disease associated with inhaling an excessive amount of iron; one source of iron exposure is welding on rusty metal. Symptoms that will occur when a person has this disease are signs of cardiac failure and also other symptoms such as diabetes and even liver cirrhosis. It's very difficult to diagnose siderosis and when it is, it's often too late. When welding or cutting on metal containing rust, clean off the surface to reduce exposure.



## ***Manganism (Manganese)***

Researchers found that welders exposed to manganese showed signs and symptoms of a Parkinsons-like disease. Although different than Parkinsonism, exposure to manganese causes tremors, muscle rigidity, slowed movement, and problems with balance and coordination. Manganese alloy is a common element added to steel as a hardening agent and rust & corrosion inhibitor. Manganese is also found in stainless steel.

***Remember... Using proper engineering controls will help prevent diseases associated with welding and cutting, always use them!***

*Courtesy of Sentry Air Systems, Inc.  
Houston, TX USA  
Model 300 Welding Fume Extractor  
[www.sentryair.com](http://www.sentryair.com)*

## Asphalt Fumes

Workers who are exposed to fumes from asphalt, a petroleum product used extensively in road paving, can experience health effects such as headache, skin rash, sensitization, fatigue, reduced appetite, throat and eye irritation, cough, and skin cancer.

There are currently no specific OSHA standards for asphalt fumes. However, exposures to various chemical components of asphalt fumes are addressed in specific standards for the general and construction industries, such as personal protective equipment (PPE).



**Asphalt fumes can irritate the eyes, nose and skin.**

If asphalt contacts the skin, workers should immediately wash the affected areas with large amounts of soap and water, seek medical attention if acute skin irritation occurs.

<b>Asphalt Hazards</b>		
	<b>Flammable</b>	Some asphalt products are highly flammable.
	<b>Irritant &amp; Sensitizer</b>	Hot asphalt can cause burns. Some people also get allergic skin reactions and rashes from contact with asphalt. You may get a condition similar to acne, or you may get skin spots. These can get worse if you work in bright sunlight or ultraviolet light (for example, when welding). Also, your eyes can get irritated from asphalt fumes, or if you touch your eyes with asphalt on your hands.
	<b>Toxic</b>	When asphalt products are heated, their fumes can irritate your nose, throat, or lungs. You may first notice a cough, scratchy throat, or mucus. You can get bronchitis or emphysema if you inhale asphalt fumes repeatedly. Mixed with the asphalt fumes may be hydrogen sulfide, a very toxic gas. Breathing too much hydrogen sulfide can cause dizziness, convulsions, coma, or death.
	<b>Carcinogen</b>	Chemicals in asphalt products also produce vapors which you may inhale. The effects depend on the particular chemical. Some of these chemicals are suspect carcinogens (may cause cancer).

## Naphtha (Coal Tar)

Coal tar pitch is a skin irritant which can cause acne and allergic skin reactions in exposed workers; it is known to cause skin cancer.

Exposure to the sun when working around coal tar pitch emissions (for long periods of time) could result in a *photosensitivity* reaction in some sensitized workers.

If coal tar naphtha contacts the skin, workers should immediately wash the affected areas with large amounts of soap and water, seek medical attention if acute skin irritation occurs.



*Workers exposure to naphtha (coal tar)*

**Photosensitivity** – A condition in which a person becomes more sensitive to light.

<b>Naphtha (Coal Tar) Hazards</b>		
	<b>Flammable</b>	The National Fire Protection Association (NFPA) has determined coal tar naphtha to be a moderate fire hazard.
	<b>Irritant &amp; Sensitizer</b>	Coal tar naphtha is expected to be an irritant of the skin, eyes, and mucous membranes. Direct contact between the liquid and the skin could result in "chapping" and possibly photosensitivity if contact was repeated. Cardiovascular system and respiratory system effects are also considered potential responses to exposures to coal tar naphtha.
	<b>Toxic</b>	Exposures to high concentrations would result in central nervous system depression. <i>Naphtha has a Permissible Exposure Limit (PEL) of 100 ppm and an IDLH of 1000 ppm.</i>
	<b>Carcinogen</b>	Because of the benzene content of the coal tar naphtha, exposures could be expected to result in blood changes, such as leukemia.

## Lead Fumes

Lead adversely affects numerous body systems and causes forms of health impairment and disease that arise after periods of exposure as short as days (acute exposure) or as long as several years (chronic exposure). The frequency and severity of medical symptoms increases with the concentration of lead in the blood. Common symptoms of acute lead poisoning are loss of appetite, nausea, vomiting, stomach cramps, constipation, difficulty in sleeping, fatigue, moodiness, headache, joint or muscle aches, anemia, and decreased sexual drive. Acute health poisoning from uncontrolled occupational exposures has resulted in fatalities. Long term (chronic) overexposure to lead may result in severe damage to the central nervous system and reproductive systems.

### **Major Elements of OSHA's Lead Standard (29 CFR 1926.62):**

- Permissible exposure limit (PEL) = 50  $\mu\text{g}/\text{m}^3$
- Action level (AL) = 30  $\mu\text{g}/\text{m}^3$
- Requirements that employers use engineering controls and work practices to reduce worker exposure.
- Requirements that employees observe good personal hygiene practices, such as washing hands before eating and taking a shower before leaving the worksite.
- Requirements that employees be provided with protective clothing and, where necessary, with respiratory protection.
- A requirement that employees exposed to high levels of lead be enrolled in a medical surveillance program.

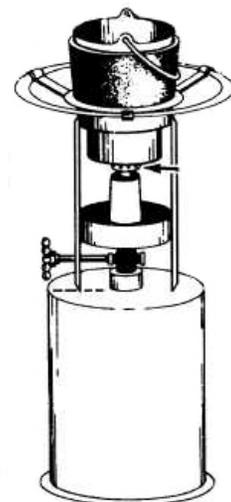
## Plumbers Melting Pot (Lead)

Plumbers sometimes will melt lead in special melting pots to make cast iron joints and fittings. This type of furnace may consist of a fire pot and valve assembly that mounts directly on a portable propane gas tank.

When melting lead, made sure the temperature never exceeds 900°F; heating lead above this temperature could cause the release of hazardous fumes. To ensure that the melted lead does not release hazardous fumes, use an electric melting pot with a temperature gage.



**Electric Melting Pot**  
(Weneco's Metal Melting Pots)



**Fuel (propane)  
Melting Pot**

## Hexavalent Chromium

Chromium hexavalent (CrVI) compounds, often called hexavalent chromium, exist in several forms. Industrial uses of hexavalent chromium compounds include chromate pigments in dyes, paints, inks, and plastics; chromates added as anticorrosive agents to paints, primers, and other surface coatings; and chromic acid electroplated onto metal parts to provide a decorative or protective coating. Hexavalent chromium can also be formed when performing "hot work" such as welding on stainless steel or melting chromium metal. In these situations the chromium is not originally hexavalent, but the high temperatures involved in the process result in oxidation that converts the chromium to a hexavalent state.

Exposures to hexavalent chromium [Cr(VI)] are addressed in specific standards for the construction industry.

### **Major Elements of OSHA's Hexavalent Chromium standard (29 CFR 1926.1126):**

- Permissible exposure limit (PEL) = 5  $\mu\text{g}/\text{m}^3$
- Action level (AL) = 2.5  $\mu\text{g}/\text{m}^3$
- Requirements that employers use engineering controls and work practices to reduce worker exposure.
- Requirements that employees observe good personal hygiene practices, such as washing hands before eating and taking a shower before leaving the worksite.
- Requirements that employees be provided with protective clothing and, where necessary, with respiratory protection.
- A requirement that employees exposed to high levels of lead be enrolled in a medical surveillance program.

## Health Effects (CrVI)

Workplace exposure to hexavalent chromium may cause the following health effects:

- Lung cancer in workers who breathe airborne hexavalent chromium.
- Irritation or damage to the nose, throat, and lung (respiratory tract) if hexavalent chromium is breathed at high levels.
- Irritation or damage to the eyes and skin if hexavalent chromium contacts these organs in high concentrations.



**Hexavalent chromium can be formed by "hot work" on stainless steel.**

## Respiratory Protection for Exposure to Fumes

Fumes are generated by the vaporization of melted substances, which condense into solids. Therefore, most applications where fumes are present require respiratory protection that deals with particulate hazards. Particulate respirators fall into three filter designations -- N, R, and P, each with three levels of filter efficiency: 95%, 99%, and 100 (99.97%) – HEPA, resulting in a matrix of nine different filter classifications.

The selection of N, R, and P series filters depends on the presence or absence of oil particulates. If no oil particles are present in the work environment, use a filter of any series -- N, R, or P. If oil particles are present, use an R or P series filter (R series use is limited to eight hours of continuous or intermittent use). If oil particles are present, and a filter will be used for more than one work shift, use only a P series filter. Check for additional time restrictions required by the manufacturer.

### Fumes Are Not Gases!

A fume is not a gas. A fume is a small particle that is formed when metal is heated and volatilizes in air as metal oxide. For example, molten lead gives off toxic lead oxides, while torched galvanized steel produces iron and zinc oxide which can produce welding fume fever.

Since most welding applications deal with fumes (very small respirable particles) – 100 (HEPA) rated filters are preferred.

If oil is present in the air, then an “R” or a “P” rated filter must be used.

<b>Particulate Air Filter Use Description</b>			
Oil Designation	P	R	N
Efficiency			
<b>95</b>	Oil Proof Low Efficiency	Oil resistant Low Efficiency	Not Oil Proof Low Efficiency
<b>99</b>	Oil Proof Medium Efficiency	Oil resistant Medium Efficiency	Not Oil Proof Medium Efficiency
<b>100</b>	Oil Proof High Efficiency	Oil resistant High Efficiency	Not Oil Proof High Efficiency

## Respiratory Protection for Asphalt Fumes

Any half-facepiece, air-purifying respirator equipped with a combination R100 or P100 filter and an organic vapor (OV) cartridge.



**MSA Advantage Series  
420 Half-Mask Respirator**



**MSA Advantage OV GMA  
Cartridge with P100 Filter**

## Dusts & Fibers

Dusts are solid particles that are formed by handling, crushing, grinding, drilling, or blasting of materials. Fibers are solid particles whose length is at least 3 times greater than its width – hazardous asbestos is an example of a fiber.

Dusts are measured as a concentration of airborne particles in a given space (weight/volume); and are measured in either milligrams or micrograms per cubic meter of air ( $\text{mg}/\text{m}^3$ ) or ( $\mu\text{g}/\text{m}^3$ ).

Fibers are measured in f/cc (fibers per cubic centimeter).

### **Remember...**

***Fibers, like asbestos, are needle sharp particles that can severely scar and damage lung tissue.***

### **Examples of Dusts & Fibers found in construction:**

- **Crystalline Silica** – a basic component of soil, sand, granite, and many other minerals; found in concrete and causes silicosis.
- **Asbestos** – extremely dangerous fiber; used as insulation in homes and buildings, and as insulation for pipes.
- **Metal Dusts** – produced by cutting and sawing metal pipes, scraping rust or coating off metal; may also be found in old paint (lead dust).
- **Lead-Based Paint** – lead was added to paint to enhance its workability and durability; workers are exposed during demolition and remodeling.
- **Fiberglass** – used as insulation material; may be released by handling, cutting or sawing pipes or ducts. Known to be very irritating to skin, eyes and lungs.

### **Important questions concerning dusts & fibers:**

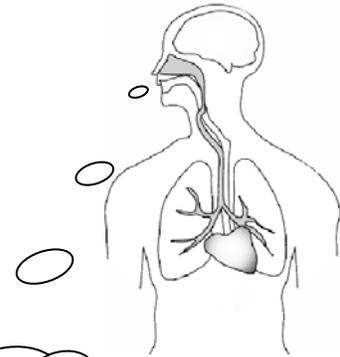
- What is the particle size of the dust and/or fiber?
- How toxic is the dust and/or fiber (PEL, TLV, REL & IDLH)?
- How does the dust or fiber affect the body?
- Is the dust or fiber regulated by OSHA?



***Stone cutting by cut-off saw with diamond wheel; example of potential exposure to crystalline silica.***

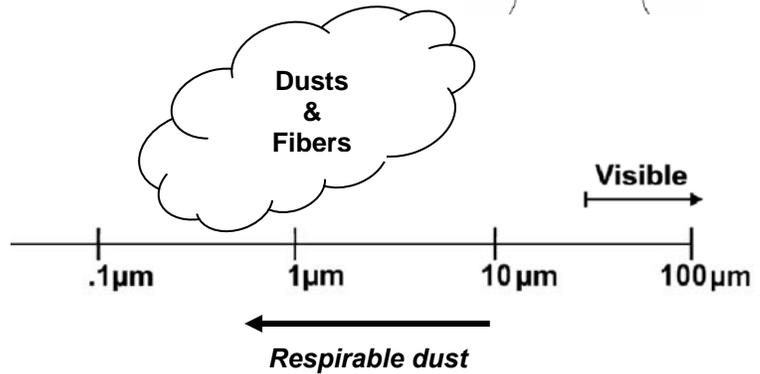
## How do dust & fibers affect the body?

Dust & fibers can irritate the eyes and nose; *causing an immediate (acute) health effect*. These affects are local to the point of contact, such as mucous membranes, eyes and lungs (e.g., shortness of breath, coughing and wheezing). Prolonged exposure to toxic dust can result in chronic health effects.



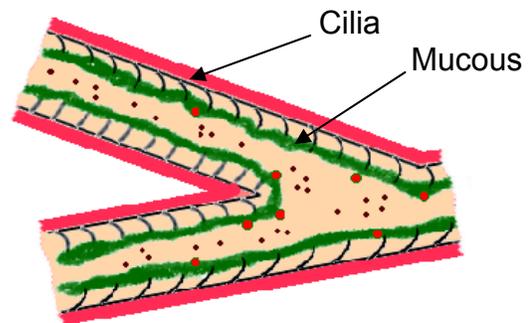
### Remember...

**Respirable dust, particles that are less than 10 microns ( $\mu\text{m}$ ) in diameter, can enter deep into the lungs where damage can occur.**



### The Body's Defense against Dust

The body's defenses against large-sized dusts (mucous, the hair-like cells called cilia and special "dust-eating" white blood cells) can break down dust particles. However, these particles can dry out the mucous. Cigarette smoke paralyzes the cilia; this enables more dust particles to reach the lungs (see *Synergistic Effect*, page 140).



### Who's at Risk?

Dusts are solid particles suspended in air. They may be produced by crushing, grinding, sanding, sawing or the impact of materials against each other; anyone performing these tasks is at risk.

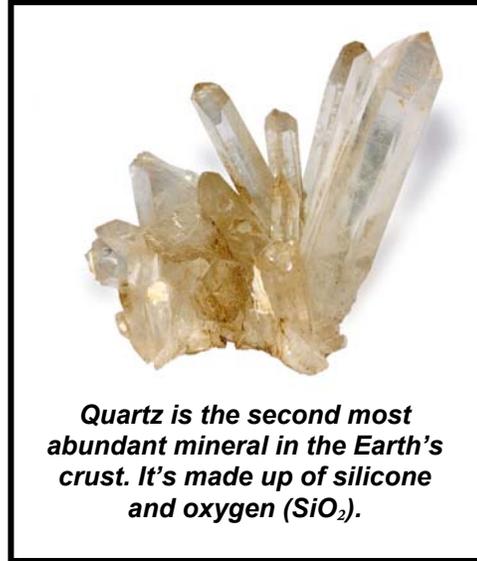


## Crystalline Silica

Silica is one of the most common minerals in the earth's crust. The most common form of crystalline silica is quartz, which is found in sand, gravel, clay, granite, and many other forms of rock.

Construction workers could be exposed to silica when cutting, grinding, drilling, sanding, mixing, or demolishing materials containing silica.

The size of the airborne silica particles determines the amount of risk. Smaller particles can be inhaled deep into the lungs where they can cause damage. Larger particles, such as beach sand, are not as great a concern because they are too large to inhale.



<b>Potential Hazards of Crystalline Silica</b>	
	<b>Flammable;</b> if dust concentrations obscure vision to 5 feet or less.
	<b>Irritant;</b> silica can irritate the eyes (may cause abrasion of the cornea).
	<b>Toxic;</b> Respirable crystalline silica (quartz) can cause silicosis, a fibrosis (scarring) of the lungs.
	<b>Carcinogen;</b> Crystalline silica (quartz) inhaled is classified as carcinogenic to humans.

## Silicosis

Silicosis is a disease of the lungs due to the breathing of dust containing crystalline silica particles. This dust can cause fibrosis or scar tissue formations in the lungs that reduce the lung's ability to work to extract oxygen from the air. There is no cure for this disease, thus, prevention is the only answer.



## Silicosis

There are three types of silicosis, depending upon the airborne concentration of crystalline silica to which a worker has been exposed:

- **Chronic silicosis** usually occurs after 10 or more years of overexposure.
- **Accelerated silicosis** results from higher exposures and develops over 5-10 years.
- **Acute silicosis** occurs where exposures are the highest and can cause symptoms to develop within a few weeks or up to 5 years.

**Chronic silicosis**, the most common form of the disease, may go undetected for years in the early stages; in fact, a chest X-ray may not reveal an abnormality until after 15 or 20 years of exposure. The body's ability to fight infections may be overwhelmed by silica dust in the lungs, making workers more susceptible to certain illnesses, such as tuberculosis. As a result, workers may exhibit one or more of the following symptoms:

- Shortness of breath following physical exertion
- Severe cough
- Fatigue
- Loss of appetite
- Chest pains
- Fever



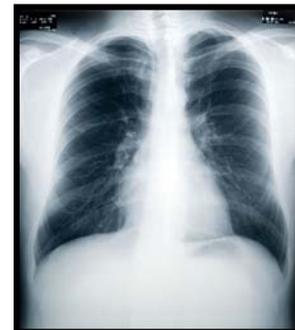
**Concrete cutting with no engineering control or PPE!**

**Silicosis is a type of fibrotic lung disease that develops when silica dust particles become trapped in the lungs and form scar tissue.**

**This can be seen in x-rays by the light areas on the lungs.**



**Silicotic Lungs**



**Normal Healthy Lungs**

## ***How Can Workers Determine If They Have Silicosis?***

A medical examination that includes a complete work history and a chest X-ray and lung function test is the only sure way to determine if a person has silicosis. Workers who believe they are overexposed to silica dust should visit a doctor who knows about lung diseases. The National Institute for Occupational Safety and Health (NIOSH) recommends that medical examinations occur before job placement or upon entering a trade, and at least every 3 years thereafter.



***Special doctors referred to as “B” Readers are trained to identify diseases of the lungs caused by dust exposure.***

## ***Exposures to crystalline silica dust include:***

- Concrete cutting.
- Sandblasting for surface preparation.
- Crushing and drilling rock and concrete.
- Masonry and concrete work (e.g., building and road construction and repair).
- Mining & tunneling.
- Demolition work.
- Cement and asphalt pavement manufacturing.



***Cement worker wearing a full-face piece negative pressure air purifying respirator.***

***Road work (street cutting): worker wearing respirator to protect against potential silica exposure.***

***NOTE: Respiratory protection must be used in conjunction with engineering controls and other safe work practices (e.g., wetting the work to minimize airborne dust).***



## ***Controlling Exposure to Crystalline Silica***

- Employers are required to provide and assure the use of appropriate controls for crystalline silica-containing dust. Be sure to use all available engineering controls such as water sprays and ventilation of containment structures. Substitution of less hazardous materials can also be used.
- Be aware of the health effects of crystalline silica and that smoking can add to the damage.
- Know the work operations where exposure to crystalline silica may occur.
- Participate in any air monitoring or training programs offered by the employer.
- Use type CE positive pressure abrasive blasting respirators for sandblasting.
- For other operations where respirators maybe required, wear a respirator approved for protection against crystalline silica-containing dust. Do not alter the respirator in any way. Workers who use tight-fitting respirators cannot have beards/mustaches which interfere with the respirator seal to the face.
- If possible, change into disposable or washable work clothes at the worksite; shower (where available) and change into clean clothing before leaving the worksite.
- Do no eat, drink, use tobacco products, or apply cosmetics in areas where there is dust containing crystalline silica.
- Wash hands and face before eating, drinking, smoking, or applying cosmetics outside of the exposure area.

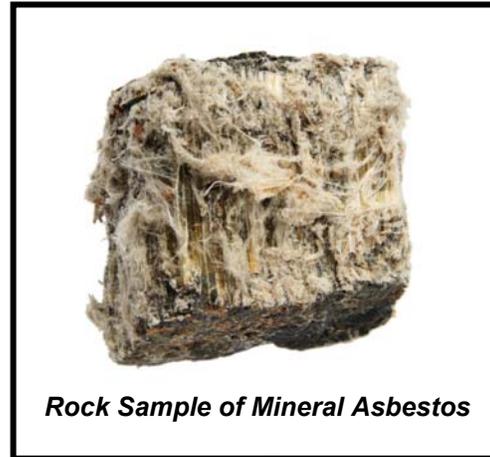
The National Institute of Occupational Safety and Health (NIOSH) defines a **Type CE respirator** as a Type C supplied-air respirator equipped with additional devices designed to protect the wearer's head and neck against impact and abrasion from rebounding abrasive material, and with shielding material such as plastic, glass, woven wire, sheet metal, or other suitable material to protect the window(s) of facepieces, hoods, and helmets. The facepiece, hood or helmet must not unduly interfere with the wearer's vision and must permit easy access to the external surface of such window(s) for cleaning.

All respirators certified by NIOSH as abrasive blasting respirators are Type CE.



## Asbestos

Asbestos is well recognized as a health hazard and is highly regulated. And although asbestos is no longer used as an insulation material; building trades workers may still be exposed to asbestos during demolition or remodeling jobs. Asbestos may also still be found in some taping compounds, asbestos cement, pipes and floor tiles. Vinyl asbestos floor tiles may be as much as 15% to 20% asbestos, which is released when old flooring is removed.



**NOTE:** Asbestos is measured by the number of fibers per volume of air; fibers per cubic centimeter (f/cc) see, page 90.

<b>Potential Hazards of Asbestos</b>	
	<b>Flammable;</b> if dust concentrations obscure vision to 5 feet or less.
	<b>Irritant;</b> Asbestos can irritate the eyes (may cause abrasion of the cornea).
	<b>Toxic;</b> Respirable asbestos can cause asbestosis and mesothelioma, a rare form of cancer that develops from the protective lining that covers many of the body's internal organs.
	<b>Carcinogen;</b> Asbestos inhaled is classified as carcinogenic to humans.

The inhalation of asbestos fibers by workers can cause serious diseases of the lungs and other organs that may not appear until years after the exposure has occurred. For instance, asbestosis can cause a buildup of scar-like tissue in the lungs and result in loss of lung function that often progresses to disability and death.

***There is no cure for asbestosis; a doctor can only help you manage your symptoms.***

## ***Types of Asbestos***

Asbestos is the name given to a group of naturally occurring minerals used in certain products, such as building materials and vehicle brakes, to resist heat and corrosion. Asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, actinolite asbestos, and any of these materials that have been chemically treated and/or altered.

**Chrysotile** – greater than 90% of all asbestos containing materials in U.S. found in thermal systems insulation, surfacing materials, such as spray-on fire proofing, plasters, acoustical treatments and other miscellaneous materials (e.g., floor and ceiling tiles, transite pipes and boards. *Color: white or gray.*

**Amosite** – found in thermal system insulation and surfacing materials. *Color: brown or tan.*

**Crocidolite** – found in thermal system insulation and high efficiency filtration for air and liquids (blue)

**Anthophyllite** – found in acid resistant application, such as lab hoods and benches.

**Actinolite & Tremolite** – found as contaminants in other mineralogical deposits, such as, tremolite in vermiculite.

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### ***OSHA Standard:***

#### ***29 CFR 1926.1101 Asbestos***

*Covers construction work, including alteration, repair, renovation, and demolition of structures containing asbestos.*

**The standards for construction classify the hazards of asbestos work activities and prescribe particular requirements for each classification:**

**Class I** is the most potentially hazardous class of asbestos jobs and involves the removal of thermal system insulation and sprayed-on or troweled-on surfacing asbestos-containing materials or presumed asbestos-containing materials.

**Class II** includes the removal of other types of asbestos-containing materials that are not thermal system insulation, such as resilient flooring and roofing materials containing asbestos.

**Class III** focuses on repair and maintenance operations where asbestos-containing or presumed asbestos-containing materials are disturbed.

**Class IV** pertains to custodial activities where employees clean up asbestos-containing waste and debris.

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***What are the permissible exposure limits for asbestos?***

Employee exposure to asbestos must not exceed 0.1 fiber per cubic centimeter (f/cc) of air, averaged over an 8-hour work shift. Short-term exposure must also be limited to not more than 1 f/cc, averaged over 30 minutes. Rotation of employees to achieve compliance with either permissible exposure limit (PEL) is prohibited.

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***Are employers required to conduct exposure monitoring?***

In construction, unless you are able to demonstrate that employee exposures will be below the PELs (a “negative exposure assessment”), you are generally required to conduct daily monitoring for workers in Class I and II regulated areas. For workers in other operations where exposures are expected to exceed one of the PELs, you must conduct periodic monitoring. In general industry, you must perform initial monitoring for workers who may be exposed above a PEL or above the excursion limit. You must conduct subsequent monitoring at reasonable intervals and in no case at intervals greater than 6 months for employees exposed above a PEL.

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***Must employers create regulated areas?***

You must create controlled zones known as regulated areas that are designed to protect employees where certain work with asbestos is performed. You must limit access to regulated areas to authorized persons who are wearing appropriate respiratory protection. You must also prohibit eating, smoking, drinking, chewing tobacco or gum, and applying cosmetics in these areas. You must display warning signs at each regulated area. In construction and shipyards, workers must perform Class I, II, and III asbestos work (and all other operations where asbestos concentrations may exceed a PEL) within regulated areas. In general industry, you must establish regulated areas wherever asbestos concentrations may exceed a PEL.

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***What compliance methods must employers use to control exposures?***

You must control exposures to or below the PELs using engineering controls and work practices to the extent feasible. Where feasible engineering controls and work practices do not ensure worker protection at the exposure limits, you must reduce employee exposures to the lowest levels achievable and then supplement them with respiratory protection to meet the PELs. In construction, each work classification has specific control method requirements. In general industry, specific controls are prescribed for brake and clutch repair work. For example, you must prohibit certain practices, such as the use of compressed air, to remove asbestos.

***When are employers required to provide respiratory protection for workers?***

You must provide and ensure the use of respirators when a PEL is exceeded. In construction, you must require workers to use respirators when performing certain work. Generally, the level of exposure determines the type of respirator needed. In addition, the standards specify the type of respirator to be used for certain asbestos work. (See CFR 1910.134.) Employees must get respirator training and medical clearance to use respirators.

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***Are employers required to provide protective clothing for workers?***

Yes. For any employee exposed to airborne concentrations of asbestos that exceed a PEL, you must provide and require the use of protective clothing such as coveralls or similar full-body clothing, head coverings, gloves, and foot coverings. You must provide face shields, vented goggles, or other appropriate protective equipment wherever the possibility of eye irritation exists and require workers to wear them.

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***Must employers provide hygiene facilities?***

Yes. You must establish decontamination areas and hygiene practices for employees exposed above a PEL. In addition, employees may not smoke in work areas that might expose them to asbestos.

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***Do OSHA standards require employers to provide training?***

Yes. In construction, you must provide training for employees exposed above a PEL and for employees involved in each identified work classification. The specific training requirements depend upon the particular class of work being performed. In general industry, you must provide training to all employees exposed above a PEL. You must also provide asbestos awareness training to employees who perform housekeeping operations covered by the standard. You must place warning labels on all asbestos products, containers, and installed construction materials when feasible.

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***What are employers required to provide concerning medical examinations?***

In construction, you must provide medical examinations for workers who, for 30 or more days per year, engage in Class I, II, or III work or experience exposure above a PEL. In general industry, you must provide medical examinations for workers who are exposed above a PEL.

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## ***Metal Dusts***

Metal dusts are produced by cutting and sawing metal pipes, scraping rust or coatings off metal, drilling through chrome or other metals, and in other cutting and sawing operations. Lead may be used in drywall to isolate radiation treatment rooms in hospitals; those who work with lead containing material must be evaluated for exposure and monitored for lead in the blood.

Breathing iron oxide (rust) is known to cause siderosis, a chronic respiratory disease. Iron oxide particles, like asbestos and silica, can get past the body's defenses and become lodged in the lung walls.

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## ***Lead-Based Paint Dust***

Lead has been used since ancient times as a paint pigment. Two major chemical forms of lead are used as colors -- they are called "white lead" (a lead carbonate) and "red lead" (a lead oxide). Both types of lead provide a thick, heavy, tough coating; one that does not crack through wear or temperature variations because it can expand and contract in unison with the base metal to which it is attached. In addition, the chemical nature of lead causes it to provide corrosion resistance as well. For many years, lead paint has been used on bridges, water tanks, ships and other steel and iron structures.

### ***Lead-Based Paint***

**"Lead-based paint"** is defined in the Residential Lead-Based Paint Hazard Reduction Act (also known as Title X) as "paint, varnish, shellac, or other coating on surfaces that contain 1.0 mg/cm<sup>2</sup> or more of lead or 0.5 percent or more lead by weight."

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## ***EPA Certified Lead Renovator***

The Environmental Protection Agency (EPA) has established training requirements for anyone who disturbs lead-based paint.

### ***Contractor requirements under EPA lead renovation laws:***

- All work must be performed under the supervision of certified lead renovators.
- Post signs clearly defining the work area and warn occupants of buildings to remain outside of the work area.
- Barricade off work area and contain lead dust that is created during work.
- Clean all objects and surfaces in and around the work area.



## ***Fiberglass Insulation***

Everyone has heard about the association between lung cancer and asbestos. Since some forms of asbestos are similar in appearance to fiberglass fibers, many people wonder if handling fiber-glass could also result in the development of cancer or other serious health hazards. Scientists have made over 400 studies of fiberglass in an attempt to answer this question. The conclusion is that it will not, because its properties are very different from asbestos. OSHA confirmed these findings in 1991 when it decided to regulate fiberglass as a nuisance dust, and not as a cancer causing agent. Still, precautions should still be taken while working with fiberglass.

<b><i>Fiberglass Insulation</i></b>					
<b><i>OSHA PEL (Nuisance Dust)</i></b>	<b><i>ACGIH TLV</i></b>	<b><i>NIOSH REL</i></b>	<b><i>NIOSH IDLH</i></b>	<b><i>NFPA 704M</i></b>	
<b>15 mg/m<sup>3</sup></b>	<b>10 mg/m<sup>3</sup></b>	<b>3 f/cc</b>	<b>N/A</b>	Fire: 0 Health: 1 Reactivity: 0 Specific Hz: NA	

### ***Engineering Controls***

Provide general or local exhaust ventilation systems to maintain airborne dust or fiber concentrations below OSHA PELs.

### ***Personal Protective Equipment***

Where airborne dusts or fibers exceed the TLV, use NIOSH approved respirator to protect against nuisance dusts. Seek professional advice prior to respirator selection and use; follow OSHA respirator regulations (29 CFR 1910.134).

Wear protective gloves or use barrier cream to protect against any mechanical irritation. Eye protection will help to prevent mechanical irritation of the eyes.

### ***Safe Work Practices***

Make emergency eyewash stations and washing facilities available in work area.

Separate contaminated work clothes from street clothes. Launder before reuse.

Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material; wash hands after handling fiberglass.



***Fiberglass insulation worker – personal protective equipment includes: hard hat, safety goggles, filtering facepiece (respirator), disposable suit & gloves.***

## ***Respiratory Protection for Exposures to Dusts & Fibers***

Respiratory protection for exposure to dusts & fibers will depend on the size of the particle and its level of toxicity. OSHA requires that specific respirators are used while working with the regulated substances asbestos and lead.

### ***Remember...***

***To achieve compliance with OSHA Permissible Exposure Limits (PELs), administrative or engineering controls must first be implemented whenever feasible.***

### ***Dust & Fiber Respirator Selection Guide***

<b><i>Hazard</i></b>	<b><i>Efficiency</i></b>	<b><i>Comments</i></b>
Silica	100 (HEPA)	Atmosphere supplying respirators may be required.
Asbestos	100 (HEPA)	Requires specific respirators to be used based on task and exposure level. <u>No disposable filtering facepieces allowed!</u> Atmosphere supplying respirators may be required.
Lead	100 (HEPA)	Requires specific respirators to be used based on task and exposure level. Atmosphere supplying respirators may be required.
Fiberglass Insulation	95, 99 or 100 (HEPA)	No specific respirator required. Select approved respirator bases on exposure level, use and comfort.
Nuisance Dust	95, 99 or 100 (HEPA)	No specific respirator required. Select approved respirator bases on exposure level, use and comfort.

***NOTE:*** Use a “P” or “R” designated respirator filter if there is oil present in the air.

- P - (oil proof)

- R - (oil resistant)

- N - (Not Oil Proof)

## Mists

Mists are tiny droplets of liquid suspended in the air.

Mists are measured as a concentration of airborne particles in a given space (weight/volume); and are measured in either milligrams or micrograms per cubic meter of air ( $\text{mg}/\text{m}^3$ ) or ( $\mu\text{g}/\text{m}^3$ ).

### **Examples of mists found in construction:**

- Oil mist produced from lubricants used in metal cutting operations.
- Paint mist from spraying operations.
- Pesticides sprayed to control or eliminate foliage.
- Aerosols from cans and bottles.

### **Important questions concerning mists:**

- How is the mist generated?
- How toxic is the mist (PEL, TLV, REL & IDLH)?
- How does the mist affect the body?



### **Who's at Risk?**

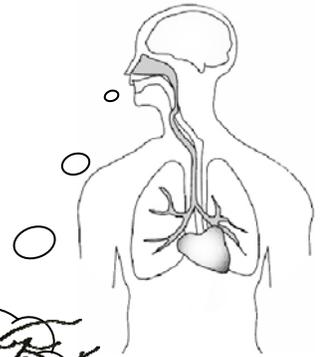
Mists are generated on construction job-sites by spraying liquids, such as, paints/coatings, form oil, pesticides, etc...

Where employees are engaged in the application of paints, coatings, herbicides, or insecticides or in other operations where contaminants may be harmful to the employees; washing facilities must be in near proximity to the worksite and must be equipped as to enable employee to remove such substances.



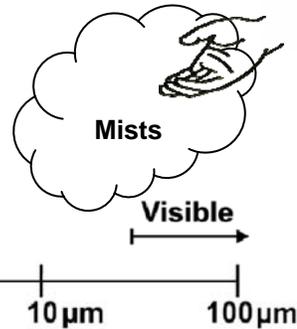
## How do mists affect the body?

Mists affect the body by being inhaled and absorbed through the lungs. Exposed skin can also absorb any mist causing an adverse health effect – this health effect is labeled as a **skin designation**.



### Mists can be...

- **Inhaled** (through the lungs)
- **Ingested** (by direct or indirect contact with the lips and **mouth**)
- **Absorbed** (through exposed skin)
- **Injected** (through high pressure & aerosol cans)



## Skin Designation

A "skin" designation serves as a warning that dermal absorption is a possible route of entry for a particular substance; this warning appears with some of the chemical hazards which are found in OSHA Standard, 29 CFR 1926.55 – Appendix A. The use of skin designation does not indicate that the substance may irritate the skin. Similarly, lack of a skin designation does not mean that the substance will not irritate or burn the skin. If a skin designation exists for a substance, be sure to wear chemical resistant clothing and gloves.



## Respiratory Protection for Exposures to Mists

When exposed to mists, employees must wear a respirator that has filters designated as a "P" or "R" if the mist contains oil, if no oil is present then a "N" designated respirator filter is acceptable. These filters have efficiencies of 95, 99 or 100 (HEPA).



**AOSafety 95110 Paint Spray Respirator**  
*Protects against organic vapors and sprays of paints, lacquers, and enamels. Also provides protection against dusts and mists. Prefilter is detachable for easy replacement when it becomes clogged with paint sprays.*

## Chemical Health Hazard Category Summary Chart

Hazardous chemicals are classified as being a **carcinogen**, **corrosive**, **toxic**, **irritant**, **sensitizer**, or any chemical that affects a **target organ** (e.g., liver, kidney, nervous system, blood, lung, reproductive organs, skin & eyes).

### Chemical Health Hazard Categories

**According to OSHA, a chemical which meets any of the following are considered hazardous...**

Chemical Hazard	Description	Examples	Symbol <i>Globally Harmonized System</i>
<b>Carcinogen</b>	Chemical or physical agent capable of causing cancer.	<ul style="list-style-type: none"> <li>Asbestos</li> <li>Silica</li> <li>Benzene</li> </ul>	
<b>Corrosive</b>	A substance that will destroy or irreversibly damage another surface (metal or skin) with which it comes into contact.	<ul style="list-style-type: none"> <li>Hydrochloric acid</li> <li>Sulfuric acid</li> </ul>	
<b>Toxic &amp; Highly Toxic</b>	A chemical that has a low to very low lethal dose value. (See 29 CFR 1910.1200 Appendix A – Health Hazards Definitions)	<ul style="list-style-type: none"> <li>Carbon Monoxide</li> <li>Hydrogen sulfide</li> <li>Phosgene</li> </ul>	
<b>Irritant</b>	A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.	<ul style="list-style-type: none"> <li>Ammonia</li> <li>Alkaline dusts and mists</li> <li>Ozone</li> <li>Concrete</li> </ul>	
<b>Sensitizer</b>	A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.	<ul style="list-style-type: none"> <li>Hexavalent Chromium</li> <li>Di-isocyanates</li> <li>Paints</li> <li>Saw dusts</li> <li>Certain woods</li> </ul>	
<b>Affects a Target Organ</b> <ul style="list-style-type: none"> <li>Specific Target Organ Toxicity (STOT)</li> </ul>	Liver, kidney, nervous system, blood, lung, reproductive organs, skin & eyes	<ul style="list-style-type: none"> <li>Lead</li> <li>Cadmium</li> <li>Silica</li> <li>Asbestos</li> </ul>	

**Reference: 29 CFR 1910.1200 Appendix A – Health Hazard Criteria**

## ***Reproductive Toxins***

Reproductive toxins are chemicals that can damage the reproductive systems of both men and women. Exposure to these agents before conception can produce a wide range of adverse effects including reduced fertility, an abnormal fetus, reduced libido, or menstrual dysfunction. Maternal exposure after conception may cause prenatal death, low birth weight, birth defects, developmental and/or behavioral disabilities, and cancer.

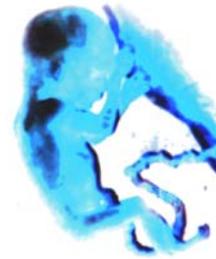
A **mutation** is defined as a permanent change in the amount or structure of the genetic material in a cell. The terms mutagenic or mutagen are used to refer to those chemicals that cause an increased occurrence of mutations in populations of cells and/or organisms.

A **teratogen** is an agent that can cause malformations of an embryo or fetus. This can be a chemical substance, a virus or ionizing radiation.

Exposure to reproductive toxins may cause one to become infertile or to have difficulty conceiving a child. Reproductive toxins may affect the parent, developing child (even after birth), or both.

### ***Examples of reproductive toxins:***

- Benzene (mutagen)
- Cadmium and compounds (fertility & teratogen)
- Chloroform (mutagen)
- Lead and compounds (fertility, teratogen & mutagen)
- Mercury and compounds (fertility & teratogen)



### ***If I'm Pregnant, Can the Chemicals I Work with Harm My Baby?***

If you are pregnant, or planning a pregnancy, you may worry that exposure to chemicals at work will harm your baby. Concern about workplace chemicals is understandable, especially since doctors encourage women not to expose the baby to other chemicals such as those found in tobacco smoke and alcohol. Most women probably don't need to worry. But if you use chemicals at work, you should get more information about them. Consult your employer for more information regarding the chemicals you work with.



## Specific Target Organ Toxicity (STOT)

(STOT) is measured as either a single (SE) or repeated exposure (RE) and is a hazard category that describes any impaired function to a body organ. Specific target organ toxicity can occur by any route that is relevant for humans, i.e., principally oral, dermal or inhalation. The following is a target organ categorization of effects which may occur, including examples of signs and symptoms and chemicals which have been found to cause such effects.

<b>Target Organ</b>	<b>Signs &amp; Symptoms</b>	<b>Chemicals (Examples)</b>
<b>Hepatotoxins:</b> Chemicals which produce <b>liver</b> damage.	<ul style="list-style-type: none"> <li>▪ Jaundice</li> <li>▪ Liver enlargement</li> </ul>	<ul style="list-style-type: none"> <li>▪ Carbon Tetrachloride</li> <li>▪ Nitrosamines</li> </ul>
<b>Nephrotoxins:</b> Chemicals which produce <b>kidney</b> damage.	<ul style="list-style-type: none"> <li>▪ Edema</li> <li>▪ Proteinuria</li> </ul>	<ul style="list-style-type: none"> <li>▪ Halogenated Hydrocarbons</li> <li>▪ Uranium</li> </ul>
<b>Neurotoxins:</b> Chemicals which produce their primary toxic effects on the <b>nervous system</b> .	<ul style="list-style-type: none"> <li>▪ Narcosis</li> <li>▪ Behavioral changes</li> <li>▪ Decrease in motor functions</li> </ul>	<ul style="list-style-type: none"> <li>▪ Mercury</li> <li>▪ Carbon Disulfide</li> </ul>
Agents which act on the <b>blood</b> or <b>hematopoietic system</b> : Decrease hemoglobin function; deprive the body tissues of oxygen.	<ul style="list-style-type: none"> <li>▪ Cyanosis</li> <li>▪ Loss of consciousness</li> </ul>	<ul style="list-style-type: none"> <li>▪ Carbon Monoxide</li> <li>▪ Cyanides</li> </ul>
Agents which damage the <b>lung</b> : Chemicals which irritate or damage pulmonary tissue.	<ul style="list-style-type: none"> <li>▪ Cough</li> <li>▪ Tightness in chest</li> <li>▪ Shortness of breath</li> </ul>	<ul style="list-style-type: none"> <li>▪ Silica</li> <li>▪ Asbestos</li> </ul>
<b>Reproductive toxins:</b> Chromosomal damage ( <b>mutations</b> ) Effects on fetuses ( <b>teratogenesis</b> )	<ul style="list-style-type: none"> <li>▪ Birth defects</li> <li>▪ Sterility</li> </ul>	<ul style="list-style-type: none"> <li>▪ Benzene</li> <li>▪ Lead</li> <li>▪ Mercury</li> </ul>
<b>Cutaneous hazards:</b> Chemicals which affect the dermal layer of the body ( <b>skin</b> ).	<ul style="list-style-type: none"> <li>▪ Defatting of the skin</li> <li>▪ Rashes</li> <li>▪ Irritation</li> </ul>	<ul style="list-style-type: none"> <li>▪ Ketones</li> <li>▪ Chlorinated Compounds</li> </ul>
<b>Eye hazards:</b> Chemicals which affect the eye or visual capacity.	<ul style="list-style-type: none"> <li>▪ Conjunctivitis</li> <li>▪ Corneal damage</li> </ul>	<ul style="list-style-type: none"> <li>▪ Organic solvents</li> <li>▪ Acids</li> </ul>

## ***Synergistic Effect***

When two or more hazardous materials are present at the same time, the resulting effect can be greater than the effect anticipated based on the cumulative effect of the individual substances.

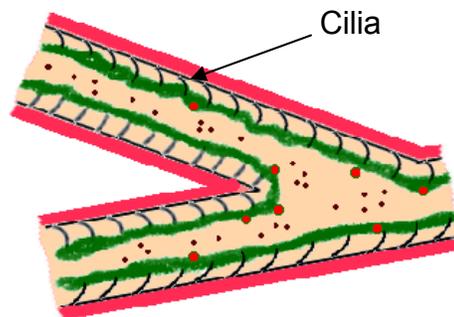
An example of synergism is the increased risk of developing lung cancer caused by exposures to both cigarette smoking and asbestos. By either smoking one pack of cigarettes per day or being heavily exposed to asbestos, you may increase your risk of lung cancer to five to ten times higher than someone who does neither. But if you smoke a pack a day and are heavily exposed to asbestos, your risk may be 50 times higher than someone who does neither.



***Smoking increases the chances of illness if you work around hazardous substances.***

## ***Effects of Smoking***

Smoking paralyzes the body's natural defense, specifically the cilia; smoking causes the cilia to relax and not perform its function as a dust capturing mechanism. This means that more dust and/or fiber can get inhaled into the lungs where damage can occur.



***Smoking causes the cilia in our body's air passages to not work properly.***

## ***Emphysema***

Emphysema is caused by a gradual destruction of the cells inside the lungs, which causes a loss of elasticity in the lung. As the disease progresses, serious and life threatening reductions in lung functional capacity can occur. Once the disease has advanced to the point of serious functional impairment, it is, for the most part, irreversible. There is evidence that smoking can cause this destruction of the lungs over time.



## ***Chemical Hazard Communication – Your Right to Know!***

In the early 80's, OSHA enacting the Hazard Communication Standard (HCS). A fundamental premise of the HCS is that employees who may be exposed to hazardous chemicals in the workplace have a right to know about the hazards and how to protect themselves. The HCS is therefore sometimes referred to as the "Worker Right-to-Know Legislation", or more often just as the "Right-to-Know" law.

In 2012, OSHA revised its Hazard Communication Standard (HCS) to be consistent with the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). The benefit of this one world system is to increase the quality and consistency of information provided to workers, employers and chemical users by adopting a standardized approach to hazard classification, labels and safety data. The GHS provides a single set of harmonized criteria for classifying chemicals according to their health and physical hazards and specifies hazard communication elements for labeling and safety data sheets.



***Safety Data Sheets (SDSs)***

***SDSs are a required source of information regarding hazardous chemicals – understand and anticipate dangerous exposures on your job-site!***

### ***Remember...***

***The best protection is prevention. With hazardous materials, the only way to prevent harm is to know all the hazards and precautions associated; take full advantage of your Right-to-Know!***

## ***Contractors Guide to HCS Compliance***

- Become familiar with the OSHA's Hazard Communication Standard (29 CFR 1910.1200)
- Prepare and implement a Hazard Communication Program.
- Assign a competent person to implement all aspects of the Program.
- Identify all hazardous chemicals in the workplace.
- Labels and other forms of warning must be in place.
- Safety Data Sheets (SDS) is made available.
- Employee information and training conducted.

***NEVER store chemicals and food in the same refrigerator!***

## ***Safety Data Sheet (SDS)***

The Hazard Communication Standard (HCS) requires chemical manufacturers, distributors, or importers to provide Safety Data Sheets (SDSs) (formerly known as Materials Safety Data Sheets or MSDSs) to communicate the hazards of hazardous chemical products. As of June 1, 2015, the HCS will require new SDSs to be in a uniform format, and include the section numbers, the headings, and associated information under the headings below:

**Section 1, Identification** includes product identifier; manufacturer or distributor name, address, phone number; emergency phone number; recommended use; restrictions on use.

**Section 2, Hazard(s) identification** includes all hazards regarding the chemical; required label elements.

**Section 3, Composition/information on ingredients** includes information on chemical ingredients; trade secret claims.

**Section 4, First-aid measures** includes important symptoms/ effects, acute, delayed; required treatment.

**Section 5, Fire-fighting measures** lists suitable extinguishing techniques, equipment; chemical hazards from fire.

**Section 6, Accidental release measures** lists emergency procedures; protective equipment; proper methods of containment and cleanup.

**Section 7, Handling and storage** list precautions for safe handling and storage, including incompatibilities.

**Section 8, Exposure controls/personal protection** lists OSHA's Permissible Exposure Limits (PELs); Threshold Limit Values (TLVs); appropriate engineering controls; personal protective equipment (PPE).

**Section 9, Physical and chemical properties** lists the chemical's characteristics.

**Section 10, Stability and reactivity** list chemical stability and possibility of hazardous reactions.

**Section 11, Toxicological information** includes routes of exposure; related symptoms, acute and chronic effects; numerical measures of toxicity.

## ***SDS (Safety Data Sheet) Continued...***

**Section 12, Ecological information\*** lists ecotoxicity (aquatic and terrestrial); persistence and degradability; bioaccumulative potential; mobility in the soil; and other adverse effects.

**Section 13, Disposal considerations\*** describes of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.

**Section 14, Transport information\*** lists transport hazard class(es); packing group, if applicable; environmental hazards [e.g.: marine pollutant (Yes/No)]; special precautions which a user needs to be aware of, or needs to comply with, in connection with the transport or conveyance within or outside their premises.

**Section 15, Regulatory information\*** lists safety, health and environmental regulations specific for the product in question.

**Section 16, Other information,** includes the date of preparation or last revision.

\* Note: Since other Agencies regulate this information, OSHA will not be enforcing Sections 12 through 15 (29 CFR 1910.1200(g)(2)).

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### ***Is a Safety Data Sheet (SDS) required for a non-hazardous chemical?***

SDSs that represent non-hazardous chemicals are not required to be a part of an employer's hazard communication program. OSHA requires that "the employer shall maintain in the workplace copies of the required SDSs for each hazardous chemical, and shall ensure that they are readily accessible during each work shift to employees when they are in their work area(s)." OSHA does not require nor encourage employers to maintain SDSs for non-hazardous chemicals. Consequently, an employer is free to discard SDSs for non-hazardous chemicals.

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<b><i>SDS Example – Group Discussion</i></b>	<b><i>(Review SDS Provided by Instructor)</i></b>
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What is the name of the Chemical? \_\_\_\_\_

What is the color of the substance? \_\_\_\_\_

What is the exposure limits listed (if applicable)? \_\_\_\_\_

What are any synonyms (if provided)? \_\_\_\_\_

What is the gas/vapor density of the chemical? \_\_\_\_\_

## OSHA Required Label Elements

The Occupational Safety & Health Administration (OSHA) specifies certain elements that must appear together on chemical labels.

**Hazard statement(s):** Phrase assigned to each hazard category that describes the nature of the hazard. Examples of hazard statements are: “Harmful if swallowed,” “Highly flammable liquid and vapor” and “Harmful to aquatic life.”

**Toxic if Swallowed!**

**Pictogram(s):** A symbol inside a diamond with a red border, denoting a particular hazard class (e.g., acute toxicity/lethality, skin irritation/corrosion, etc.).



**Precautionary statement(s):** Phrases that describe recommended measures that should be taken to minimize or prevent adverse effects resulting from exposure to a hazardous product, or improper storage or handling of a hazardous product. These phrases cover prevention, response, storage, and disposal of products.

**Do not eat, drink or smoke  
when using this product.**

**Product identifiers:** Names or numbers used on a hazardous product label or in a safety data sheet. They provide a unique means by which the product user can identify the chemical substance or mixture.

Muriatic Acid

**Signal word:** One word used to indicate the relative severity of hazard and alert the reader to a potential hazard on the label and safety data sheet. The GHS includes two signal words: “Warning” and “Danger”.



**Supplier identification:** Under the GHS supplier identification would include the name, address and telephone number of the manufacturer or supplier of the substance.

CJS Manufacturing  
Charlestown, Anywhere. USA

## OSHA Required Label Elements

Sample label, identifying the required label elements, is shown below. Supplemental information can also be provided on the label as needed.

SAMPLE LABEL	
<p style="text-align: center; color: #0070C0;"><b>PRODUCT IDENTIFIER</b></p> <p>CODE _____  <b>Product Name</b> _____</p> <p style="text-align: center; color: #0070C0;"><b>SUPPLIER IDENTIFICATION</b></p> <p><b>Company Name</b> _____                      Street Address _____                      City _____ State _____                      Postal Code _____ Country _____                      Emergency Phone Number _____</p> <p style="text-align: center; color: #0070C0;"><b>PRECAUTIONARY STATEMENTS</b></p> <p>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.</p> <p><b>In Case of Fire:</b> use dry chemical (BC) or Carbon dioxide (CO<sub>2</sub>) fire extinguisher to extinguish.</p> <p><b>First Aid</b>                      If exposed call Poison Center.                      If on skin (on hair): Take off immediately any contaminated clothing. Rinse skin with water.</p>	<p style="text-align: center; color: #0070C0;"><b>HAZARD PICTOGRAMS</b></p> <div style="text-align: center;">  </div> <p style="text-align: center; color: #0070C0;"><b>SIGNAL WORD</b> <b>Danger</b></p> <p style="text-align: center; color: #0070C0;"><b>HAZARD STATEMENT</b> <b>Highly flammable liquid and vapor.                      May cause liver and kidney damage.</b></p> <p style="text-align: center; color: #0070C0;"><b>SUPPLEMENTAL INFORMATION</b></p> <p><b>Directions for use</b>                      _____                      _____                      _____</p> <p>Fill weight: _____ Lot Number _____                      Gross weight: _____ Fill Date: _____                      Expiration Date: _____</p>

## HAZARD COMMUNICATION PROGRAM

**PURPOSE:** To provide a safe and healthful workplace for all [Company] employees and to ensure that the hazards of all chemicals handled are communicated to employees and others that may be exposed either through routine handling or as a result of a foreseeable emergency. This communication shall be accomplished through container labeling, safety data sheets, appropriate information and training programs, and notification of affected contractors.

**POLICY:** [Company] will maintain a safe and healthful workplace and will ensure that employees receive training in chemical exposure recognition, training in the physical and health hazards of the chemicals in the work area, measures that employees can take to protect themselves from chemical hazards, and training in locating and obtaining material safety data sheets for all hazardous chemicals at each location.

### RESPONSIBILITIES:

The most senior [Company] superintendent or foreman at the job will be responsible for assuring that the Hazard Communication Policy is implemented and enforced.

**Name:**

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### ***Checklist for Compliance***

The following checklist will help to ensure you comply with OSHA's Hazard Communication rule:

- Obtained a copy of the rule (29 CFR 1910.1200).
- Read and understood the requirements.
- Assigned responsibility for tasks.
- Prepared an inventory of chemicals.
- Ensured containers are labeled.
- Obtained SDS for each chemical.
- Prepared written program.
- Made SDSs available to workers.
- Conducted training of workers.
- Established procedures to maintain current program.
- Established procedures to evaluate effectiveness.

## PROCEDURES

### Labeling:

[Company] requires that labels be provided on all containers used to store hazardous chemicals on the job-site. In the event a container of hazardous chemicals is missing a label or the label is defaced, a new label must be obtained and placed on the container immediately. At no time is an employee to remove or deface existing labels on containers of hazardous chemicals.

Prior to shipping or transportation, all containers of chemicals are to be examined to verify that they are properly labeled. Each container of hazardous chemicals entering or leaving the job-site must be labeled, tagged or marked with the following information:

1. Product and Supplier Identification
2. Hazard Statements with Pictogram
3. Precautionary Statement with Single Word (“Danger” or “Warning”)

If the hazardous chemical is regulated by OSHA in a substance-specific health standard, the chemical distributor or supplier must ensure that the labels, or other forms of warning used, are in accordance with the requirements of that standard.

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### Safety Data Sheets:

In order to ensure that a current SDS for each chemical is on the job-site as required, and that employees have access to these SDSs, the following information must be in your written program:

- Designation of person(s) responsible for obtaining and maintaining the SDSs;
  - How such sheets are to be maintained in the workplace (e.g., in notebooks in the work area(s) or in a computer with terminal access), and how employees can obtain access to them when they are in their work area during the work shift;
  - Procedures to follow when the SDS is not received at the time of the first shipment;
  - Procedures to update the SDS when new and significant health information is found; and,
  - Description of alternatives to actual data sheets on the job-site, if used.
- 

For employers using hazardous chemicals, the most important aspect of the written program in terms of SDSs is to ensure that someone is responsible for obtaining and maintaining the SDSs for every hazardous chemical in the workplace. The list of hazardous chemicals required to be maintained as part of the written program will serve as an inventory. As new chemicals are purchased, the list should be updated. Many companies have found it convenient to include on their purchase order the name and address of the person designated in their company to receive SDSs.

### **Chemical List:**

[Company] will maintain a listing of all hazardous chemicals and will ensure that a Safety Data Sheet (SDS) is available for each hazardous chemical. These Safety Data Sheets (SDSs) will be maintained in a binder provided to each foreman at the job-site where they are readily accessible to all employees. Each foreman is responsible for ensuring that the book of SDSs is maintained and updated as items containing hazardous chemicals are added or deleted from the list. It is the responsibility of all employees at [Company] who purchase supplies and materials to ensure that a SDS is obtained and distributed for all products that contain a hazardous chemical. No new supply or material is to be purchased without first obtaining a safety data sheet.

---

### **Notification of Subcontractors:**

It shall be the responsibility of the field superintendent or foreman at the job-site to supply each subcontractor with the list of hazardous chemicals and SDSs, if that subcontractor has employees that may be exposed to hazardous chemicals used by [Company].

---

### **Emergencies Involving Hazardous Chemicals:**

Spills or accidental releases of hazardous chemicals must be reported at once to a foreman. In the event a release of hazardous chemicals occurs as a result of a broken container or other incident, employees not trained in small spill clean-up procedures will be instructed to evacuate the affected area.

Employees that have received training in small spill clean-up procedures will, under the guidance of their foreman, absorb, neutralize, or otherwise control spills of hazardous chemicals that occur in the immediate release area. Should a spill or release occur that is beyond the capability to control through absorption or neutralization, all employees will be instructed to evacuate the area and assistance in controlling and cleaning up the spill will be summoned from outside sources by site management.

---

### **Outside Contractors:**

[Company] sub-contractors shall be required to provide a list of chemicals that they intend to use, along with copies of the SDSs covering such chemicals to the job-site. [Company] will have the opportunity and right to deny the contractor use of certain chemicals which are deemed inappropriate. The contractor will certify that he is working in accordance with the federal Hazard Communication Standard, has a written program which includes a chemical inventory list and SDSs and, further, that all his employees have been trained in the requirements of the Standard. If necessary, [Company] reserves the right to require the contractor provide specific chemical training to those [Company] employees who could be affected by the contractor's activities.

### Information and Training:

Each employee must, initially upon hiring and annually thereafter, receive training covering chemical safety and hazard communication. This training will consist of:

- Viewing of a videotape (optional).
  - Review of training materials provided by [Company].
  - Signing of a form acknowledging completion of hazard communication training.
- 

Each employee will receive training in the following:

1. The location and requirements of the Federal Hazard Communication Standard, 29 CFR 1926.59 (see 29 CFR 1910.1200).
  2. The location and availability of the company's written hazard communication policy and program.
  3. Location at the job-site where hazardous chemicals are present.
  4. Training in methods that may be used to detect the presence or release of a hazardous chemical in the work area.
  5. Explanation of the potential physical and health hazards of chemicals stored or used at the job-site.
  6. Measures that the employees can take to protect themselves from the hazards of chemicals in the work area.
  7. Specific actions employees are to take in the event of an emergency spill.
  8. Hazardous chemical labeling system, sections of the SDS, explanation of the terminology used on the SDS, how to locate the SDS, and how to request a printed copy of the SDS.
- 

The employee's superintendent or foreman will oversee the training to ensure the employee understands the information presented and to answer any specific questions the employee may have.

The training will be conducted prior to the new employee's first work assignment and will be repeated annually thereafter. Training will also be conducted any time a new hazard is introduced through the purchase of a new supply or material that contains a hazardous chemical.

Upon successful completion of the training program, each employee will be asked to sign a form acknowledging that they have participated in and received hazard communication training. This form will be maintained in the employee's personnel file. Hazard communication training information will be provided to each employee at the conclusion of their training.

## Employee Information and Training Evaluation

**INSTRUCTIONS:** Check the appropriate box if the item described has been completed...

### Information:

- I have been informed of the new Hazard Communication Standard (29 CFR 1910.1200) requirements.
- I have been informed of the operations in my work area where hazardous chemicals are present.
- I have been informed of the location and availability of the written Hazard Communication Program, for my work area which includes a list of hazardous chemicals and their Safety Data Sheets (SDSs).

### Training:

- I have been taught the methods and observations that will help me detect the presence or release of any hazardous chemical in my work area.
- I have been taught the physical and health hazards of the chemicals in my work area.
- I have been taught how to protect myself from the hazardous chemicals in my work area. This included appropriate work practices and personal protective equipment to be used.
- I have been taught emergency procedures to be followed in the event of accidental contact with or release of a hazardous chemical in my work area.
- I have been taught how to use the labeling system and the Safety Data Sheets (SDSs) in my work area.
- I have read the policy statements contained in the written Hazard Communication Program.
- I am aware that a copy of the policy statements contained in the written Hazard Communication Program is available to me upon my request.

Employee Signature:

Date:

---

**Review**

***Match the letter to correct acronym, word or phrase...***

- \_\_\_\_\_ Gases, vapors, fumes, dusts/fibers & mists
- \_\_\_\_\_ Routes of entry
- \_\_\_\_\_ Units of concentration
- \_\_\_\_\_ Respirable
- \_\_\_\_\_ Breathable Air
- \_\_\_\_\_ Simple asphyxiant
- \_\_\_\_\_ Chemical asphyxiant
- \_\_\_\_\_ Gas & vapor density
- \_\_\_\_\_ Synergistic Effect
- \_\_\_\_\_ OSHA’s Hazard Communication Standard
- \_\_\_\_\_ SDS (acronym)

- a.** Chemical hazards that can damage the lungs, skin, eyes, mucous membranes, and target specific organs in the body.
- b.** Normal concentration of gases in air that we breathe.
- c.** Inhalation, absorption ingestion and injection.
- d.** Relative weight of a gas compared to air, which has an arbitrary value of one (1).
- e.** The resulting effect of two substances, which can be greater than the anticipated effect of the individual substances.
- f.** Parts per million (ppm), milligrams per cubic meter of air (mg/m<sup>3</sup>), micrograms per cubic meter of air (µg/m<sup>3</sup>) and fibers per cubic centimeter of air (f/cc).
- g.** “Your Right to Know”
- h.** Particles that are less than 10 microns (µm) in diameter and can penetrate deep into the respiratory system.
- i.** A gas that displaces oxygen thus lowers the overall amount of oxygen in the air.
- j.** A gas that reduces the body’s ability to absorb, transport, or utilize inhaled oxygen. They are often toxic at very low concentrations (a few ppm).
- k.** Safety Data Sheet

**Review**

**Match the letter to correct acronym, word or phrase...**

- \_\_\_\_\_ Carcinogens
- \_\_\_\_\_ Toxic & highly toxic
- \_\_\_\_\_ Irritants
- \_\_\_\_\_ Corrosives
- \_\_\_\_\_ Sensitizers
- \_\_\_\_\_ Hepatotoxins
- \_\_\_\_\_ Nephrotoxins
- \_\_\_\_\_ Neurotoxins
- \_\_\_\_\_ Hematopoietic agents

**Write in the name of the pictogram according to the Globally Harmonized System of Classification and Labeling of Chemicals...**

- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_
- \_\_\_\_\_

- a.** Chemical or physical agent capable of causing cancer.
- b.** A substance that will destroy or irreversibly damage another surface (metal or skin) with which it comes into contact.
- c.** A chemical that has a low to very low lethal dose value.
- d.** A chemical, which is not corrosive, but which causes a reversible inflammatory effect on living tissue by chemical action at the site of contact.
- e.** A chemical that causes a substantial proportion of exposed people or animals to develop an allergic reaction in normal tissue after repeated exposure to the chemical.
- f.** Chemicals which produce liver damage.
- g.** Chemicals which produce kidney damage.
- h.** Chemicals which produce their primary toxic effects on the nervous system.
- i.** Agents which act on the blood.



# PHYSICAL HEALTH HAZARDS

## ***Learning Goals:***

- Be able to explain what a physical health hazard is and how construction workers might be exposed to these hazards.
- Define important terms used to describe physical hazards in the workplace.
- Overview the health effects of these hazards on the human body.

## ***Important Terms:***

- Heat Cramps, Heat Exhaustion & Heat Stroke
- Frost Bite & Hypothermia
- Noise Induced Hearing Loss
- Cumulative Trauma Disorder
- Ergonomics
- Ionizing Radiation
- Non-Ionizing Radiation
- Melanoma

## Physical Health Hazards in Construction

***Temperature Extremes;*** such as environments that are too hot or too cold.

***Noise;*** loud noise can damage your ear and cause irreversible hearing loss.

***Repetitive Motion, Awkward Postures & Vibration;*** can cause carpal tunnel syndrome, tendonitis, back pain & muscle soreness and nerve damage.

***Ionizing & Non-Ionizing Radiation;*** causes increased risk of cancer (ionizing), tissue heating, discomfort and eye damage (non-ionizing).



For purposes of this discussion, a physical health hazard are those hazards that induce a negative effect on the human body but also do not originate from a traumatic event such as a fall, electrocution or blunt force trauma.

## Temperature

Construction workers generally work outside and are exposed to heat, cold and the sun. Too much heat or cold, especially if combined with high humidity or high winds, can harm your health and interfere with work. Hot, humid conditions can cause heat exhaustion, cramps, and even fainting, while working in very cold conditions can result in chapped skin, frost-bite and hypothermia; cold temperatures can also increase the effects of vibration.

## Heat

At times, workers may be required to work in hot environments for long periods. When the human body's unable to maintain a normal temperature, heat-related illnesses can occur and may result in death.



## Heat Disorders and Health Effects

<p><b>Heat Cramps</b></p>	<p>Painful, brief muscle spasms caused by performing hard physical labor in a hot environment.</p> <p>Cramps have been attributed to an electrolyte imbalance caused by sweating.</p> <p>Cramps can be caused by both too much and too little salt.</p> <p>Cramps appear to be caused by the lack of water replenishment.</p>	<p>Thirst cannot be relied on as a guide to the need for water; instead, water must be taken every 15 to 20 minutes in hot environments.</p> <p>Drinking commercially available carbohydrate-electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.</p>
<p><b>Heat Exhaustion</b></p>	<p>Signs and symptoms; headache, nausea, vertigo, weakness, thirst, and giddiness.</p> <p>Fainting can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended.</p>	<p>Workers suffering from heat exhaustion should be removed from the hot environment and given fluid replacement.</p> <p>Stop physical activity and get adequate rest.</p>
<p><b>Heat Stroke</b></p>	<p>Body's system of temperature regulation fails and body temperature rises to critical levels.</p> <p>Signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature</p>	<p>Professional medical treatment should be obtained immediately.</p> <p>Worker should be placed in a shady area and the outer clothing should be removed.</p> <p>Skin should be wetted and air movement around the worker should be increased to improve evaporative cooling.</p> <p>Fluids should be replaced as soon as possible.</p> <p>No employee suspected of being ill from heat stroke should be sent home or left unattended.</p>

## Contractor Responsibilities towards Heat

OSHA does not have a specific regulation regarding heat stress. However, feasible and acceptable methods can be used to reduce heat stress hazards in workplaces. These include, but are not limited to:

1. Monitor weather conditions (NOAA's Heat Index) and adhere to precautions and warnings.
2. Permitting workers to drink water at liberty.
3. Establishing provisions for a work/rest regimen so that exposure time to high temperatures and/or the work rate is decreased.
4. Developing a program that provides for training on the effects of heat stress, and how to recognize heat-related illness symptoms and prevent heat-induced illnesses.

OTI South West Education Center/elcoshimages.org



**Temperature Hazard Example...  
Enclosed spaces, such as attics, can be a temperature extreme hazard (hot).**

### NOAA's National Weather Service (National Oceanic and Atmospheric Administration)

#### Heat Index Temperature (°F)

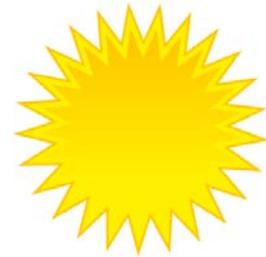
	80	82	84	86	88	90	92	94	96	98	100	102	104	106	118	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	126	130					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

#### Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

- Caution
  Extreme Caution
  Danger
  Extreme Danger

### **Sun**

Sunlight contains ultraviolet (UV) radiation, which causes premature aging of the skin, wrinkles, cataracts, and skin cancer. There are no safe UV rays or safe suntans. Be especially careful in the sun if you burn easily, spend a lot of time outdoors, or have any of the following physical features: numerous, irregular, or large moles; freckles; fair skin; or blond, red, or light brown hair. Here's how to block those harmful rays:



- Cover up. Wear loose-fitting, long-sleeved shirts and long pants.
- Use sunscreen with a sun protection factor (SPF) of at least 30. Be sure to follow application directions on the bottle or tube.
- Wear a wide brim hard hat, this works best because it protects the neck, ears, eyes, forehead, nose, and scalp.
- Wear UV-absorbent sunglasses (eye protection). Check for ANSI Z87 approval if required by employer or exposed to eye hazard.
- Sunglasses should block 99 to 100 percent of UVA and UVB radiation. Before you buy sunglasses, read the product tag or label.
- Limit exposure. UV rays are most intense between 10 a.m. and 4 p.m.

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### **Safe Work Practices (Heat)**

The combination of heat and humidity can be a serious health threat during the summer months. If you work outside you may be at increased risk for heat related illness. So, take precautions. Here's how:

- Drink small amounts of water frequently.
- Wear light-colored, loose-fitting, breathable clothing—cotton is good.
- Take frequent short breaks in cool shade.
- Eat smaller meals before work activity.
- Avoid caffeine and alcohol or large amounts of sugar.
- Work in the shade.
- Find out from your health care provider if your medications and heat don't mix.
- Know that equipment such as respirators or work suits can increase heat stress.



## Cold

Prolonged exposure to cold, wet and windy conditions, even when the temperatures are above freezing, can be dangerous. Extreme cold conditions exist when the equivalent (wind) chill temperature is at or below -25° F (-32 °C). Wind chill temperature is a function of the actual temperature and the estimated wind speed. Under windless conditions, air provides an invisible blanket around the skin. As wind speed increases, this layer of heated air is carried away from the body at an accelerated rate resulting in apparent temperatures well below the air temperature.



***When working in cold weather, employers and workers should take simple precautions, such as those listed below:***

- Wear several layers of clothing rather than one thick layer.
- Wear gloves and a warm hat or a helmet liner under the hard hat.
- Wear synthetic or cotton clothing next to the skin to control sweat.
- Wear warm footwear with one or two pairs of warm socks; footwear should not fit too tightly because it will restrict blood flow and cause more harm than good.
- Wear a scarf or face mask in cold windy weather.
- Take frequent short breaks in a warm shelter to allow the body to warm up.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Drink warm, sweet beverages and avoid drinks with caffeine or alcohol.
- Eat warm, high calorie food such as pasta dishes.
- Workers who take certain medications, are in poor physical condition or suffer from illnesses such as diabetes, high blood pressure, or cardiovascular disease are at increased risk and should therefore check with a doctor for additional advice.



***Workers exposed to cold must dress appropriately for the weather.***

## ***Frostbite & Hypothermia***

The two serious medical conditions that can result from prolonged exposure to the cold are ***frostbite*** and ***hypothermia***.

***Frostbite*** is an injury to the skin and underlying tissue—most often that of the nose, ears, fingers or toes—resulting from prolonged exposure to extreme cold. The first symptoms are a “pins and needles” sensation followed by numbness or pain in the affected extremities. Frostbite is distinguishable by hard, pale, and cold skin. As the area thaws, the flesh becomes red and very painful.

---

### ***First Aid (Frostbite)***

- Move the victim to a warmer place and remove any constricting jewelry and wet clothing.
  - Wrap the affected areas in sterile dressings (remember to separate affected fingers and toes) and immediately get medical attention.
  - Do not rub or massage the affected skin and do not apply hot water or heat.
  - Look for signs of hypothermia and treat accordingly.
- 

***Hypothermia*** is a medical condition in which the victim’s core body temperature drops significantly below normal and normal metabolism begins to be impaired. This begins to happen when the core temperature drops below 95 °F (35 °C). When body temperature falls below 90 °F (32 °C) the condition can become critical and eventually fatal. The early warning signs of hypothermia are: excessive shivering, blue lips and fingers, slurred speech, poor coordination, confusion and impaired thinking. Hypothermia may occur at temperatures well above freezing when a victim is submerged in cold water.

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### ***First Aid (Hypothermia)***

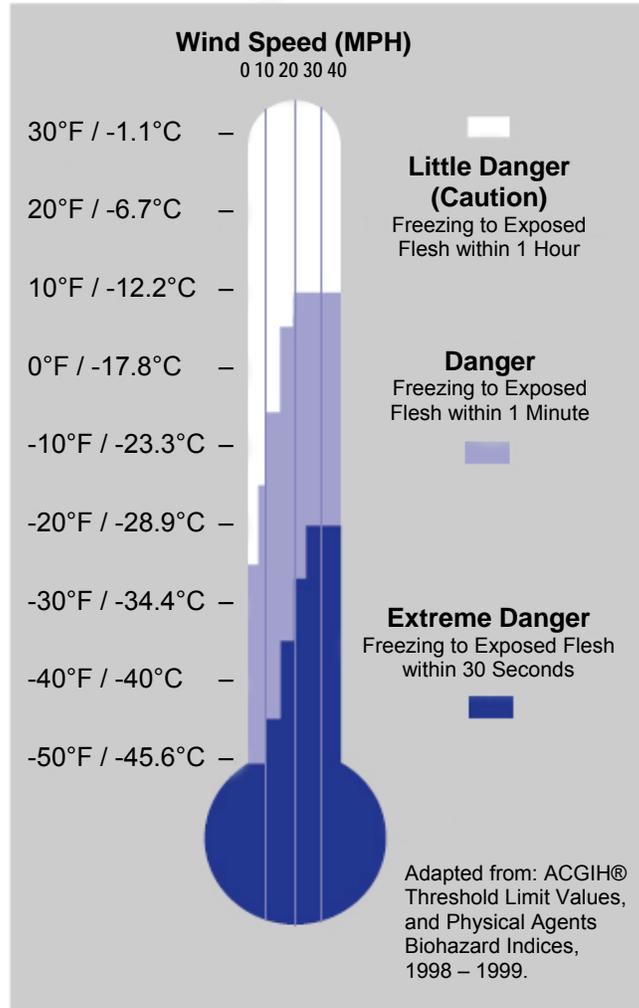
- If any of the symptoms of hypothermia are observed, the victim should immediately be taken to shelter (e.g., heated office, trailer, car or truck).
- Remove wet clothing and wrap victim in warm covers or provide him/her with warm dry clothing.
- Keep the victim awake if possible.
- Provide victim with warm, sweet drinks (sugar water, sports type drinks), avoiding drinks with caffeine (e.g., coffee, tea, sodas or hot chocolate) and alcoholic beverages.
- Get medical attention.

## THE COLD STRESS EQUATION

**LOW TEMPERATURE + WIND SPEED + WETNESS  
= INJURIES & ILLNESS**

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result.

**Hypothermia** can occur when *land temperatures* are **above** freezing or *water temperatures* are below 98.6°F/37°C. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



U.S. Department of Labor  
Occupational Safety and Health Administration

OSHA 3156  
1998

## Occupational Noise

Every year, approximately 30 million workers are exposed to hazardous noise that is often ignored because the harmful effects of overexposure are typically not visible and develop over an extended period of time (chronic health hazard). Damage to the ear could also occur from a single impact noise (explosion), this is an example of an acute hearing loss. Workers exposed to high noise levels can develop elevated blood pressure, ringing in the ears (*tinnitus*), and temporary and/or permanent hearing loss.

***Hearing loss is often a chronic, long-term health effect that is caused by prolonged exposure to loud noise.***

### ***How is Noise Measured?***

Noise is measured using sound level meters, and the **decibel** (abbreviated **dB**) is the unit used to measure the intensity of a sound.



**Standard Sound Level Meter  
Quest Technologies**

***Sound is measured and expressed in...  
dB (decibel)***



***Normal Conversation 60 – 65 dB***



***Yelling 80 – 85 dB***

### ***What is A-Weighted?***

The sensitivity of the human ear to sound depends on the frequency or pitch of the sound. People hear some frequencies better than others; high frequency noise is much better heard than low frequency noise. Noise measurement readings can be adjusted to correspond to this fact; putting more emphasis, or weight, onto the frequencies that people can hear. An *A-weighting* filter which is built into the instrument de-emphasizes low frequencies or pitches.

Because the A-weighted response most resembles the sensitivity of the human ear, OSHA's permissible exposure limit (PEL) for noise is determined using this scale.

## Tinnitus

The National Institute of Health describes tinnitus as a **“ringing in the ears”**. Although not technically a disease, tinnitus is a symptom of something wrong.

People who work in noisy environments—such as construction workers and road crews, can develop tinnitus over time when ongoing exposure to noise damages tiny sensory hair cells in the inner ear that help transmit sound to the brain.

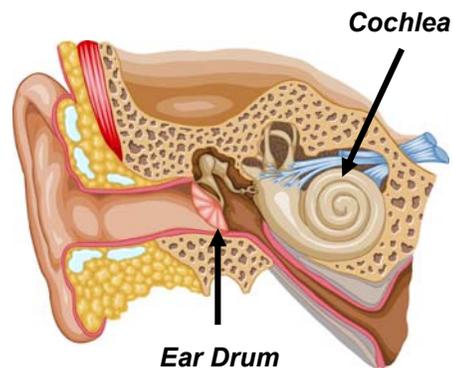
Anything you can do to limit your exposure to loud noise—by moving away from the sound or wearing earplugs or earmuffs—will help prevent tinnitus and/or hearing loss.



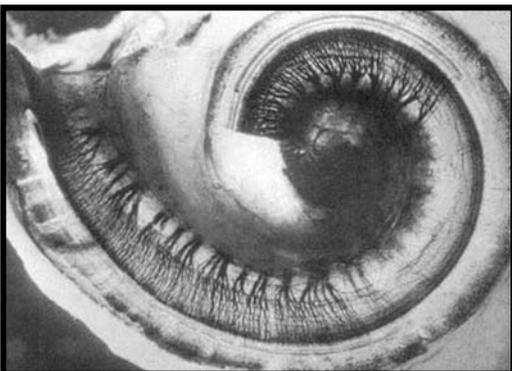
## The Inner Ear

The inner ear is a complex system of bones, muscles and nerves. Inside the cochlea (part of the inner ear) are tiny hair-like structures that vibrate nerves which the brain interprets as sound. Loud noises can temporarily paralyze these hairs causing temporary hearing loss; prolonged exposure to loud noise can permanently destroy them!

*The Inner Ear*



## Cochlea



Micro photo of the spiral curve of the human cochlea revealing a total loss of the outer hair cells and their accompanying nerve fibers following occupational noise exposure; this is what could happen to people who expose themselves to prolonged levels of loud noise.

## How Noise Damages the Ear

Think of the hair-like structures in the ear (cochlea) as grass; as grass is walked on, it gets smashed down and flattens, but over time the blades of grass spring back up – this is like temporary hearing loss. But, if the grass gets walked on repeatedly, over a long period of time, a path gets worn into the grass and the blades of grass get destroyed, never to come back – this is permanent hearing loss.



*Every time you are exposed to loud noise, you damage the hair-like structures in the ear – much like walking on grass. Overtime a path is worn, and like the blades of grass, the tiny hair-like structures in the ear (cochlea) are permanently destroyed!*

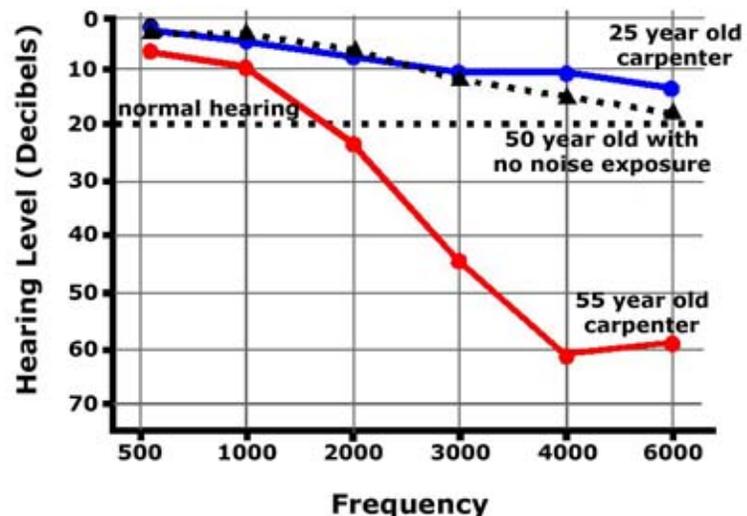
### NIOSH – REL for Noise...

NIOSH has established a Recommended Exposure Limit (REL) for noise at 85 decibels, A-weighted, as an 8-hr Time-Weighted Average -TWA - (85 dBA as an 8-hr TWA).

## NIOSH Occupational Noise Exposure Study

The National Institute for Occupational Safety & Health (NIOSH) has conducted studies that show that people in the construction industry are at a higher risk of some kind of hearing loss due to their occupation; one such study was performed on carpenters. *For more information on NIOSH and its studies on noise induced hearing loss, visit their website at [www.cdc.gov/niosh](http://www.cdc.gov/niosh)*

**The average 25-year old carpenter has the ears of a 50-year old person who has not been exposed to noise.**



Source: eLCOSH



## Occupational Noise Exposures (29 CFR 1926.52)

### OSHA Requirement...

Employers have the responsibility to protect against the effects of noise exposure when the sound levels exceed those shown in Table D-2 of 29 CFR 1926.52 when measured on the **A-weighted scale** of a standard sound level meter at slow response.

**Table D-2 Permissible Noise Exposures**

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1 ½	102
1	105
½	110
¼ or less	115

### OSHA Requirement...

When employees are subjected to sound levels exceeding those listed in Table D-2, feasible\* administrative or engineering controls must first be utilized. If such controls fail to reduce sound levels within the levels of the table (D-2), ear protective devices must be provided and used.

\* **Feasible means – capable of being done.**

## Hearing Conservation

In all cases where the sound levels exceed the values shown in Table D-2, *Permissible Noise Exposures*, a continuing, effective **hearing conservation program** must be administered.

A hearing conservation program should be implemented whenever an employee has an exposure of 85 decibels (A-weighted) as an 8-hr Time-Weighted Average -TWA - (85 dBA as an 8-hr TWA).



## Engineering & Administrative Controls for Noise

Contractors can analysis jobs, tasks and equipment; once loud operations are identified, employers can then seek out alternative tools and equipment that are less noisy (eliminate the hazard).

### **Noise Control Strategies...**

- Enclose equipment operators inside cabs.
- Routine maintenance on tools and equipment can help to reduce sound; replace worn, loose, or unbalanced machine parts that cause vibration.
- Keep machine parts well lubricated to reduce friction.
- Place acoustical enclosures and barriers around generators.
- Use sound absorbing material and vibration isolation systems on hand tools.
- Use rubber mallets to erect and dismantle scaffolding and formwork.
- Rotate workers performing loud tasks, and post signs warning of areas where hearing protection is required.
- Train all employees on how to properly wear hearing protective devices.



**Equipment Operator Cab Enclosure**



**Important administrative controls such as posting warning signs and the proper training of employees must be conducted along with the wearing of hearing protection.**



**Plain cotton is not an acceptable protective device against noise.**

### Hearing Conservation Program

The Occupational Safety and Health Administration (OSHA) has determined that an effective hearing conservation program consists of the following elements:

1. Monitoring of employee noise exposures; (e.g., frequent and regular inspection of the job-site is required by competent person).
2. The institution of engineering, work practice, and administrative controls for excessive noise; (e.g., maintain equipment to run smooth and quiet, rotate workers, put up signs and barriers to warn workers of high noise levels).
3. The provision of each overexposed employee with an individually fitted hearing protector with an adequate *noise reduction rating*; [e.g., attenuation to below 85 decibels (dBA)].
4. Employee training and education regarding noise hazards and protection measures; (e.g., inform workers of the hazards of noise and when and where to wear hearing protectors).
5. Baseline and annual audiometry; before beginning work, have an audiometry test conducted to establish pre-work conditions and periodically re-test to determine any hearing loss.
6. Procedures for preventing further occupational hearing loss by an employee whenever such an event has been identified (e.g., requiring employee use of hearing protective device at 85 decibels (dbA), and;
7. Recording Keeping (e.g., audiometry tests, inspection logs & noise monitoring data).

Every construction industry employer's hearing conservation program must incorporate as many of the above elements as are feasible\*.

*\* Feasible means – capable of being done.*

#### **Recommendations for Protecting Hearing...**

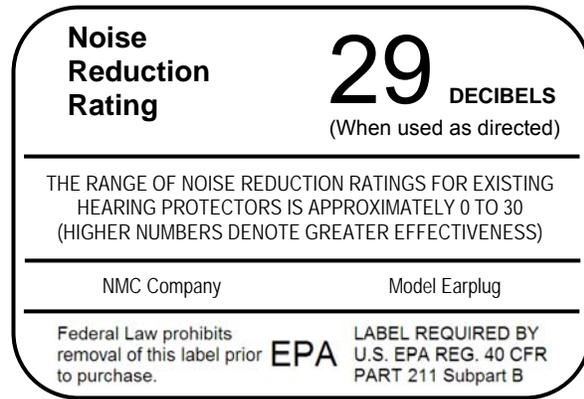
- Know your hazard. Whenever possible, measure the noise levels in your environment on a frequent basis to determine exactly what the hazards are. Determine, if any, off-the-job exposures to noise.
- Trust the annual audiogram. Rely on this information to gauge any hearing loss from year to year.
- Select hearing protection that is right for you, that is comfortable for you, and that you will wear.
- Wear your hearing protection right. Each type of hearing protector is slightly different. The important thing to remember is that you need to insert ear plugs correctly, or ear muffs completely over the ears. Then, you must always test the fit.
- To test the fit, cup your hands over your ears, then release. If you can hear a difference, you may not be wearing your hearing protector correctly. Remove, and then fit again.

## Noise Reduction Rating (NRR)

The **noise reduction rating (NRR)** is the measurement, in decibels (dB), of how well a hearing protector reduces noise. The higher the NRR number the greater the noise reduction. This noise reduction rating is based on the C-weighted sound level scale. Because noise exposures are measured on the A-weighted sound level scale, an adjustment must be made to determine the actual noise reduction (see *NRR Adjustment Calculation*).

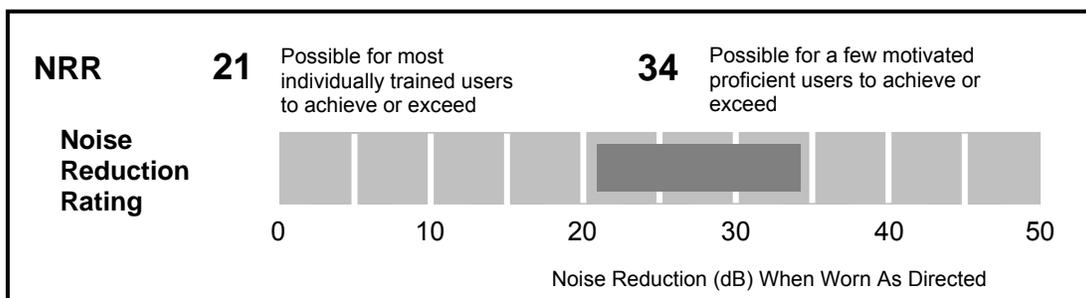
### Noise Reduction Ratings (NRR)...

- A hearing protector's ability to reduce noise is its Noise Reduction Rating (NRR).
- The greater the NRR, the better the noise reduction.
- The NRR is usually listed on the hearing protector box.



## Proposed Noise Reduction Rating (NRR)

Under a new proposed regulation, a new rating system will be used. While it will be known as the NRR, it will now represent a range of expected protection, as opposed to a single-number estimate. While the proposed method still uses ANSI-standard lab testing to generate the attenuation ratings, the new **range noise reduction rating (NRR)** will provide an indication of how much attenuation minimally trained users (the lower number) versus highly motivated, trained users (the higher number) can be expected to achieve. For some hearing protectors, the spread of this range may be quite significant. Also, to more accurately depict attenuation of sound to the human ear, range noise reduction ratings are based on the A-weighted sound level scale (no adjustment calculation required).



## OSHA NRR Adjustment Calculation

To adjust for inconsistencies in the human ear canal and the fact that manufacturers do not use the A-weighted sound level scale to determine noise reduction ratings, OSHA requires that the users of hearing protectors reduce downward the manufacturers' *noise reduction rating (NRR)*; this is done by subtracting seven (7) from the listed NRR.

$$NRR - 7$$

*For example, ear plugs with a listed NRR of 29...*



$$29 - 7 = 22$$

**NOTE:** *If using the manufacturer's new proposed range noise reduction rating, no correction is necessary because the listed range NRR is based on the A-weighted sound level scale. Just make sure you are properly trained and highly motivated to use the device to its fullest potential.*

## NIOSH NRR Adjustment Calculation

*NIOSH has established these percentages to reduce an adjusted noise reduction rating (NRR - 7)...*

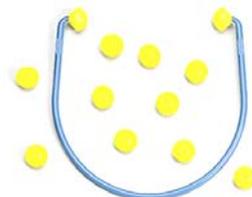
<b>Earmuffs</b>	Subtract 25% from the manufacturer's adjusted NRR
<b>Formable Ear Plugs</b>	Subtract 50% from the manufacturer's adjusted NRR
<b>All Other Ear Plugs (Canal Caps)</b>	Subtract 70% from the manufacturer's adjusted NRR



**Earmuffs**



**Formable Ear Plugs**



**Canal Caps**

## Dual Hearing Protection

Workers whose 8-hour time weighted average exposures exceed 100 decibels should wear double hearing protection (wearing earplugs and earmuffs simultaneously).

**NOTE:** The term "double hearing protection" is misleading. The attenuation provided from any combination earplug and earmuff is not equal to the sum of their individual attenuation values.

### Dual Protection Calculation for Noise Reduction Rating

To calculate the dual hearing protection using the noise reduction rating, take the higher NRR and add five (5) to the field adjusted NRR (listed NRR – 7 + 5); the extra five (5) is all that is added for the second device.

#### Example of dual protection calculation using noise reduction rating (NRR)...

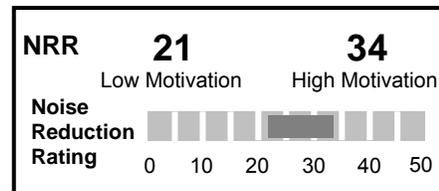
 <p><b>22</b> (Adjusted NRR)</p> <p><b>Formable Ear Plugs</b> Listed NRR = 29 Adjusted NRR (29 – 7) = 22</p>	 <p><b>+ 5 = 27</b> (Dual Protection NRR)</p> <p><b>Earmuffs</b> Listed NRR = 16 Adjusted NRR for Dual Protection = 5</p>
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**WARNING!** Make sure that any plugs used with double protection do not have a cord; it will interfere with the fit of the earmuffs and not provide added protection.



### Dual Protection Calculation (Proposed Range Noise Reduction Rating)

When using the proposed range noise reduction rating (NRR); select the appropriate NRR based on user motivation (low or high) and add five (5) – no subtraction of 7 required. For example, formable ear plugs with range NRR of 21 through 34, a highly motivated user will add 5 to 34 (34 + 5 = 39). A minimally trained low motivated user will add 5 to 21 (21 + 5 = 26).



Repetitive motion, awkward postures and vibration are health hazards in construction. These hazards cause a variety of **cumulative trauma disorders**.

### Cumulative Trauma Disorders (CTDs)

Cumulative trauma disorders (CTDs) also known as repetitive strain injuries, repetitive motion disorders, overuse syndrome, and work-related musculoskeletal disorders are the largest cause of occupational disease in the United States. CTDs are injuries of the musculoskeletal system (joints, muscles, tendons, ligaments, nerves, and blood vessels) which are caused by over use as a result of stressful work over a period of time.



**Cumulative trauma disorders are usually caused by a combination of the following risk factors common to construction work:**

- **Repetitive motions** - Doing the same task over and over again.
- **Forceful exertions** - pulling, pushing, lifting, and gripping.
- **Awkward postures** - body positions that are not the natural resting position.
- **Static postures** - body positions held without moving.
- **Mechanical compression of soft tissues** in the hand against edges or ridges, such as using tools or objects which press against the palm.
- **Fast movement** of body parts.
- **Vibration**, especially in the presence of cold conditions.
- **Lack of sufficient recovery time** (rest breaks, days off), which will increase the risk of developing a CTD by any of the above factors.

*Source:  
Connecticut Department of Public Health  
Environmental and Occupational Health Assessment Program*

Concrete finishers using hand trowels can be very stressful on the back, hands and arms. If physically able to do so, stretching before work and taking mini breaks (a few seconds) can help relieve stress and fatigue. Try not to over reach, as this can place additional stress on your back and wrists. Try to maintain a comfortable position while working.

*NIOSH/Steve Clark/elcoshimages.org*



## CTDs Common to Construction

Source:  
Connecticut Department of Public Health  
Environmental and Occupational Health Assessment Program

Construction work frequently demands performing tasks above the head and the use of vibrating hand and power tools, which are often poorly designed and uncomfortable. There are many different types of CTDs. The most well known CTDs related to construction work are **tendonitis**, **carpal tunnel syndrome (CTS)**, **rotator cuff tendonitis**, **tennis elbow**, **golfer's elbow**, **thoracic outlet syndrome**, **Raynaud's syndrome**, and **trigger finger**.

**Tendonitis** is inflammation of the tendons (bundles of fibrous tissue that connect the muscles to the bones) that occurs when a muscle/tendon is repeatedly used or tensed. With normal use, fibers that make up the tendons are exposed to "micro-traumas" or small tears that are easily repaired by the body. With continued overuse and lack of recovery time, however, some of the fibers that make up the tendon can actually fray or tear apart. Commonly affected areas are the wrists, elbows, and shoulders.

**Carpal tunnel syndrome (CTS)** refers to compression of the median nerve as it passes through the carpal tunnel in the wrist. As the tendons in the carpal tunnel are over used or the tunnel itself is compressed the median nerve is compressed. Commonly reported symptoms of CTS include numbness, burning, and tingling in the first 3 ½ digits. If left untreated, symptoms can become much worse and may result in loss of grip strength, clumsiness, increased pain at night, and possibly permanent loss of hand function. Tasks like electrical work and inserting caulking in windows require repetitive bending and flexing of the fingers and wrists. These jobs and others like them can contribute to the development of CTS.



**Rotator cuff tendonitis** is the most common shoulder tendon disorder. It is often associated with work that requires the elbow to be in an elevated position for long periods of time, such as when performing overhead tasks. These tasks put stress on shoulder tendons and arm sockets. This can give rise to "frozen shoulder" syndrome, which may include severe pain and the loss of shoulder function. Jobs like sheet metal work, plumbing, painting, and drywall installation can all contribute to the development of rotator cuff tendonitis.



**Golfer's elbow** (Medial Epicondylitis) is associated with tasks that require repeated or forceful rotation of the forearm and bending of the wrist at the same time. Tasks that require the use of poorly designed tools contribute to the frequency of this CTD.



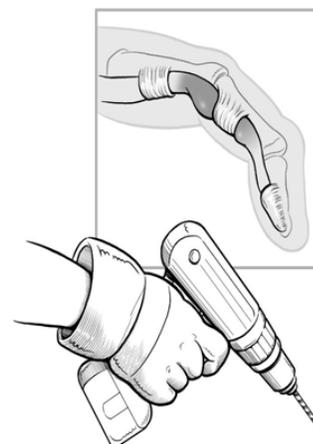
**Thoracic outlet syndrome** involves the compression of nerves from the spine and blood vessels from the heart that go to the muscles in the arms. Performing overhead tasks for extended periods of time and bending over can cause this condition. Like carpal tunnel syndrome, symptoms of thoracic outlet syndrome include numbness in the fingers along with weakened wrist pulse and the sensation of one's arm "falling asleep."



**Raynaud's syndrome**, also referred to as "vibration white finger" or "hand-arm vibration syndrome," (HAVS) is a condition caused by forceful gripping and/or prolonged use of vibrating tools such as hand-held power drill, power saws, needle guns, chipping hammers, and rotary hammer drills. The risk of Raynaud's syndrome is even higher when vibrating tools are used in cold temperatures. Symptoms include numbness and tingling in the fingers, skin that turns pale and cold, and ultimately loss of sensation and muscle control in the fingers and hands.



**Trigger finger** occurs when the tendon sheath of a finger is so swollen that the tendon becomes locked in the sheath. This is often associated with using tools that have handles with hard edges or ridges, and/or repetitive bending of the fingers with continued forceful gripping of equipment. Although severe pain is uncommon, attempting to move the finger will cause snapping and jerking movements.



## How Can CTDs be Prevented?

Source:  
Connecticut Department of Public Health  
Environmental and Occupational Health Assessment Program

- Hand tools with smooth, rounded edges and long handles are better than tools with hard edges and short handles.
- Work area layout is very important. Your tools, parts, and equipment should be easy to reach without excessive stretching or bending.
- Job rotation or reassignment as well as having a variety of job duties is helpful in preventing CTDs from occurring. Using different muscles and body parts helps to prevent CTDs caused by repetition, force, and awkward posture.
- Regular breaks give your muscles and tendons time to heal naturally from repetitive motions and force.
- Adjusting physical factors in the work environment such as temperature, lighting, and humidity can also help prevent CTDs.
- The ability to stretch and move around whenever you feel any pain or tingling in your neck, shoulders, arms, or hands is essential to the prevention of CTDs.

## Ergonomics

**Ergonomics** is the study of fitting the job to the person rather than forcing the person to fit the job. An ergonomist is a trained professional who is qualified to evaluate and make recommendations regarding work areas, work organizations, work practices, tools, and equipment. Once a CTD has developed, however, early diagnosis and treatment are very important in order to prevent further or permanent damage.

### Tool Tip

A tool can be considered “ergonomic” when it fits the task you do, fits your hand, allows a good grip, takes less effort, does not require you to work in an awkward position, does not dig into your fingers or hand, and is comfortable and effective. Remember that a tool designed for one task may put more stress on the hand or wrist when used for a different task.



**Paladin Tools 1300 Series**

**Ergonomically-designed handles  
for effortless operation.**

## Pre-Work Stretch & Flex

**WARNING:** Before beginning any stretching program, check with your healthcare provider. If you question any of the following stretches, or feel any discomfort while doing any of these stretches, stop immediately and check with your healthcare provider before continuing.

### Trunk & Low Back

#### Side Bend

- Feet shoulder width apart, arms at side.
- With one hand, reach up overhead and slowly lean towards opposite side. Keep both feet flat on ground.
- Hold for 3 – 5 seconds.
- Return to starting position and repeat as desired.



#### Back Bend

- Feet shoulder width apart, hands on hips.
- Looking straight ahead slowly and gently bend backwards.
- Caution – you should feel tension, not pain in the low back.
- Hold for 3 – 5 seconds (do not hold your breath).
- Return to starting position and repeat as desired.



### Legs

#### Hamstring Stretch

- Raise your foot on an elevated surface, at least 10" to 12" high (a truck's running board or overturned bucket).
- Looking forward, slowly bend at the hip keeping raised leg straight.
- Stop when you feel tension and hold 3 – 5 seconds.
- To increase tension, pull toes towards body.
- Switch legs and repeat stretch.



#### Quadriceps Stretch

- Holding on for balance with your left hand, grab your right foot or ankle with your right hand.
- Hold for 3 – 5 seconds and feel the pull in the front of your thigh.
- Repeat on opposite side.



**WARNING:** Before beginning any stretching program, check with your healthcare provider. If you question any of the following stretches, or feel any discomfort while doing any of these stretches, stop immediately and check with your healthcare provider before continuing.

## Upper Body

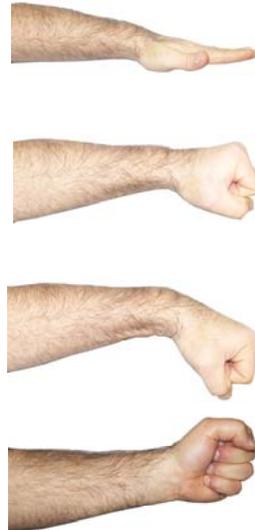
### Chest & Shoulder Stretch

- Standing up straight, raise your arms with your elbows bent so that your upper arms are parallel to the floor, fingers pointing up.
- Slowly squeeze your shoulder blades together and hold for 3 – 5 seconds.
- Return to the starting position and repeat.



### Forearm Stretch

- Hold your arms out straight in front of you with your palms facing down.
- Make a loose fist with your hands.
- Slowly and gently bend your fists down towards the floor. Your knuckles should be pointing towards the floor.
- Now, slowly and gently rotate your fists.
- Hold for 3 – 5 seconds. You should feel a stretch from the topside of the wrists out to the elbow.
- Relax and shake out your hands and arms.
- Repeat as desired.



### Open Hand Stretch

- Start with your hands in a loose fist position.
- Slowly open your hands and extend your fingers.
- Return to a loose fist position and repeat as desired.



## Ionizing Radiation

Ionizing radiation is energy in the form of waves or particles that has enough force to remove electrons from atoms. One source of radiation is the nuclei of unstable atoms. As these radioactive atoms seek to become more stable, their nuclei eject or emit particles and high-energy waves. This process is known as radioactive decay. Some radioactive materials, such as radium, uranium, and thorium, have existed since the formation of the earth. The radioactive gas radon is one type of radioactive material produced as these naturally-occurring radioisotopes decay. Human activities, such as the splitting of atoms in a nuclear reactor, can also create radioactive materials.



**Symbol for  
Radiation**

The major types of radiation emitted during radioactive decay are **alpha particles**, **beta particles**, and **gamma rays**.

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## Protection against Radiation

In occupations where there is exposure to ionizing radiation, *time*, *distance*, and *shielding* are important tools in ensuring worker safety. Danger from radiation increases with the amount of time one is exposed to it; hence, the shorter the time of exposure the smaller the danger.

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## Alpha Particles

Alpha particles are energetic, positively charge particles consisting of two protons and two neutrons. Alpha particles are commonly emitted in the radioactive decay of the heaviest radioactive elements. Even though they are highly energetic, the high mass of alpha particles means they move slowly through the air.

The health effects of alpha particles depend heavily upon how exposure takes place. External exposure (external to the body) is of far less concern than internal exposure, because alpha particles lack the energy to penetrate the outer dead layer of skin. Internally alpha particle can be very harmful. If alpha emitters are inhaled, ingested (swallowed), or absorbed into the blood stream, sensitive living tissue can be exposed to alpha radiation.

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## Beta Particles

Beta particles are fast moving electrons emitted from the nucleus during radioactive decay. Humans are exposed to beta particles from man-made and natural radiation sources.

Beta particles are more penetrating than alpha particles but are less damaging over equally traveled distances. They travel considerable distances in air but can be reduced or stopped by a layer of clothing or by a few millimeters of a substance, such as aluminum. Some beta particles are capable of penetrating the skin and causing radiation damage, such as skin burns. However, as with alpha-emitters, beta-emitters are most hazardous when they are inhaled or ingested.

## Gamma Rays

Like visible light and x-rays, gamma rays are weightless packets of energy called photons. Gamma rays often accompany the emission of alpha or beta particles from a nucleus. They have neither a charge nor a mass and are very penetrating. Several feet of concrete or a few inches of lead may be required to stop gamma rays.

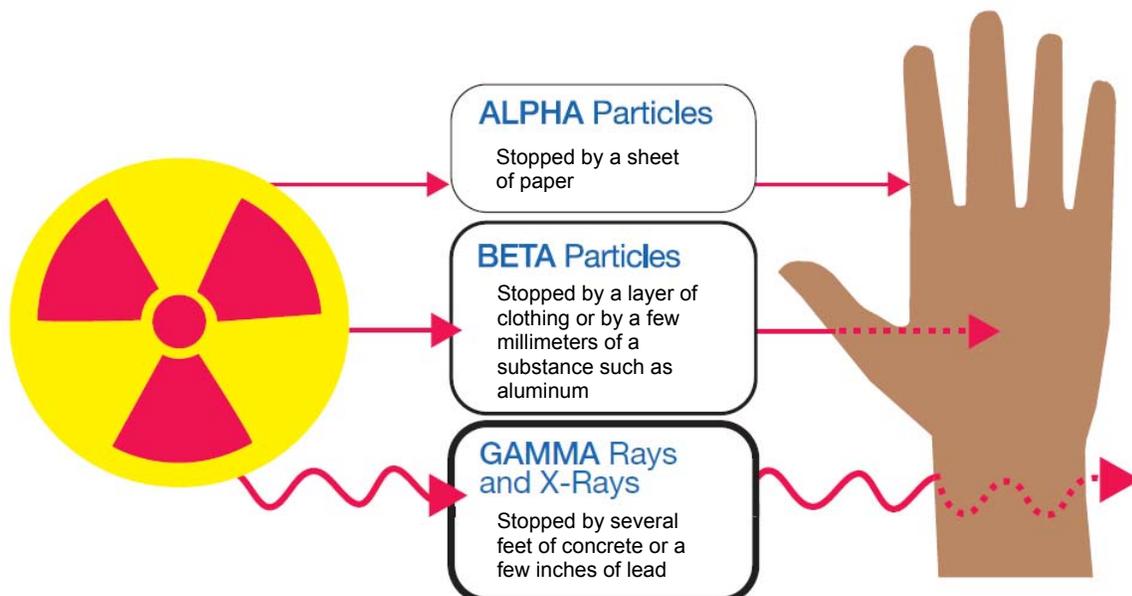
One source of gamma rays in the environment is naturally-occurring potassium-40. Man-made sources include cobalt-60 and cesium-137. Gamma rays are a radiation hazard for the entire body. While gamma rays can easily pass completely through the human body, a fraction will always be absorbed by tissue.

## X-Rays

X-rays are high-energy photons produced by the interaction of charged particles with matter. X-rays and gamma rays have essentially the same properties but differ in origin. X-rays are either produced from a change in the electron structure of the atom or are machine produced. They are emitted from processes outside the nucleus, while gamma rays originate inside the nucleus. They also are generally lower in energy and therefore less penetrating than gamma rays. A few millimeters of lead can stop x-rays.

Literally thousands of x-ray machines are used daily in medicine and industry for examinations, inspections, and process controls. Because of their many uses, x-rays are the single largest source of man-made radiation exposure.

### ***Penetrating Powers of Alpha Particles, Beta Particles, Gamma and X-Rays***



## ***Radiation Exposure***

Any release of radioactive material is a potential source of radiation exposure to the population. In addition to exposure from external sources, radiation exposure can occur internally from ingesting, inhaling, injecting, or absorbing radioactive materials. Both external and internal sources may irradiate the whole body or a portion of the body.

The amount of radiation exposure is expressed in a unit called millirem (mrem). In the United States, the average person is exposed to an effective dose equivalent of approximately 360 mrem (whole-body exposure) per year from all sources.

Radiation affects people by depositing energy in body tissue, which can cause cell damage or cell death. In some cases there may be no noticeable effect. In other cases, the cell may survive but become abnormal, either temporarily or permanently. Additionally, an abnormal cell may become malignant. Both large and small doses of radiation can cause cellular damage. The extent of the damage depends upon the total amount of energy absorbed, the time period and dose rate of the exposure, and the particular organs exposed.

By damaging the genetic material (DNA) contained in the body's cells, radiation can cause cancer. Damage to genetic material in reproductive cells can cause genetic mutations that can be passed on to future generations. In rare occurrences where there is a large amount of radiation exposure, sickness or even death can occur in a limited amount of hours or days.

Chronic exposure is continuous or intermittent exposure to low doses of radiation over a long period of time. With chronic exposure, there is a delay between the exposure and the observed health effect. These effects can include cancer and other health outcomes such as benign tumors, cataracts, and potentially harmful genetic effects.

Acute exposure is exposure to a large, single dose of radiation, or a series of moderate doses received during a short period of time. Large acute doses can result from accidental or emergency exposures or from specific medical procedures (radiation therapy). For approved medical exposures, the benefit of the procedure may outweigh the risk from exposure.

In most cases, a large acute exposure to radiation causes both immediate and delayed effects. Delayed biological effects can include cataracts, temporary or permanent sterility, cancer, and harmful genetic effects. For humans and other mammals, acute exposure to the whole body, if large enough, can cause rapid development of radiation sickness, evidenced by gastrointestinal disorders, bacterial infections, hemorrhaging, anemia, loss of body fluids, and electrolyte imbalance. Extremely high dose of acute radiation exposure can result in death within a few hours, days, or weeks.

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### ***OSHA Standard:***

#### ***29 CFR 1926.53 – Ionizing Radiation***

*In construction and related activities involving the use of sources of ionizing radiation, the pertinent provisions of the Nuclear Regulatory Commission's Standards for Protection Against Radiation (10 CFR part 20), relating to protection against occupational radiation exposure, shall apply.*

## Non-Ionizing Radiation

Non-ionizing radiation refers to any type of electromagnetic radiation that does not carry enough energy to ionize atoms or molecules – that is, to completely remove an electron from an atom or molecule.

Non-ionizing radiation includes the spectrum of *infrared (IR)*, *microwave (MW)*, *radio frequency (RF)*, and *extremely low frequency (ELF)* and *ultraviolet (UV)*. Lasers commonly operate in the UV, visible, and IR frequencies. Non-ionizing radiation is found in a wide range of occupational settings and can pose a considerable health risk to potentially exposed workers if not properly controlled.

### *Infrared Radiation (IR)*

The skin and eyes absorb infrared radiation (IR) as heat. Workers normally notice excessive exposure through heat sensation and pain. Sources of IR radiation include furnaces, heat lamps, and IR lasers.



*Symbol for  
Infrared Radiation (IR)*

### *Microwave (MW) & Radiofrequency (RF)*

Microwave (MW) & Radiofrequency (RF) radiation are electromagnetic radiation in the frequency ranges 3 kilohertz (kHz) - 300 Megahertz (MHz), and 300 MHz - 300 gigahertz (GHz), respectively. Research continues on possible biological effects of exposure to MW/RF radiation from radios, cellular phones, the processing and cooking of foods, heat sealers, vinyl welders, high frequency welders, induction heaters, flow solder machines, communications transmitters, radar transmitters, ion implant equipment, microwave drying equipment, sputtering equipment and glue curing.



*Symbol for  
Microwave (MW) & Radio (RF)*

### *Extremely Low Frequency (ELF)*

Extremely low frequency (ELF) fields includes alternating current (AC) fields and other electromagnetic, non-ionizing radiation from 1 Hz to 300 Hz. ELF fields at 60 Hz are produced by power lines, electrical wiring, and electrical equipment. Some epidemiological studies have suggested increased cancer risk associated with magnetic field exposures near electric power lines.



*Symbol for  
Magnetic Field*

## ***OSHA Standards Relating to Non-Ionizing Radiation***

- Only qualified and trained employees must be assigned to install, adjust, and operate laser equipment.
- Proof of qualification of the laser equipment operator must be available and in possession of the operator at all times.
- Employees, when working in areas in which a potential exposure to direct or reflected laser light greater than 0.005 watts (5 milliwatts) exists, must be provided with anti-laser eye protection devices as specified in Subpart E of this part.
- Areas in which lasers are used must be posted with standard laser warning placards.
- Beam shutters or caps must be utilized, or the laser turned off, when laser transmission is not actually required.
- When the laser is left unattended for a substantial period of time, such as during lunch hour, overnight, or at change of shifts, the laser must be turned off.
- Only mechanical or electronic means must be used as a detector for guiding the internal alignment of the laser.
- The laser beam must not be directed at employees.
- When it is raining or snowing, or when there is dust or fog in the air, the operation of laser systems must be prohibited where practicable; in any event, employees must be kept out of range of the area of source and target during such weather conditions.
- Laser equipment must bear a label to indicate maximum output.
- Laser unit in operation should be set up above the heads of the employees, when possible.
- Employees must not be exposed to microwave power densities in excess of 10 milliwatts per square centimeter.

### ***Selecting Laser Safety Glasses***

**Laser safety glasses** - These specialty glasses protect against intense concentrations of light produced by lasers. Table below lists the maximum power or energy densities and appropriate protection levels for optical densities 5 through 8.

Intensity, CW maximum power density (watts/cm <sup>2</sup> )	Attenuation	
	Optical density (O.D.)	Attenuation factor
10-2	5	10 <sup>5</sup>
10-1	6	10 <sup>6</sup>
1.0	7	10 <sup>7</sup>
10.0	8	10 <sup>8</sup>



***Glendale 3NTX2 Laser Eyewear***

## Ultraviolet Radiation (UV)

Ultraviolet radiation (UV) has a high photon energy range and is particularly hazardous because there are usually no immediate symptoms of excessive exposure. Sources of UV radiation include the sun, black lights, welding arcs, and UV lasers.



***Welding & cutting creates radiant energy that must be protected against (see requirements for filter lens shade number).***

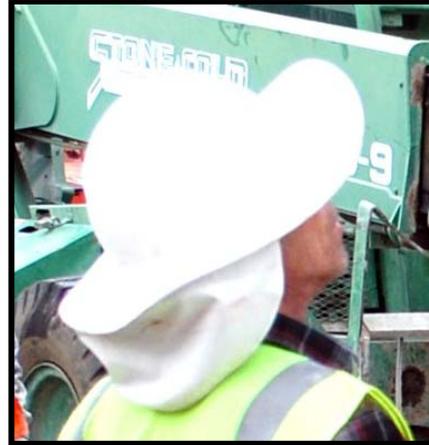
### Construction Industry Requirements for Filter Lens Shade Numbers for Protection against Radiant Energy

<b>Welding Operation</b>	<b>Shade Number</b>
Shielded metal-arc welding 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	10
Gas-shielded arc welding (nonferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	11
Gas-shielded arc welding (ferrous) 1/16-, 3/32-, 1/8-, 5/32-inch diameter electrodes	12
Shielded metal-arc welding 3/16-, 7/32-, 1/4-inch diameter electrodes	12
5/16-, 3/8-inch diameter electrodes	14
Atomic hydrogen welding	10 - 14
Carbon-arc welding	14
Soldering	2
Torch brazing	3 or 4
Light cutting, up to 1 inch	3 or 4
Medium cutting, 1 to 6 inches	4 or 5
Heavy cutting, more than 6 inches	5 or 6
Gas welding (light), up to 1/8-inch	4 or 5
Gas welding (medium), 1/8- to 1/2-inch	5 or 6
Gas welding (heavy), more than 1/2-inch	6 or 8

### ***Ultraviolet Radiation (UV) – Hazard Control***

***Hazard Control Example...***

***Worker wearing sun protection for  
back of neck.***



### ***Ultraviolet Radiation (UV) – Hazard Recognition***

*NIOSH/John Rekus/elcoshimages.org*



***Bad Work Practice – not wearing a shirt  
will result in sunburn and skin damage.***



***Bad Work Practice – welder  
unprotected from ultraviolet radiation.***

## ***Melanoma***

Melanoma is the most dangerous type of skin cancer and is the leading cause of death from skin disease. The single most contributing factor that causes melanoma is excessive exposure to sun light. Complications of melanoma include damage to internal organs and damage to deep tissue. Side effects of treatment include nausea, hair loss, fatigue and pain.



**What can you do to protect yourself from UV radiation from the sun?**

- Avoiding working in the sun, wear protective clothing (hats) and apply sunscreens.
- Protective clothing can include long pants, hats, and long-sleeved shirts. Sun-resistant fabrics are more efficient in blocking UV radiation.
- Physical sunscreens (e.g., zinc oxide) are opaque (and often greasy) products that reflect or block both UVA and UVB. Chemical sunscreens are non-opaque (i.e., you can see through them on your skin). They absorb UVA, UVB, or both. Wide spectrum sunscreens are intended to block both types of UV radiation.
- Sunscreens are rated according to Sun Protection Factor (SPF), an index of protection against skin erythema (reddening of the skin). SPF ranges from 1-50 or more. The higher the SPF is, the more protection it offers from UVB radiation.

- \* SPF 15 sunscreen may absorb more than 92 percent of UVB radiation.
- \* SPF 30 sunscreen may absorb 96.7 percent.
- \* SPF 40 sunscreen may absorb 97.5 percent of UVB radiation.

The UV index is a measure of the intensity of UV radiation in the sunlight that causes reddening of the skin. The UV index scale runs from 0 (when there is no sunlight) to 11+ (extreme).

<b>UV Index</b>	<b>Description</b>	<b>Sun Protection Actions</b>
0 – 2	Low	Minimal sun protection required for normal activity. Wear sunglasses on bright days. If outside for more than one hour, cover up and use sunscreen. Reflections off snow can nearly double UV strength. Wear sunglasses and apply sunscreen.
3 – 5	Moderate	Take precautions - cover up, wear a hat, sunglasses and sunscreen especially if you will be outside for 30 minutes or more. Look for shade near midday when the sun is strongest.
6 – 7	High	Protection required - UV radiation damages the skin and can cause sunburn. Reduce time in the sun between 11 a.m. and 4 p.m. and take full precautions - seek shade, cover up, wear a hat, sunglasses and sunscreen.
8 – 10	Very High	Extra precautions required - unprotected skin will be damaged and can burn quickly. Avoid the sun between 11 a.m. and 4 p.m. and take full precautions - seek shade, cover up, wear a hat, sunglasses and sunscreen.
11+	Extreme	The UV Index can reach 14 or more in the tropics and southern U.S. Take full precautions. Unprotected skin will be damaged and can burn in minutes. Avoid the sun between 11 a.m. and 4 p.m., cover up, wear a hat, sunglasses and sunscreen. White sand and other bright surfaces reflect UV radiation and increase UV exposure.

**Review**

*Match the letter to correct acronym, word or phrase...*

- \_\_\_\_\_ Heat Cramps
- \_\_\_\_\_ Heat Exhaustion
- \_\_\_\_\_ Heat Stroke
- \_\_\_\_\_ Frost Bite
- \_\_\_\_\_ Hypothermia
- \_\_\_\_\_ Noise Induced Hearing Loss
- \_\_\_\_\_ Tinnitus
- \_\_\_\_\_ NRR (acronym)
- \_\_\_\_\_ Cumulative Trauma Disorder
- \_\_\_\_\_ Ergonomics
- \_\_\_\_\_ Ionizing Radiation
- \_\_\_\_\_ Non—Ionizing Radiation
- \_\_\_\_\_ Melanoma

- a.** Medical condition in which the victim's core body temperature drops significantly below normal.
- b.** Painful, brief muscle spasms caused by performing hard physical labor in a hot environment.
- c.** Signs and symptoms include headache, nausea, vertigo, weakness, thirst, and giddiness.
- d.** The study of fitting the job to the person rather than forcing the person to fit the job.
- e.** Body's system of temperature regulation fails and body temperature rises to critical levels.
- f.** An injury to the skin and underlying tissue resulting from prolonged exposure to extreme cold.
- g.** A chronic, long-term health effect that is caused by prolonged exposure to loud noise.
- h.** Ringing in the ears.
- i.** A dangerous type of skin cancer caused by exposure to too much sun light.
- j.** Noise Reduction Rating
- k.** Injuries of the musculoskeletal system which are caused by over use as a result of stressful work over a period of time.
- l.** Energy in the form of waves or particles that has enough force to remove electrons from atoms.
- m.** Electromagnetic radiation that does not carry enough energy to ionize atoms or molecules.

# BIOLOGICAL HEALTH HAZARDS

## ***Learning Goals:***

- Be able to explain what a biological health hazard is and how construction workers might be exposed to these hazards.
- Define important terms used to describe biological hazards in the workplace.
- Overview the health effects of these hazards on the human body.

## ***Important Terms:***

- Fungi (mold)
- Histoplasmosis
- Hantavirus
- Blood Borne Pathogens
- Universal Precautions
- HIV
- Hepatitis – HBV & HCV
- Rabies

## **Biological Health Hazards**

Biological agents include bacteria, viruses, fungi (mold), other microorganisms and their associated toxins. They have the ability to adversely affect human health in a variety of ways, ranging from relatively mild, allergic reactions to serious medical conditions, even death. These organisms are widespread in the natural environment; they are found in air, water, soil, plants, and animals. Because many microbes reproduce rapidly and require minimal resources for survival, they are a potential danger in a wide variety of occupational settings.

***In the construction industry, biological health hazards are most commonly found:***

- When working in health care facilities.
- Where there has been an accumulation of animal waste and the presence of rodents, insects and birds.
- During demolition and remodeling of old structures and buildings where there is likely the presence of mold.
- During clearing operations and the removal of plants, trees and other foliage.
- Landscaping.



***Biological Hazards Example...  
Flood damaged structure – preparing  
for demolition; mold invested building  
and potential harborage of rodents,  
insects and other vermin.***

## Fungi (Mold)

Fungi (mold) are found everywhere – both indoors and outdoors all year round. The terms fungi and mold are often used interchangeably, but mold is actually a type of fungi. There are many thousands of species of mold and most if not all of the mold found indoors comes from outdoor sources. Mold seems likely to grow and become a problem only when there is water damage, high humidity, or dampness.

Molds are organized into three groups according to human responses: **Allergenic**, **Pathogenic** and **Toxigenic**.

### Allergenic Molds

Allergenic molds do not usually produce life-threatening health effects and are most likely to affect those who are already allergic or asthmatic. The human system responses to allergenic molds tend to be relatively mild, depending on individual sensitivities, typically producing scratchy throats, eye and nose irritations and rashes.

### Pathogenic Molds

Pathogenic molds usually produce some type of infection. They can cause serious health effects in persons with suppressed immune systems. Healthy people can usually resist infection by these organisms regardless of dose. In some cases, high exposure may cause hypersensitivity pneumonitis (an acute response to exposure to an organism).

### Toxigenic Molds

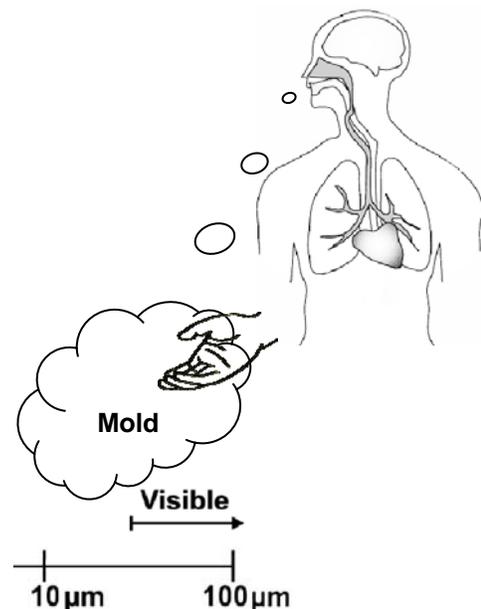
Mycotoxins can cause serious health effects in almost anybody. These agents have toxic effects ranging from short-term irritation to immuno-suppression and possibly cancer. Therefore, when toxigenic molds are found further evaluation is recommended.

## How do Molds Affect the Body?

Molds produce and release millions of spores small enough to be airborne. They can also produce toxic agents known as mycotoxins. Spores and mycotoxins can have negative effects on human health.

The most common route of entry into the body is through inhalation; mold has a characteristic smell – if you smell mold, you could be inhaling mold.

Mold is generally visible; however, some of the most toxic mold spores are small enough to be considered respirable [less than 10 micrometers (10  $\mu\text{m}$ ) in diameter].



## ***Ten Things You Should Know About Mold***

1. Potential health effects and symptoms associated with mold exposures include allergic reactions, asthma, and other respiratory complaints.
2. There is no practical way to eliminate all molds and mold spores in the indoor environment; the way to control indoor mold growth is to control moisture.
3. If mold is a problem in your workplace, you must clean up the mold and eliminate sources of moisture.
4. Fix the source of the water problem or leak to prevent mold growth.
5. Reduce indoor humidity (to 30-60%) to decrease mold growth.
6. Clean and dry any damp or wet building materials and furnishings to prevent mold growth.
7. Clean mold off hard surfaces with water and detergent, and dry completely.
8. Absorbent materials such as ceiling tiles, that are moldy, may need to be replaced.
9. Prevent condensation on cold surfaces by adding insulation.
10. In areas where there is a perpetual moisture problem, do not install carpeting.

***Remember... molds can be found almost anywhere; they can grow on virtually any substance, providing moisture is present.***

### ***Basic Mold Cleanup***

- Make sure the working area is well ventilated.
- Place mold damaged materials in a plastic bag and discard.
- Clean mold off hard surfaces and other nonporous materials with detergent and water, and dry completely.
- Disinfect these cleaned surfaces with one of the following household bleach solutions: 1/4 cup household bleach per 1 gallon of clean water for light contamination. 1 1/2 cups household bleach per 1 gallon of clean water for heavy contamination.



***Worker exposed to fungi (mold) – wearing personal protective equipment.***

## **Histoplasmosis**

Histoplasmosis is an infectious disease caused by inhaling the spores of a fungus called *Histoplasma capsulatum* (*H. capsulatum*). Histoplasmosis is not contagious; it cannot be transmitted from an infected person or animal to someone else.

*H. capsulatum* is a dimorphic fungus, which means it has two forms. It is a mold in soil at ambient temperatures, and after being inhaled by humans or animals, it produces a yeast phase when spores undergo genetic, biochemical, and physical alterations. Spores of *H. capsulatum* are oval and have two sizes. Macroconidia (large spores) have diameters ranging from 8 to 15 micrometers ( $\mu\text{m}$ ), and microconidia (small spores) range from 2 to 5  $\mu\text{m}$  in diameter. Yeast cells of *H. capsulatum* have oval to round shapes and diameters ranging from 1 to 5  $\mu\text{m}$ .

Histoplasmosis primarily affects a person's lungs, and its symptoms vary greatly. The vast majority of infected people are asymptomatic (have no apparent ill effects), or they experience symptoms so mild they do not seek medical attention and may not even realize that their illness was Histoplasmosis. If symptoms do occur, they will usually start within 3 to 17 days after exposure, with an average of 10 days. Histoplasmosis can appear as a mild, flu-like respiratory illness and has a combination of symptoms, including malaise (a general ill feeling), fever, chest pain, dry or nonproductive cough, headache, loss of appetite, shortness of breath, joint and muscle pains, chills, and hoarseness.

Source:  
NIOSH Publication  
*Histoplasmosis – Protecting Workers at Risk*

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### **Where are *H. capsulatum* spores found?**

*H. capsulatum* grows in soils throughout the world. In the United States, the fungus is endemic and the proportion of people infected by *H. capsulatum* is higher in central and eastern states, especially along the Ohio and Mississippi River valleys. The fungus seems to grow best in soils having high nitrogen content, especially those enriched with bird manure or bat droppings.

Construction workers who work in areas where there is the accumulation of bird and/or bat droppings must be protected against the harmful effects of *H. capsulatum*.



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### **Hantavirus Pulmonary Syndrome**

Hantavirus is a disease spread by rodents that is similar to the flu. The virus is in their urine and feces, but it does not make the carrier animal sick. Humans are thought to become infected when they are exposed to contaminated dust from mice nests or droppings.

The disease is not passed between humans. People may encounter contaminated dust when cleaning long-empty homes, sheds, or other enclosed areas.



## ***Respiratory Protection for Exposures to Fungi (Mold)***

Respiratory protection for exposure to fungi (mold) will depend on the size of the particle and its level of toxicity. Whenever you smell or see the presence of mold, it is important to take precautions to LIMIT YOUR EXPOSURE to mold and mold spores.

***Avoid breathing in mold or mold spores!***

In order to limit your exposure to airborne mold, wear at a minimum an N-95 respirator; for higher level of protection use a 99 or 100 (HEPA) rated filter. If oil is present in the air then make sure to use either an R or a P designated filter.

***Respiratory protection for exposure to fungi (mold)...***



***Approved Filtering Facepiece Respirator (Disposable) – any combination of N, R & P with efficiency 95, 99 or 100.***



***Half Mask, Elastomeric, Air Purifying Respirator – any combination of N, R & P with efficiency 95, 99 or 100.***

## ***NIOSH Recommendation for Mold***

The NIOSH minimum recommendation for respiratory protection for workers remediating dusty areas contaminated with highly infectious *Histoplasma capsulatum* spores (from bird and bat manure) is a full-facepiece respirator (APF 50).



***Full Facepiece, Elastomeric, Air Purifying Respirator – any combination of N, R & P with efficiency 95, 99 or 100.***

## Bloodborne Pathogens

Bloodborne pathogens means pathogenic microorganisms that are present in human blood and can cause disease in humans. These pathogens include, but are not limited to, **hepatitis B virus (HBV)**, **hepatitis C virus (HCV)** and **human immunodeficiency virus (HIV)**.

### **Bloodborne pathogens include:**

- Hepatitis B Virus (HBV)
- Hepatitis C Virus (HCV)
- Human Immunodeficiency Virus (HIV)

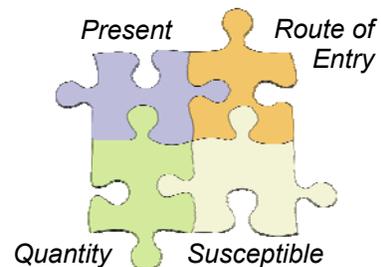


**Symbol for Bloodborne Pathogen**

## How Bloodborne Pathogens are Spread

For any disease to be spread, including bloodborne diseases, all four of the following conditions must be met:

1. A pathogen must be present;
2. There has to be enough of the pathogen to cause disease;
3. The pathogen enters the body through a route of entry; and
4. The person is susceptible to the pathogen.



**For an infection to occur, all four conditions must be present.**

## OSHA Policy towards Bloodborne Pathogens in Construction

OSHA bloodborne pathogens standards do not apply to the construction. However, Section 5(a)(1) of the OSH Act (General Duty Clause) provides that "each employer shall furnish to each of his employees employment and a place of employment which is free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." Where construction workers are exposed to this health hazard, precautions must be taken.

## Universal Precautions

Universal precautions are OSHA's required methods of control to protect employees from exposure to all human blood and other bodily fluids. The term "universal precautions" refers to a concept of bloodborne disease control which requires that all human blood and fluids be treated as if known to be infectious for HIV, HBV, HCV or other bloodborne pathogens.



**Protect yourself against bloodborne pathogens – always wear gloves.**

## Hepatitis B Virus (HBV)

Hepatitis B is a liver infection caused by the hepatitis B virus (HBV). Hepatitis B may be severe or even fatal. The disease may be in the body for up to 6 months before signals appear. Chronic hepatitis B may eventually cause liver cirrhosis and liver cancer.

### Symptoms of Hepatitis B Virus (HBV) include:

- Flu-like signals such as fatigue, abdominal pain, loss of appetite, nausea, vomiting and joint pain.
- Jaundice



**Hepatitis B vaccine prevents against serious disease.**

There are medications available to treat chronic hepatitis B infections; however these medications work only for some people. To prevent hepatitis B, a vaccine is available; this vaccine is given in a series of three doses to provide immunity.

## Hepatitis C Virus (HCV)

Hepatitis C is a liver disease caused by the hepatitis C virus (HCV). It is the most common chronic bloodborne infection in the United States. There is no vaccine against hepatitis C, and no treatment after an exposure occurs that results in infection. Hepatitis C is the leading cause of liver transplants; for these reasons, hepatitis C is a very serious disease.



**Hepatitis C is a serious disease of the liver.**

### Symptoms of Hepatitis C Virus (HCV) include:

- Flu-like signals such as fatigue, abdominal pain, loss of appetite, nausea, vomiting and joint pain.
- Jaundice

## Preventing Hepatitis

Get vaccinated for hepatitis B and follow the universal precautions towards bloodborne pathogens. Also, practice good hygiene; hands must be washed after using toilet facilities and before preparing food.

**NOTE:** The viruses that cause hepatitis can live outside the body and be infectious for certain periods of time. A good rule of thumb is that wet material is infectious and dried material is much less infectious.



**Frequent hand washing will help to prevent sickness and disease.**

## ***Human Immunodeficiency Virus (HIV)***

AIDS (acquired immunodeficiency syndrome) is a condition caused by HIV (human immunodeficiency virus) and is the result of a weakened immune system. HIV attacks white blood cells and destroys the body's ability to fight infection, such as severe pneumonia, tuberculosis and tumors.

People infected with HIV may not feel or look sick. When the infected person shows signs of having certain infections or cancers, the infected person may be diagnosed as having AIDS. People with AIDS could develop life-threatening infections and can die from the infections.



***Red Ribbon –  
Symbol of solidarity of people  
living with HIV/AIDS.***

***There is no vaccine against HIV – prevention is the only defense against the virus!***

## ***HIV Cannot Live Outside the Body***

Studies have proven time and time again that HIV does not survive well outside the human body. In artificially high concentrations produced in the lab, HIV drying that occurs outside of the body reduces the number of infectious viral particles by 99 percent in just a few hours. Since the concentration of HIV in blood or other bodily fluids is much lower, HIV drying outside the human body virtually eliminates all infectious HIV particles therefore making the risk of HIV infection from blood or bodily fluids outside the body essentially zero.

### ***HIV Facts***

***Source:  
United States, National Library of Medicine***

- HIV enters the body through blood, semen, vaginal fluid or breast milk from an infected person.
- A healthy person cannot get HIV by using the same toilet seat as an infected person. HIV is not transmitted through sweat or urine
- HIV cannot be spread by kissing an infected person on the cheek with no cuts or sores on it.
- Sharing a swimming pool is not known to cause the spread of HIV.

## Poisonous Plants

Many native and exotic plants are poisonous to humans when ingested or if there is skin contact with plant chemicals. However, the most common problems with poisonous plants arise from contact with the sap oil of several ever-present native plants that cause an allergic skin reaction—poison ivy, poison oak, and poison sumac.

Poison ivy, poison oak, and poison sumac release oil when the leaf or other plant parts are bruised, damaged, or burned. When the oil gets on the skin an allergic reaction, referred to as contact dermatitis, occurs in most exposed people as an itchy red rash with bumps or blisters.

### ***Plant Identification***

The old saying "*Leaves of three, Let it be!*" is a helpful reminder for identifying poison ivy and oak, but not poison sumac which usually has clusters of 7-13 leaves. Even poison ivy and poison oak may have more than three leaves and their form may vary greatly depending upon the exact species encountered, the local environment, and the season. Being able to identify local varieties of these poisonous plants throughout the seasons and differentiating them from common nonpoisonous look-a-likes are the major keys to avoiding exposure.

#### ***Poison Ivy***

- Eastern poison ivy is typically a hairy, ropelike vine with three shiny green (or red in the fall) leaves budding from one small stem.
- Western poison ivy is typically a low shrub with three leaves that do not form a climbing vine.
- May have yellow or green flowers and white to green-yellow or amber berries.



#### ***Poison Oak***

- Typically a shrub with leaves of three, similar to poison ivy.
- Pacific poison oak may be vine-like.
- May have yellow or green flowers and clusters of green-yellow or white berries.



#### ***Poison Sumac***

- Woody shrub that has stems that contain 7-13 leaves arranged in pairs.
- May have glossy, pale yellow or cream-colored berries.



## Poisonous & Infectious Animals

A number of different poisonous & infectious animals are found throughout the United States; workers should be made aware of these health hazards before starting work in a specific location.

### ***Group Discussion...***

***What are, if any, the poisonous & infectious animals on your job-site?***

## ***Rabies***

Rabies is a viral disease caused by infection of the central nervous systems of wild and domestic animals and humans. The initial symptoms of human rabies resemble those of other systemic viral infections, including fever, headache and disorders of the upper respiratory and gastrointestinal tracts. Recognizing that a person has been exposed to the virus and prompt treatment are essential for preventing rabies. Once clinical symptoms have begun, there is no treatment for rabies and almost all patients will die from the disease or its complications within a few weeks of onset.

The most sensible way to avoid contact with rodents is to prevent rodents from infesting the places where you live and work, and to follow safety precautions if you do stumble into a rodent-infested area. Safe disposal of rodents and proper cleaning and disinfection of rodent-inhabited areas are keys to minimizing exposure to the virus.

The Center for Disease Control specifically recommends following these steps for safe disposal and clean-up of dead rodents and/or rodent droppings:

- Wear rubber gloves.
- Thoroughly spray dead rodents, traps, droppings, and contaminated areas with a general household disinfectant.
- Place disinfectant-soaked rodents into a plastic bag and seal it. Then place it into a second plastic bag and seal. If possible, burn or bury the bag or contact your local or state health department about other appropriate disposal methods.
- Disinfect floors, countertops and other surfaces with a general household disinfectant.
- Before removing the gloves, wash gloved hands in disinfectant, and then in soap and water. Thoroughly wash hands with soap and water after removing the gloves.
- Disinfect all used traps, and then set them again or replace them.
- Eliminate possible rodent nesting sites such as junk cars, old tires and trash piles. Do not leave animal food and water in feeding dishes overnight, and keep all food in rodent-proof containers.
- Cut grass, brush and dense shrubbery within the immediate area of buildings.

Remember to keep an eye out for signs of rodents and to use the precaution measures listed above.

## Review

**Match the letter to correct acronym, word or phrase...**

\_\_\_\_\_ Fungi (mold)  
 \_\_\_\_\_ Histoplasmosis  
 \_\_\_\_\_ Hantavirus  
 \_\_\_\_\_ Blood Borne Pathogens  
 \_\_\_\_\_ Universal Precautions  
 \_\_\_\_\_ HIV (acronym)  
 \_\_\_\_\_ HBV (acronym)  
 \_\_\_\_\_ HCV (acronym)  
 \_\_\_\_\_ Rabies

- a.** A concept of bloodborne disease control which requires that all human blood and fluids be treated as if known to be infectious.
- b.** A disease spread by rodents that is similar to the flu.
- c.** Seems likely to grow and become a problem only when there is water damage, high humidity, or dampness.
- d.** A viral disease caused by infection of the central nervous systems of wild and domestic animals and humans.
- e.** An infectious disease caused by inhaling the spores of a fungus called *Histoplasma capsulatum* (*H. capsulatum*).
- f.** Pathogenic microorganisms that are present in human blood and can cause disease in humans.
- g.** Hepatitis C Virus
- h.** Human Immunodeficiency Virus
- i.** Hepatitis B Virus



# SPECIAL CONSIDERATIONS FOR CONSTRUCTION

To help protect the health of a construction worker, it is important to understand how construction work operates and that special situations need to be considered. These special considerations can make protecting a construction worker's health a challenge...

- Construction sites are temporary and change constantly as the work moves ahead.
- New trades arrive on the site constantly; this creates problems for enforcing protective regulations.
- Multi-employer work sites; several trades may share the same work area, exposing each other to unsuspected hazards.
- Construction workers change employers often and will work for a number of different contractors during the course of their career; making it difficult to track and monitor an individual's exposure.
- Small and specialty trade contractors do not often have the resources or expertise to effectively anticipate, identify and control occupational health hazards.

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To effectively deal with these special considerations, contractors will have to work together...

- Anticipate change in work conditions and document exposures as work moves ahead.
- Communicate with other contractors to discuss problems and coordinate work.
- Conduct medical surveillance to employees and encourage workers to request medical surveillance from all employers; inform workers of their rights to request medical records and express to them the importance of having regular medical checkups.
- Share information about air sample results to contractor groups and associations; like exposures can be anticipated and historical databases of common exposures can be created.
- Market your efforts so as clients, government and trade unions recognize your hard work and compassion for safety.

## ***Responsibility to Health and Safety***

<b><i>Host Employer (Owner)</i></b>	<b><i>Controlling Contractor</i></b>	<b><i>Sub-Contractors</i></b>
<ul style="list-style-type: none"> <li>➤ Perform an engineering survey to determine the presence of hazardous materials before accepting bids for work.</li> <li>➤ Carefully review all bids for appropriate procedures and allowances for the safe handling, use and disposal of hazardous materials.</li> <li>➤ Specify that engineering and administrative controls are to be implemented before personal protective equipment (PPE) and acknowledge that these controls may be more expensive to purchase up-front. Exercise caution towards contractors who do not have detailed engineering and administrative control plans.</li> <li>➤ Consider the presence of confined spaces and inform all contractors as to the nature of the hazards associated and the special precautions to take relative to owned confined spaces.</li> <li>➤ Certain health standards require owner to notify presence and location of hazardous substances (e.g., asbestos).</li> </ul>	<ul style="list-style-type: none"> <li>➤ Has general supervisory authority over the worksite, including the power to correct safety and health violations or require others to correct them.</li> <li>➤ Must exercise reasonable care to prevent and detect violations on the site.</li> <li>➤ Award sub-contract to only those employers who provide detailed safety and health plans outlining specific engineering and administrative controls.</li> <li>➤ Coordinate entry operations into newly constructed or existing confined spaces.</li> <li>➤ Provide adequate hygiene facilities (e.g., toilets, hand washing stations, etc...).</li> <li>➤ Provide required medical services and first aid supplies.</li> </ul>	<ul style="list-style-type: none"> <li>➤ Perform hazard analyses on jobs and tasks.</li> <li>➤ Identify worker exposures to hazardous substances</li> <li>➤ Implement feasible engineering and administrative controls.</li> <li>➤ Provide personal protective equipment when required.</li> <li>➤ Train employees on how to recognize and avoid unsafe conditions on the job-site and regulations that apply to their jobs.</li> <li>➤ Assign a competent person to perform frequent and regular inspections of the job-site.</li> </ul>

***Remember... Cheap is good, until someone gets hurt!***

## ***Chemical (Liquid) – Resistant Gloves***

Chemical-resistant gloves are made with different kinds of rubber: natural, butyl, neoprene, nitrile and fluorocarbon (viton); or various kinds of plastic: polyvinyl chloride (PVC), polyvinyl alcohol and polyethylene. These materials can be blended or laminated for better performance. As a general rule, the thicker the glove material, the greater the chemical resistance but thick gloves may impair grip and dexterity, having a negative impact on safety.

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### ***Chemical-resistant gloves include:***

**Butyl gloves** are made of a synthetic rubber and protect against a wide variety of chemicals, such as peroxide, rocket fuels, highly corrosive acids (nitric acid, sulfuric acid, hydrofluoric acid and red-fuming nitric acid), strong bases, alcohols, aldehydes, ketones, esters and nitrocompounds. Butyl gloves also resist oxidation, ozone corrosion and abrasion, and remain flexible at low temperatures. Butyl rubber does not perform well with aliphatic and aromatic hydrocarbons and halogenated solvents.

**Natural (latex) rubber gloves** are comfortable to wear, which makes them a popular general-purpose glove. They feature outstanding tensile strength, elasticity and temperature resistance. In addition to resisting abrasions caused by grinding and polishing, these gloves protect workers' hands from most water solutions of acids, alkalis, salts and ketones. Latex gloves have caused allergic reactions in some individuals and may not be appropriate for all employees. Hypoallergenic gloves, glove liners and powderless gloves are possible alternatives for workers who are allergic to latex gloves.

**Neoprene gloves** are made of synthetic rubber and offer good pliability, finger dexterity, high density and tear resistance. They protect against hydraulic fluids, gasoline, alcohols, organic acids and alkalis. They generally have chemical and wear resistance properties superior to those made of natural rubber.

**Nitrile gloves** are made of a copolymer and provide protection from chlorinated solvents such as trichloroethylene and perchloroethylene. Although intended for jobs requiring dexterity and sensitivity, nitrile gloves stand up to heavy use even after prolonged exposure to substances that cause other gloves to deteriorate. They offer protection when working with oils, greases, acids, caustics and alcohols but are generally not recommended for use with strong oxidizing agents, aromatic solvents, ketones and acetates.

The following table from the U.S. Department of Energy (Occupational Safety and Health Technical Reference Manual) rates various gloves as being protective against specific chemicals and will help you select the most appropriate gloves to protect your employees. The ratings are abbreviated as follows: VG: Very Good;

G: Good; F: Fair; P: Poor (not recommended). Chemicals marked with an asterisk (\*) are for limited service.

Chemical Resistance Selection Chart for Protective Gloves

<b>Chemical</b>	<b>Neoprene</b>	<b>Latex/Rubber</b>	<b>Butyl</b>	<b>Nitrile</b>
Acetaldehyde*	VG	G	VG	G
Acetic acid	VG	VG	VG	VG
Acetone*	G	VG	VG	P
Ammonium hydroxide	VG	VG	VG	VG
Amy acetate*	F	P	F	P
Aniline	G	F	F	P
Benzaldehyde*	F	F	G	G
Benzene*	P	P	P	F
Butyl acetate	G	F	F	P
Butyl alcohol	VG	VG	VG	VG
Carbon disulfide	F	F	F	F
Carbon tetrachloride*	F	P	P	G
Castor oil	F	P	F	VG
Chlorobenzene*	F	P	F	P
Chloroform*	G	P	P	F
Chloronaphthalene	F	P	F	F
Chromic acid (50%)	F	P	F	F
Citric acid (10%)	VG	VG	VG	VG
Cyclohexanol	G	F	G	VG
Dibutyl phthalate*	G	P	G	G
Diesel fuel	G	P	P	VG
Diisobutyl ketone	P	F	G	P
Dimethylformamide	F	F	G	G
Diethyl phthalate	G	P	F	VG
Dioxane	VG	G	G	G
Epoxy resins, dry	VG	VG	VG	VG
Ethyl acetate*	G	F	G	F
Ethyl alcohol	VG	VG	VG	VG
Ethyl ether*	VG	G	VG	G
Ethylene dichloride*	F	P	F	P
Ethylene glycol	VG	VG	VG	VG
Formaldehyde	VG	VG	VG	VG
Formic acid	VG	VG	VG	VG
Freon 11	G	P	F	G
Freon 12	G	P	F	G
Freon 21	G	P	F	G

<b>Chemical</b>	<b>Neoprene</b>	<b>Latex/Rubber</b>	<b>Butyl</b>	<b>Nitrile</b>
Freon 22	G	P	F	G
Furfural*	G	G	G	G
Gasoline, leaded	G	P	F	VG
Gasoline, unleaded	G	P	F	VG
Glycerin	VG	VG	VG	VG
Hexane	F	P	P	G
Hydrazine (65%)	F	G	G	G
Hydrochloric acid	VG	G	G	G
Hydrofluoric acid (48%)	VG	G	G	G
Hydrogen peroxide (30%)	G	G	G	G
Hydroquinone	G	G	G	F
Isooctane	F	P	P	VG
Kerosene	VG	F	F	VG
Ketones	G	VG	VG	P
Lacquer thinners	G	F	F	P
Lactic acid (85%)	VG	VG	VG	VG
Lauric acid (36%)	VG	F	VG	VG
Lineolic acid	VG	P	F	G
Linseed oil	VG	P	F	VG
Maleic acid	VG	VG	VG	VG
Methyl alcohol	VG	VG	VG	VG
Methylamine	F	F	G	G
Methyl bromide	G	F	G	F
Methyl chloride*	P	P	P	P
Methyl ethyl ketone*	G	G	VG	P
Methyl isobutyl ketone*	F	F	VG	P
Methyl methacrylate	G	G	VG	F
Monoethanolamine	VG	G	VG	VG
Morpholine	VG	VG	VG	G
Naphthalene	G	F	F	G
Napthas, aliphatic	VG	F	F	VG
Napthas, aromatic	G	P	P	G
Nitric acid*	G	F	F	F
Nitric acid, red and white fuming	P	P	P	P
Nitromethane (95.5%)*	F	P	F	F
Nitropropane (95.5%)	F	P	F	F
Octyl alcohol	VG	VG	VG	VG
Oleic acid	VG	F	G	VG
Oxalic acid	VG	VG	VG	VG

## Chemical Glove Selection Chart

<b>Chemical</b>	<b>Neoprene</b>	<b>Latex/Rubber</b>	<b>Butyl</b>	<b>Nitrile</b>
Palmitic acid	VG	VG	VG	VG
Perchloric acid (60%)	VG	F	G	G
Perchloroethylene	F	P	P	G
Petroleum distillates (naphtha)	G	P	P	VG
Phenol	VG	F	G	F
Phosphoric acid	VG	G	VG	VG
Potassium hydroxide	VG	VG	VG	VG
Propyl acetate	G	F	G	F
Propyl alcohol	VG	VG	VG	VG
Propyl alcohol (iso)	VG	VG	VG	VG
Sodium hydroxide	VG	VG	VG	VG
Styrene	P	P	P	F
Styrene (100%)	P	P	P	F
Sulfuric acid	G	G	G	G
Tannic acid (65)	VG	VG	VG	VG
Tetrahydrofuran	P	F	F	F
Toluene*	F	P	P	F
Toluene diisocyanate (TDI)	F	G	G	F
Trichloroethylene*	F	F	P	G
Triethanolamine (85%)	VG	G	G	VG
Tung oil	VG	P	F	VG
Turpentine	G	F	F	VG
Xylene*	P	P	P	F

**NOTE:** When selecting chemical-resistant gloves be sure to consult the manufacturer's recommendations, especially if the gloved hand(s) will be immersed in the chemical.

---

## Care of Protective Gloves

Protective gloves should be inspected before each use to ensure that they are not torn, punctured or made ineffective in any way. A visual inspection will help detect cuts or tears but a more thorough inspection by filling the gloves with water and tightly rolling the cuff towards the fingers will help reveal any pinhole leaks. Gloves that are discolored or stiff may also indicate deficiencies caused by excessive use or degradation from chemical exposure.

Any gloves with impaired protective ability should be discarded and replaced. Reuse of chemical-resistant gloves should be evaluated carefully, taking into consideration the absorptive qualities of the gloves. A decision to reuse chemically-exposed gloves should take into consideration the toxicity of the chemicals involved and factors such as duration of exposure, storage and temperature.

# RESPIRATORY PROTECTION PROGRAM FOR CONTRACTORS

Respiratory illnesses in construction are unforgiving; they can make the strongest, hardworking tradesman weak, exhausted and unable to work. These illnesses are attributed to the chemicals we work with to the very building materials we mold into structures and roads. As a contractor, knowing the basics of an effective respiratory protection program will allow a better understanding of the seriousness of the hazard.

**IMPORTANT:** *Respirators should be used for protection only when engineering controls have been shown to be infeasible for the control of the hazard or during the interim period when engineering controls are being installed.*

---

***An effective respiratory protection program needs to be able to perform the following key functions:***

- a. Determine whether respirators are required due to hazards in the work environment.
- b. Identify which respirator will be needed to provide the best protection.
- c. Ensure that all employees required to do so are medically able to wear a respirator and perform their work.
- d. Ensure that the selected respirator properly fits each employee required to wear one.
- e. Ensure that each employee is trained on the respirator's use, limitations, storage, maintenance, cleaning and disinfecting.
- f. Ensure that each of the above is properly documented and reviewed for its effectiveness as part of a site-specific written respiratory protection program.

## **(a) Need for Respiratory Protection**

Respirators are **required** to be worn by workers whenever the following three conditions arise:

1. Exposures exceed the OSHA Permissible Exposure Limit for a chemical or substance;
2. Engineering controls are being put in place, but have not yet reduced exposures below the OSHA Permissible Exposure Limit; or
3. The employer **requires** respirators to be worn.

***If the above three conditions do not exist, then the use of respirators is not required.***

---

**(b) Respirator Selection**

The type of respirator to use in any situation is determined by the *Program Administrator*. OSHA requires that an employer designate a Program Administrator to oversee employee respiratory protection and ensure compliance to the OSHA Regulations.

Cartridge-type respirators or air supplying respirators can only reduce exposures to hazardous gases or vapors. Filtering facepiece respirators, filtered elastomeric facepiece respirators, or air supplying respirators can reduce exposures to hazardous dusts, fumes, mists and other particles.

Each type of mask gives a different level of protection, measured by the amount of air leaking into the mask where it comes in contact with the face.

A respirator can only reduce exposure never eliminate it.

The Program Administrator must take into account the type of exposure, the level of exposure (amount) and other work and environmental factors to choose the most appropriate respirator to protect workers.

Respirator Cartridge/filter Color-Codes	
Organic Vapor.....	Black
Acid Gas.....	White
Organic Vapor/Acid Gas.....	Yellow
Ammonia.....	Green
P-100 (HEPA).....	Magenta
Multi-Gas/Vapor.....	Olive

<b>Particulate Air Filter Use Description</b>			
<b>Oil Designation</b>	<b>P</b>	<b>R</b>	<b>N</b>
<b>Efficiency</b>			
<b>95</b>	Oil Proof Low Efficiency	Oil resistant Low Efficiency	Not Oil Proof Low Efficiency
<b>99</b>	Oil Proof Medium Efficiency	Oil resistant Medium Efficiency	Not Oil Proof Medium Efficiency
<b>100</b>	Oil Proof High Efficiency	Oil resistant High Efficiency	Not Oil Proof High Efficiency

## (c) Medical Evaluation

After determining which respirator is required, the Program Administrator needs to make sure that the employees are physically able to wear the respirators required. The medical evaluation is performed in one of two manners. First, a confidential questionnaire (Appendix C of the Respirator Standard, 29 CFR 1910.134) can be given during work hours or at a time and location convenient for the workers. It must be given in a language that the employee can read. OSHA has translated the questionnaire into Spanish. If the employee cannot read, they may bring someone from home to read the questions to the employee. The employer may not provide this person, or be present during the questioning. After completing the questionnaire, the employee puts it into an envelope and seals it. The employer can then send the sealed questionnaire to their designated Physician or Licensed Health Care Professional (PLHCP).

Another method of medical evaluation is to send the employee to the PLHCP for a face-to-face evaluation where the PLHCP asks the same questions as those found on the questionnaire. The employer must provide a copy of their written respirator program to the PLHCP as well as the medical evaluation section of the Respirator Standard.

After evaluating the employees, the PLHCP sends a letter back to the employer stating four things:

1. The employee can or cannot wear the respirator;
2. Any limitations on respirator use for that employee;
3. The need and frequency for follow-up evaluations; and
4. That the PLHCP has communicated this information to the employee.

This is the Medical Record, which must be kept for the employee's duration of employment plus thirty (30) years thereafter. At no time does the employer ever see the questionnaire.

## ***Respiratory Medical Evaluation***

***A physical examination for respiratory use could include:***

- Pulmonary function test
- Initial chest x-ray
- Detailed work / health history



**Appendix C to Sec. 1910.134: OSHA Respirator Medical Evaluation  
Questionnaire (Mandatory)**

**To the employer:** Answers to questions in Section 1, and to question 9 in Section 2 of Part A, do not require a medical examination.

**To the employee:**

Can you read (circle one):       Yes    No

Your employer must allow you to answer this questionnaire during normal working hours, or at a time and place that is convenient to you. To maintain your confidentiality, your employer or supervisor must not look at or review your answers, and your employer must tell you how to deliver or send this questionnaire to the health care professional who will review it.

**Part A. Section 1.** (Mandatory) The following information must be provided by every employee who has been selected to use any type of respirator (please print).

1. Today's date:
2. Your name:
3. Your age (to nearest year):
4. Sex (circle one): Male/Female
5. Your height: \_\_\_\_\_ ft. \_\_\_\_\_ in.
6. Your weight: \_\_\_\_\_ lbs.
7. Your job title:
8. A phone number where you can be reached by the health care professional who reviews this questionnaire (include the Area Code):
9. The best time to phone you at this number:  
 Before    After    Between \_\_\_\_:\_\_\_\_    a.m.    p.m. - \_\_\_\_:\_\_\_\_    a.m.    p.m.
10. Has your employer told you how to contact the health care professional who will review this questionnaire (circle one): Yes/No
11. Check the type of respirator you will use (you can check more than one category):  
 N    R    P disposable respirator (filter-mask, non-cartridge type only).  
 Other type (e.g., half- or full-facepiece type, powered-air purifying, supplied-air)
12. Have you worn a respirator?  
If "yes," what type(s)...

*Continue... →*

**Part A. Section 2.** (Mandatory) Questions 1 through 9 below must be answered by every employee who has been selected to use any type of respirator.

1. Do you *currently* smoke tobacco, or have you smoked tobacco in the last month?

2. Have you *ever had* any of the following conditions?

- a. Seizures (fits)
- b. Diabetes (sugar disease)
- c. Allergic reactions that interfere with your breathing
- d. Claustrophobia (fear of closed-in places)
- e. Trouble smelling odors

3. Have you *ever had* any of the following pulmonary or lung problems?

- a. Asbestosis
- b. Asthma
- c. Chronic bronchitis
- d. Emphysema
- e. Pneumonia
- f. Tuberculosis
- g. Silicosis
- h. Pneumothorax (collapsed lung)
- i. Lung cancer
- j. Broken ribs
- k. Any chest injuries or surgeries
- l. Any other lung problem that you've been told about

4. Do you *currently* have any of the following symptoms of pulmonary or lung illness?

- a. Shortness of breath
- b. Shortness of breath when walking fast on level ground or walking up a slight hill or incline
- c. Shortness of breath when walking with other people at an ordinary pace on level ground
- d. Have to stop for breath when walking at your own pace on level ground
- e. Shortness of breath when washing or dressing yourself
- f. Shortness of breath that interferes with your job
- g. Coughing that produces phlegm (thick sputum)
- h. Coughing that wakes you early in the morning
- i. Coughing that occurs mostly when you are lying down
- j. Coughing up blood in the last month
- k. Wheezing
- l. Wheezing that interferes with your job
- m. Chest pain when you breathe deeply
- n. Any other symptoms that you think may be related to lung problems

5. Have you *ever had* any of the following cardiovascular or heart problems?

- a. Heart attack
- b. Stroke
- c. Angina
- d. Heart failure
- e. Swelling in your legs or feet (not caused by walking)
- f. Heart arrhythmia (heart beating irregularly)
- g. High blood pressure
- h. Any other heart problem that you've been told about

*Continue... →*

## Respiratory Protection Program for Contractors

6. Have you *ever had* any of the following cardiovascular or heart symptoms?

- a. Frequent pain or tightness in your chest
- b. Pain or tightness in your chest during physical activity
- c. Pain or tightness in your chest that interferes with your job
- d. In the past two years, have you noticed your heart skipping or missing a beat
- e. Heartburn or indigestion that is not related to eating
- f. Any other symptoms that you think may be related to heart or circulation problems

7. Do you *currently* take medication for any of the following problems?

- a. Breathing or lung problems
- b. Heart trouble
- c. Blood pressure
- d. Seizures (fits)

8. If you've used a respirator, have you *ever had* any of the following problems?

- a. Eye irritation
- b. Skin allergies or rashes
- c. Anxiety
- d. General weakness or fatigue
- e. Any other problem that interferes with your use of a respirator

9. Would you like to talk to the health care professional who will review this questionnaire about your answers to this questionnaire?

---

Questions 10 to 15 below must be answered by every employee who has been selected to use either a full-facepiece respirator or a self-contained breathing apparatus (SCBA). For employees who have been selected to use other types of respirators, answering these questions is voluntary.

10. Have you *ever lost* vision in either eye (temporarily or permanently)?

11. Do you *currently* have any of the following vision problems?

- a. Wear contact lenses
- b. Wear glasses
- c. Color blind
- d. Any other eye or vision problem

12. Have you *ever had* an injury to your ears, including a broken ear drum?

13. Do you *currently* have any of the following hearing problems?

- a. Difficulty hearing
- b. Wear a hearing aid
- c. Any other hearing or ear problem

14. Have you *ever had* a back injury?

*Continue... →*

15. Do you *currently* have any of the following musculoskeletal problems?

- a. Weakness in any of your arms, hands, legs, or feet
- b. Back pain
- c. Difficulty fully moving your arms and legs
- d. Pain or stiffness when you lean forward or backward at the waist
- e. Difficulty fully moving your head up or down
- f. Difficulty fully moving your head side to side
- g. Difficulty bending at your knees
- h. Difficulty squatting to the ground
- i. Climbing a flight of stairs or a ladder carrying more than 25 lbs
- j. Any other muscle or skeletal problem that interferes with using a respirator

---

**Part B.** Any of the following questions, and other questions not listed, may be added to the questionnaire at the discretion of the health care professional who will review the questionnaire.

1. In your present job, are you working at high altitudes (over 5,000 feet) or in a place that has lower than normal amounts of oxygen?

If "yes," do you have feelings of dizziness, shortness of breath, pounding in your chest or other symptoms when you're working under these conditions?

2. At work or at home, have you ever been exposed to hazardous solvents, hazardous airborne chemicals (e.g., gases, fumes, or dust), or have you come into skin contact with hazardous chemicals?

If "yes," name the chemicals if you know them...

3. Have you ever worked with any of the materials, or under any of the conditions, listed below:

- a. Asbestos
- b. Silica (e.g., in sandblasting)
- c. Tungsten/cobalt (e.g., grinding or welding this material)
- d. Beryllium
- e. Aluminum
- f. Coal (for example, mining)
- g. Iron
- h. Tin
- i. Dusty environments
- j. Any other hazardous exposures

If "yes," describe these exposures...

4. List any second jobs or side businesses you have...

5. List your previous occupations...

6. List your current and previous hobbies...

7. Have you been in the military services?

If "yes," were you exposed to biological or chemical agents (either in training or combat)?

*Continue... →*

## Respiratory Protection Program for Contractors

8. Have you ever worked on a HAZMAT team?
9. Other than medications for breathing and lung problems, heart trouble, blood pressure, and seizures mentioned earlier in this questionnaire, are you taking any other medications for any reason (including over-the-counter medications)?

If "yes," name the medications if you know them...

10. Will you be using any of the following items with your respirator(s)?
- a. HEPA Filters
  - b. Canisters (for example, gas masks)
  - c. Cartridges

11. How often are you expected to use the respirator(s)?

- a. Escape only (no rescue)
- b. Emergency rescue only
- c. Less than 5 hours *per week*
- d. Less than 2 hours *per day*
- e. 2 to 4 hours per day
- f. Over 4 hours per day

12. During the period you are using the respirator(s), is your work effort:

- a. *Light* (less than 200 kcal per hour)

If "yes," how long does this period last during the average shift?

Examples of a light work effort are *sitting* while writing, typing, drafting, or performing light assembly work; or *standing* while operating a drill press (1-3 lbs.) or controlling machines.

- b. *Moderate* (200 to 350 kcal per hour)

If "yes," how long does this period last during the average shift?

Examples of moderate work effort are *sitting* while nailing or filing; *driving* a truck or bus in urban traffic; *standing* while drilling, nailing, performing assembly work, or transferring a moderate load (about 35 lbs.) at trunk level; *walking* on a level surface about 2 mph or down a 5-degree grade about 3 mph; or *pushing* a wheelbarrow with a heavy load (about 100 lbs.) on a level surface.

- c. *Heavy* (above 350 kcal per hour)

If "yes," how long does this period last during the average shift?

Examples of heavy work are *lifting* a heavy load (about 50 lbs.) from the floor to your waist or shoulder; working on a loading dock; *shoveling*; *standing* while bricklaying or chipping castings; *walking* up an 8-degree grade about 2 mph; climbing stairs with a heavy load (about 50 lbs.).

*Continue... →*

13. Will you be wearing protective clothing and/or equipment (other than the respirator) when you're using your respirator?

If "yes," describe this protective clothing and/or equipment...

14. Will you be working under hot conditions (temperature exceeding 77 deg. F)?

15. Will you be working under humid conditions?

16. Describe the work you'll be doing while you're using your respirator(s)...

17. Describe any special or hazardous conditions you might encounter when you're using your respirator(s) (for example, confined spaces, life-threatening gases)...

18. Provide the following information, if you know it, for each toxic substance that you'll be exposed to when you're using your respirator(s)...

Name of the first toxic substance...

Estimated maximum exposure level per shift...

Duration of exposure per shift...

Name of the second toxic substance...

Estimated maximum exposure level per shift...

Duration of exposure per shift...

Name of the third toxic substance...

Estimated maximum exposure level per shift...

Duration of exposure per shift...

The name of any other toxic substances that you'll be exposed to while using your respirator...

19. Describe any special responsibilities you'll have while using your respirator(s) that may affect the safety and well-being of others (for example, rescue, and security)...

## (d) Fit Testing

The next step is to fit test the employee with the selected respirator. There are four methods of fit testing qualitatively (pass/fail) and three methods quantitatively (measures actual fit). These are detailed in Appendix A of the Respiratory Protection Standard, 29 CFR 1910.134. OSHA allows qualitative testing for all respirators except full-face, negative pressure, air-purifying respirators – These are required to be quantitatively fitted.

***Only properly trained persons are allowed to administer an employee respirator fit test – follow the procedures in 29 CFR 1910.134.***

### ***Respirator User Seal Check***

Prior to the fit test, a fit check is performed to make sure a good seal is obtained. In addition, the employee should wear the mask for five minutes prior to fitting to ensure comfort. Fit checks are done both negatively and positively.

***To perform a negative pressure fit check;*** cover the inlets to the filters or cartridges, and inhale to cause the face piece to pull against the face. The employee then holds their breath. If the face piece relaxes, there is a substantial leak and either another mask is selected or the mask is adjusted.

***To perform a positive pressure fit check;*** cover or block the exhalation valve and blow out steadily, as if blowing out a candle. The face piece should expand, but no air should be felt leaking out.

***After passing the fit check, the fit test can be performed.***



***Positive Pressure Fit Check***



***Negative Pressure Fit Check***

## Qualitative Fit Test

The qualitative fit test is done using a taste test (saccharin or Bitrex<sup>®</sup>), an odor test (banana oil/iso amyl acetate), or a reaction test to irritant smoke. A qualitative fit test kit includes a hood and odorant – testing must be performed by qualified person.



**3M FT-10 Qualitative Fit Test Kit**

## Quantitative Fit Test

The quantitative tests use machines to measure the actual leakage through the face seal of particles or the change in pressure due to air leakage. The three tests are corn oil mist particle counting, condensation nuclei counter (CNC) or PortaCount, and the Dynatech FitTester 3000, which measures pressure difference. They all need adapters to allow sampling inside the mask. Quantitative fit tests must be performed by qualified persons.



**Dynatech FitTester 3000**

Employees must be re-fitted at least annually and if employee experiences any of the following:

- Has substantial weight gain or loss (> 10% of their body weight);
- Has cosmetic surgery;
- Has had extensive dental work; or
- If the employee reports that the respirator is not passing a fit check.

## (e) Training

In addition to the fit testing, employees require training on how to use, maintain, store, clean and disinfect their respirators (procedures for cleaning and disinfecting are found in Appendix B of the Respiratory Protection Standard, 29 CFR 1910.134). The wearer must be trained on the respirator's limitations. This training must be performed prior to using the respirator in a work or rescue environment and must include annual refresher training and re-training when an employee demonstrates misuse. The training, as with the medical questionnaire, must be in a language that the employee understands.

## (f) Written Program

Finally, after selection, medical clearance, fit testing and training, an employee is able to wear a respirator in the work area. The Program Administrator is required to have at the job site a written program that details specifically each aspect of respirator use at that site. This written program must be made available to employees or their representatives and OSHA compliance officers during inspections.

**Appendix D to Sec. 1910.134 (Mandatory) – Information for Employees  
Using Respirators When Not Required Under the Standard**

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

***When using a respirator, do the following:***

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

Respirator User's Signature: \_\_\_\_\_

Date: \_\_\_\_\_

# RESPIRATOR CLEANING & MAINTENANCE

The manufacturer's guidance for cleaning and sanitizing a respirator should always be followed and is included with the packaging of all products. If you do not have access to that copy, check the manufacturer's web site. If still not accessible, general cleaning and sanitizing guidance is provided by the Occupational Safety and Health Administration (OSHA).

## **Appendix B-2 to § 1910.134: Respirator Cleaning Procedures (Mandatory)**

These procedures are provided for employer use when cleaning respirators. They are general in nature, and the employer as an alternative may use the cleaning recommendations provided by the manufacturer of the respirators used by their employees, provided such procedures are as effective as those listed here in Appendix B- 2. Equivalent effectiveness simply means that the procedures used must accomplish the objectives set forth in Appendix B-2, i.e., must ensure that the respirator is properly cleaned and disinfected in a manner that prevents damage to the respirator and does not cause harm to the user.

---

### ***Procedures for Cleaning Respirators***

- A. Remove filters, cartridges, or canisters. Disassemble facepieces by removing speaking diaphragms, demand and pressure- demand valve assemblies, hoses, or any components recommended by the manufacturer. Discard or repair any defective parts.
- B. Wash components in warm (43 deg. C [110 deg. F] maximum) water with a mild detergent or with a cleaner recommended by the manufacturer. A stiff bristle (not wire) brush may be used to facilitate the removal of dirt.
- C. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain.
- D. When the cleaner used does not contain a disinfecting agent, respirator components should be immersed for two minutes in one of the following:
  1. Hypochlorite solution (50 ppm of chlorine) made by adding approximately one milliliter of laundry bleach to one liter of water at 43 deg. C (110 deg. F); or,
  2. Aqueous solution of iodine (50 ppm iodine) made by adding approximately 0.8 milliliters of tincture of iodine (6-8 grams ammonium and/or potassium iodide/100 cc of 45% alcohol) to one liter of water at 43 deg. C (110 deg. F); or,
  3. Other commercially available cleansers of equivalent disinfectant quality when used as directed, if their use is recommended or approved by the respirator manufacturer.
- E. Rinse components thoroughly in clean, warm (43 deg. C [110 deg. F] maximum), preferably running water. Drain. The importance of thorough rinsing cannot be overemphasized. Detergents or disinfectants that dry on facepieces may result in dermatitis. In addition, some disinfectants may cause deterioration of rubber or corrosion of metal parts if not completely removed.
- F. Components should be hand-dried with a clean lint-free cloth or air-dried.
- G. Reassemble facepiece, replacing filters, cartridges, and canisters where necessary.
- H. Test the respirator to ensure that all components work properly.

## Job/Task Description

---

### Health Hazard Type

Chemical Hazard:	Gas <input type="checkbox"/>	Vapor <input type="checkbox"/>	Fume <input type="checkbox"/>	Dust/Fiber <input type="checkbox"/>	Mist <input type="checkbox"/>
Physical Hazard:	Temperature <input type="checkbox"/>	Noise <input type="checkbox"/>	CTD <input type="checkbox"/>	Radiation <input type="checkbox"/>	Other <input type="checkbox"/>
Biological Hazard:	Fungi (Mold) <input type="checkbox"/>	Bloodborne Pathogen <input type="checkbox"/>	Poisonous Plant/Animal <input type="checkbox"/>	Other <input type="checkbox"/>	

---

### Recognize the Problem

- What is the substance?
  - How toxic is it?
  - Are potential health effects acute, chronic, or both?
  - Is there evidence based on studies of animals or humans that the substance is a carcinogen?
    - A mutagen?
    - A teratogen or reproductive toxin?
  - How does this substance enter the body (routes of entry): inhalation, skin absorption, ingestion?
  - What is the legal exposure limit (PEL) or recommended TLV?
- 

### Evaluate the Problem

- *Air monitoring* – How much of the substance are you being exposed to?
  - *Personal monitoring* – Has the concentration of the substance in the workplace air been tested? How long are you exposed?
  - *Historical data* – What data, if any, has been collected in the past that could cause to assume a certain level of exposure?
  - *Medical surveillance* – What symptoms, if any, are you or your co-workers experiencing? Is any type of medical testing recommended?
- 

### Control the Problem

- *Engineering* – What engineering controls are feasible?
  - *Administrative & Work Practice* – What safe work procedures are associated with the task?
  - *Personal Protective Equipment* – What is the required personal protective equipment (PPE) that is to be worn while using or being exposed to a hazardous substance?
  - What other controls are recommended to prevent overexposure?
-

**Appendix D to §1910.146 -- Sample Permits**

Appendix D-1

Confined Space Entry Permit

Date and Time Issued: \_\_\_\_\_ Date and Time Expires: \_\_\_\_\_  
 Job site/Space I.D.: \_\_\_\_\_ Job Supervisor: \_\_\_\_\_  
 Equipment to be worked on: \_\_\_\_\_ Work to be performed: \_\_\_\_\_  
 Stand-by personnel: \_\_\_\_\_

1. Atmospheric Checks:
 

Time	_____		
Oxygen	_____	%	
Explosive	_____	% L.F.L.	
Toxic: CO	_____	ppm	
H <sub>2</sub> S	_____	ppm	
  
2. Tester's signature: \_\_\_\_\_
  
3. Source isolation (No Entry):
 

	N/A	Yes	No
Pumps or lines blinded:	( )	( )	( )
Disconnected, or blocked:	( )	( )	( )
  
4. Ventilation Modification:
 

	N/A	Yes	No
Mechanical	( )	( )	( )
Natural Ventilation only	( )	( )	( )
  
5. Atmospheric check after isolation and Ventilation: Time \_\_\_\_\_
 

Oxygen	_____	%	> 19.5%
Explosive	_____	% L.F.L.	< 10%
Toxic	_____	ppm	< 10 ppm (H <sub>2</sub> S)
Toxic	_____	ppm	< 35 ppm (CO)

 Tester's signature: \_\_\_\_\_
  
6. Communication procedures: \_\_\_\_\_
  
7. Rescue procedures: \_\_\_\_\_
  
8. Entry, standby, and back up persons:
 

Successfully completed required training? Is it current?	Yes	No
	( )	( )
  
9. Equipment:
 

	N/A	Yes	No
• Direct reading gas monitor - tested	( )	( )	( )
• Safety harnesses & lifelines for entry and standby persons	( )	( )	( )
• Hoisting equipment	( )	( )	( )
• Powered communications	( )	( )	( )
• SCBA's for entry and standby persons	( )	( )	( )
• Protective Clothing	( )	( )	( )
• All electric equipment listed Class I, Division I, Group D and Non-sparking tools	( )	( )	( )

10. Periodic atmospheric tests:

Oxygen	%	Time	Oxygen	%	Time
Oxygen	%	Time	Oxygen	%	Time
Explosive	%	Time	Explosive	%	Time
Explosive	%	Time	Explosive	%	Time
Toxic	%	Time	Toxic	%	Time
Toxic	%	Time	Toxic	%	Time

We have reviewed the work authorized by this permit and the information contained herein. Instructions and safety procedures have been received and are understood. Entry cannot be approved if any squares are marked in the "No" column. This permit is not valid unless all appropriate items are completed.

Permit Prepared By: (Supervisor) \_\_\_\_\_

Approved By: (Unit Supervisor) \_\_\_\_\_

Reviewed By (Operations Personnel):

\_\_\_\_\_

(Printed name)

(Signature)

This permit is to be kept at job site; return job site copy to Safety Office following job completion.

- Copies:      White Original (Safety Office)
- Yellow (Unit Supervisor)
- Hard (Job-site)

## Standard Interpretation

Date: January 24, 2003

### Enforcement Policy for Respiratory Hazards Not Covered by OSHA Permissible Exposure Limits

As you are aware, the General Duty Clause (Section 5(a)(1) of the Occupational Safety and Health Act) is occasionally used to cite air contaminant hazards that are not presently covered by any OSHA Permissible Exposure Limit (PEL). In the last two years, five (5) such 5(a)(1) citations were issued by federal OSHA for an air contaminant not presently covered by an OSHA PEL.

In order to effectively evaluate worker exposure, Agency industrial hygienists must evaluate all workplace chemical hazards, including those hazards not presently covered by a PEL. In those cases where an OSHA PEL has not been issued, OSHA will review available occupational exposure references and recommendations. The most commonly available sources or reference points are the occupational exposure levels established by the National Institute for Occupational Safety and Health (NIOSH) in their Recommended Exposure Limits (RELs), the Threshold Limit Values (TLVs) published by the American Conference of Governmental Industrial Hygienists (ACGIH) and the Workplace Environmental Exposure Levels (WEELs) published by the American Industrial Hygiene Association (AIHA). In some cases, manufacturers have also conducted literature searches or studies and have proposed occupational exposure recommendations for chemicals they manufacture. Care should be taken that these recommendations or references are not considered or used as either OSHA PELs or as "national consensus standards" such as referenced under Section 12(d) of the National Technology Transfer and Advancement Act of 1995.

Section 5(a)(1) of the OSHAct requires each employer to "furnish to 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." The general duty provisions are to be used only where there is no standard that applies to the particular hazard involved, as outlined in 29 CFR 1910.5(f). In addition, the Occupational Safety and Health Review Commission and court precedent have determined that the following elements must be established in order to prove a violation of the general duty clause:

1. The employer failed to keep the workplace free of a hazard to which employees of that employer were exposed;
2. The hazard was recognized;
3. The hazard was causing or was likely to cause death or serious physical harm; and
4. There was a feasible and useful method to correct the hazard.

It is important to note that in workplaces where an employer has workers exposed to chemicals and where OSHA did not have a PEL for the contaminant, those employers would not automatically receive a citation if the exposure is above the recommendation. In the majority of cases, the employer would receive a letter from the local OSHA Area Office advising that a worker(s) at the establishment had exceeded an occupational exposure recommendation. The letter would also provide a series of recommended exposure control suggestions.

Further, as has been discussed during several recent Regional Administrator/Enforcement Issues conference calls, it is important for OSHA Compliance Officers to document, prior to citing the General Duty Clause, that a *hazardous exposure* is occurring or has occurred at the workplace, not just that a recognized occupational exposure recommendation has been exceeded. OSHA must document that an exposure to a physical agent or chemical at a *hazardous level or amount*, i.e., an exposure (amount) which is capable of causing death or serious physical harm, has occurred and that employees are or could be experiencing adverse health effects if exposure

continues. This must be done in order for an employer to be cited for a violation of 5(a)(1) of the OSHAct. Exceeding an occupational exposure recommendation therefore is not the hazardous or violative condition, but rather that employees were exposed to **harmful levels** of a chemical. Recommended occupational exposure levels such as TLVs are guidelines developed for industrial hygienists to be used in their professional evaluation of worker exposures and are not meant to be enforced, in and of themselves, by government agents. When evaluating a potential hazard, the compliance officer should document how the chemical is being used, any efforts the employer has taken to reduce the hazard and any adverse health effects that may be experienced by employees.

If there is an established OSHA PEL which applies to a given workplace air contaminant, Section 5(a)(1) cannot normally be used to impose a stricter requirement than that required by the standard. An exception to this rule may apply if it can be documented that, "an employer knows a particular safety or health standard is inadequate to protect his workers against the specific hazard it is intended to address." **International Union, UAW. vs. General Dynamics Land Systems Div.**, 815 F.2d 1570 (D.C. Cir. 1987).

### Policy

In order to assure that the Agency is consistently applying the General Duty Clause with regard to workplace air contaminant hazards, citations for such violations shall not be issued without prior approval by the Regional Administrator.

Establishing serious physical harm for some recommended exposures may be particularly difficult if the resulting illness would require a substantial period of time to occur. In some of these situations expert testimony may be crucial to establish that serious physical harm would occur with such illnesses. In general, the compliance officer must establish that the hazard causes or is likely to cause death or serious physical harm when such illness or death will occur only after a substantial period of time. In order to do so, the CSHO needs to substantiate the following:

1. Regular and continuing employee exposure at the workplace to the toxic substance at the measured levels reasonably could occur;
2. Illness reasonably could result from such regular and continuing employee exposure; and
3. If illness does occur, its likely result is death or serious physical harm.

**§1926.55**

**Gases, vapors, fumes, dusts, and mists**

- (a) Exposure of employees to inhalation, ingestion, skin absorption, or contact with any material or substance at a concentration above those specified in the "Threshold Limit Values of Airborne Contaminants for 1970" of the American Conference of Governmental Industrial Hygienists, shall be avoided. See Appendix A to this section. [§1926.55(a)]
- (b) To achieve compliance with paragraph (a) of this section, administrative or engineering controls must first be implemented whenever feasible. When such controls are not feasible to achieve full compliance, protective equipment or other protective measures shall be used to keep the exposure of employees to air contaminants within the limits prescribed in this section. Any equipment and technical measures used for this purpose must first be approved for each particular use by a competent industrial hygienist or other technically qualified person. Whenever respirators are used, their use shall comply with §1926.103. [§1926.55(b)]
- (c) Paragraphs (a) and (b) of this section do not apply to the exposure of employees to airborne asbestos, tremolite, anthophyllite, or actinolite dust. Whenever any employee is exposed to airborne asbestos, tremolite, anthophyllite, or actinolite dust, the requirements of §1910.1101 or §1926.58 of this title shall apply. [§1926.55(c)]
- (d) Paragraphs (a) and (b) of this section do not apply to the exposure of employees to formaldehyde. Whenever any employee is exposed to formaldehyde, the requirements of §1910.1048 of this title shall apply. [§1926.55(d)]

**§1926.55 Appendix A**

**1970 American Conference of Governmental Industrial Hygienists' Threshold Limit Values of Airborne Contaminants**

Threshold Limit Values of Airborne Contaminants for Construction

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Abate; see Temephos				
Acetaldehyde	75-07-0	200	360	
Acetic acid	64-19-7	10	25	
Acetic anhydride	108-24-7	5	20	
Acetone	67-64-1	1000	2400	
Acetonitrile	75-05-8	40	70	
2-Acetylaminofluorene; see §1926.1114	53-96-3			
Acetylene	74-86-2	E		
Acetylene dichloride; see 1,2-Dichloroethylene				
Acetylene tetrabromide	79-27-6	1	14	
Acrolein	107-02-8	0.1	0.25	
Acrylamide	79-06-1		0.3	X
Acrylonitrile; see §1926.1145	107-13-1			
Aldrin	309-00-2		0.25	X
Allyl alcohol	107-18-6	2	5	X
Allyl chloride	107-05-1	1	3	
Allyl glycidyl ether (AGE)	106-92-3	(C)10	(C)45	
Allyl propyl disulfide	2179-59-1	2	12	
alpha-Alumina Total dust Respirable fraction	1344-28-1			
Alundum; see alpha-Alumina				
4-Aminodiphenyl; see §1926.1111	92-67-1			
2-Aminoethanol; see Ethanolamine				
2-Aminopyridine	504-29-0	0.5	2	

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Ammonia	7664-41-7	50	35	
Ammonium sulfamate Total dust Respirable fraction	7773-06-0		15 5	
n-Amyl acetate	628-63-7	100	525	
sec-Amyl acetate	626-38-0	125	650	
Aniline and homologs	62-53-3	5	19	X
Anisidine (o-, p-isomers)	29191-52-4		0.5	X
Antimony and compounds (as Sb)	7440-36-0		0.5	
ANTU (alpha Naphthylthiourea)	86-88-4		0.3	
Argon	7440-37-1	E		
Arsenic, inorganic compounds (as As); see §1926.1118	7440-38-2			
Arsenic, organic compounds (as As)	7440-38-2		0.5	
Arsine	7784-42-1	0.05	0.2	
Asbestos; see §1926.58				
Azinphos-methyl	86-50-0		0.2	X
Barium, soluble compounds (as Ba)	7440-39-3		0.5	
Benzene <sup>g</sup> ; see §1926.1128	71-43-2			
Benzo(a)pyrene; see Coal tar pitch volatiles	92-87-5			
p-Benzoquinone; see Quinone				
Benzoyl peroxide	94-36-0		5	
Benzyl chloride	100-44-7	1	5	
Beryllium and beryllium compounds (as Be)	7440-41-7		0.002	
Biphenyl; see Diphenyl				
Bisphenol A; see Diglycidyl ether				
Boron oxide Total dust	1303-86-2		15	
Boron tribromide	10294-33-4	1	10	
Boron trifluoride	7637-07-2	(C)1	(C)3	
Bromine	7726-95-6	0.1	0.7	
Bromine pentafluoride	7789-30-2	0.1	0.7	
Bromoform	75-25-2	0.5	5	X
Butadiene (1,3-Butadiene); see 29 CFR 1910.1051; 29 CFR 1910.19(l)	106-99-0		1 ppm/ 5 ppm STEL	
Butanethiol; see Butyl mercaptan				
2-Butanone (Methyl ethyl ketone)	78-93-3	200	590	
2-Butoxyethanol	111-76-2	50	240	X
n-Butyl acetate	123-86-4	150	710	
sec-Butyl acetate	105-46-4	200	950	
tert-Butyl acetate	540-88-5	200	950	
n-Butyl alcohol	71-36-3	100	300	
sec-Butyl alcohol	78-92-2	150	450	
tert-Butyl alcohol	75-65-0	100	300	
Butylamine	109-73-9	(C)5	(C)15	X
tert-Butyl chromate (as CrO <sub>3</sub> ); see §1910.1026 <sup>n,t</sup>	1189-85-1			
n-Butyl glycidyl ether (BGE)	2426-08-6	50	270	
Butyl mercaptan	109-79-5	0.5	1.5	
p-tert-Butyltoluene	98-51-1	10	60	
Cadmium (as Cd); see §1926.1127	7440-43-9			
Calcium carbonate Total dust Respirable fraction	1317-65-3			
Calcium oxide	1305-78-8		5	
Calcium sulfate Total dust Respirable fraction	7778-18-9		15 5	
Camphor, synthetic	76-22-2		2	
Carbaryl (Sevin)	63-25-2		5	
Carbon black	1333-86-4		3.5	
Carbon dioxide	124-38-9	5000	9000	
Carbon disulfide	75-15-0	20	60	X
Carbon monoxide	630-08-0	50	55	
Carbon tetrachloride	56-23-5	10	65	X

§1926.55 Appendix A

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Cellulose Total dust Respirable fraction	9004-34-6			
Chlordane	57-74-9		0.5	X
Chlorinated camphene	8001-35-2		0.5	X
Chlorinated diphenyl oxide	55720-99-5		0.5	
Chlorine	7782-50-5	1	3	
Chlorine dioxide	10049-04-4	0.1	0.3	
Chlorine trifluoride	7790-91-2	(C)0.1	(C)0.4	
Chloroacetaldehyde	107-20-0	(C)1	(C)3	
a-Chloroacetophenone (Phenacyl chloride)	532-27-4	0.05	0.3	
Chlorobenzene	108-90-7	75	350	
o-Chlorobenzylidene malononitrile	2698-41-1	0.05	0.4	
Chlorobromomethane	74-97-5	200	1050	
2-Chloro-1,3-butadiene; see beta-Chloroprene				
Chlorodiphenyl (42% Chlorine)(PCB)	53469-21-9		1	X
Chlorodiphenyl (54% Chlorine)(PCB)	11097-69-1		0.5	X
1-Chloro-2,3-epoxypropane; see Epichlorohydrin				
2-Chloroethanol; see Ethylene chlorohydrin				
Chloroethylene; see Vinyl chloride				
Chloroform (Trichloromethane)	67-66-3	(C)50	(C)240	
bis(Chloromethyl) ether; see §1926.1108	542-88-1			
Chloromethyl methyl ether; see §1926.1106	107-30-2			
1-Chloro-1-nitropropane	600-25-9	20	100	
Chloropicrin	76-06-2	0.1	0.7	
beta-Chloroprene	126-99-8	25	90	X
Chromium (II) compounds (as Cr)	7440-47-3		0.5	
Chromium (III) compounds (as Cr)	7440-47-3		0.5	
Chromium (VI) compounds; see §1926.1126 <sup>o</sup>				
Chromium metal and insol. salts (as Cr)	7440-47-3		1	
Chrysene; see Coal tar pitch volatiles				
Coal tar pitch volatiles (benzene soluble fraction), anthracene, BaP, phenanthrene, acridine, chrysene, pyrene	65996-93-2		0.2	
Cobalt metal, dust, and fume (as Co)	7440-48-4		0.1	
Coke oven emissions; see §1926.1129				
Copper Fume (as Cu) Dusts and mists (as Cu)	7440-50-8		0.1 1	
Corundum; see Emery				
Cotton dust (raw)			1	
Crag herbicide (Sesone) Total dust Respirable fraction	136-78-7			
Cresol, all isomers	1319-77-3	5	22	X
Crotonaldehyde	123-73-9; 4170-30-3	2	6	
Cumene	98-82-8	50	245	X
Cyanides (as CN)	Varies with compound		5	X
Cyanogen	460-19-5	10		
Cyclohexane	110-82-7	300	1050	
Cyclohexanol	108-93-0	50	200	
Cyclohexanone	108-94-1	50	200	
Cyclohexene	110-83-8	300	1015	
Cyclonite	121-82-4		1.5	X
Cyclopentadiene	542-92-7	75	200	
DDT, see Dichlorodiphenyltrichloroethane				
DDVP, see Dichlorvos				
2,4-D (Dichlorophenoxyacetic acid)	94-75-7		10	
Decaborane	17702-41-9	0.05	0.3	X

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Demeton (Systox)	8065-48-3		0.1	X
Diacetone alcohol (4-Hydroxy-4-methyl-2-pentanone)	123-42-2	50	240	
1,2-Diaminoethane; see Ethylenediamine				
Diazomethane	334-88-3	0.2	0.4	
Diborane	19287-45-7	0.1	0.1	
1,2-Dibromo-3-chloropropane (DBCP); see §1926.1144	96-12-8			
1,2-Dibromoethane; see Ethylene dibromide				
Dibutyl phosphate	107-66-4	1	5	
Dibutyl phthalate	84-74-2		5	
Dichloroacetylene	7572-29-4	(C)0.1	(C)0.4	
o-Dichlorobenzene	95-50-1	(C)50	(C)300	
p-Dichlorobenzene	106-46-7	75	450	
3,3'-Dichlorobenzidine; see §1926.1107	91-94-1			
Dichlorodifluoromethane	75-71-8	1000	4950	
1,3-Dichloro-5,5-dimethyl hydantoin	118-52-5		0.2	
Dichlorodiphenyltrichloroethane (DDT)	50-29-3		1	X
1,1-Dichloroethane	75-34-3	100	400	
1,2-Dichloroethane; see Ethylene dichloride				
1,2-Dichloroethylene	540-59-0	200	790	
Dichloroethyl ether	111-44-4	(C)15	(C)90	X
Dichloromethane; see Methylene chloride				
Dichloromonofluoromethane	75-43-4	1000	4200	
1,1-Dichloro-1-nitroethane	594-72-9	(C)10	(C)60	
1,2-Dichloropropane; see Propylene dichloride				
Dichlorotetrafluoroethane	76-14-2	1000	7000	
Dichlorvos (DDVP)	62-73-7		1	X
Dieldrin	60-57-1		0.25	X
Diethylamine	109-89-7	25	75	
2-Diethylaminoethanol	100-37-8	10	50	X
Diethylene triamine	111-40-0	(C)10	(C)42	X
Diethyl ether; see Ethyl ether				
Difluorodibromomethane	75-61-6	100	860	
Diglycidyl ether (DGE)	2238-07-5	(C)0.5	(C)2.8	
Dihydroxybenzene; see Hydroquinone				
Diisobutyl ketone	108-83-8	50	290	
Diisopropylamine	108-18-9	5	20	X
4-Dimethylaminoazobenzene; see §1926.1115	60-11-7			
Dimethoxymethane; see Methylal				
Dimethyl acetamide	127-19-5	10	35	X
Dimethylamine	124-40-3	10	18	
Dimethylaminobenzene; see Xylidine				
Dimethylaniline (N,N-Dimethylaniline)	121-69-7	5	25	X
Dimethylbenzene; see Xylene				
Dimethyl-1,2-dibromo-2,2-dichloroethyl phosphate	300-76-5		3	
Dimethylformamide	68-12-2	10	30	X
2,6-Dimethyl-4-heptanone; see Diisobutyl ketone				
1,1-Dimethylhydrazine	57-14-7	0.5	1	X
Dimethylphthalate	131-11-3		5	
Dimethyl sulfate	77-78-3	1	5	X
Dinitrobenzene (all isomers) (ortho) (meta) (para)	528-29-0 99-65-0 100-25-4		1	X
Dinitro-o-cresol	534-52-1		0.2	X
Dinitrotoluene	25321-14-6		1.5	X
Dioxane (Diethylene dioxide)	123-91-1	100	360	X
Diphenyl (Biphenyl)	92-52-4	0.2	1	
Diphenylamine	122-39-4		10	

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Diphenylmethane diisocyanate; see Methylene bisphenyl isocyanate				
Dipropylene glycol methyl ether	34590-94-8	100	600	X
Di-sec octyl phthalate (Di-(2-ethylhexyl) phthalate)	117-81-7		5	
Emery Total dust Respirable fraction	12415-34-8			
Endosulfan	115-29-7		0.1	X
Endrin	72-20-8		0.1	X
Epichlorohydrin	106-89-8	5	19	X
EPN	2104-64-5		0.5	X
1,2-Epoxypropane; see Propylene oxide				
2,3-Epoxy-1-propanol; see Glycidol				
Ethane	74-84-0	E		
Ethanethiol; see Ethyl mercaptan				
Ethanolamine	141-43-5	3	6	
2-Ethoxyethanol (Cellosolve)	110-80-5	200	740	X
2-Ethoxyethyl acetate (Cellosolve acetate)	111-15-9	100	540	X
Ethyl acetate	141-78-6	400	1400	
Ethyl acrylate	140-88-5	25	100	X
Ethyl alcohol (Ethanol)	64-17-5	1000	1900	
Ethylamine	75-04-7	10	18	
Ethyl amyl ketone (5-Methyl-3-heptanone)	541-85-5	25	130	
Ethyl benzene	100-41-4	100	435	
Ethyl bromide	74-96-4	200	890	
Ethyl butyl ketone (3-Heptanone)	106-35-4	50	230	
Ethyl chloride	75-00-3	1000	2600	
Ethyl ether	60-29-7	400	1200	
Ethyl formate	109-94-4	100	300	
Ethyl mercaptan	75-08-1	0.5	1	
Ethyl silicate	78-10-4	100	850	
Ethylene	74-85-1	E		
Ethylene chlorohydrin	107-07-3	5	16	X
Ethylenediamine	107-15-3	10	25	
Ethylene dibromide	106-93-4	(C)25	(C)190	X
Ethylene dichloride (1,2-Dichloroethane)	107-06-2	50	200	
Ethylene glycol dinitrate	628-96-6	(C)0.2	(C)1	X
Ethylene glycol methyl acetate; see Methyl cellosolve acetate				
Ethyleneimine; see §1926.1112	151-56-4			
Ethylene oxide; see §1926.1147	75-21-8			
Ethylidene chloride; see 1,1-Dichloroethane				
N-Ethylmorpholine	100-74-3	20	94	X
Ferbam Total dust	14484-64-1		15	
Ferrovandium dust	12604-58-9		1	
Fibrous Glass Total dust Respirable fraction				
Fluorides (as F)	Varies with compound		2.5	
Fluorine	7782-41-4	0.1	0.2	
Fluorotrichloromethane (Trichlorofluoromethane)	75-69-4	1000	5600	
Formaldehyde; see §1926.1148	50-00-0			
Formic acid	64-18-6	5	9	
Furfural	98-01-1	5	20	X
Furfuryl alcohol	98-00-0	50	200	
Gasoline	8006-61-9		A <sup>3</sup>	
Glycerin (mist) Total dust Respirable fraction	56-81-5			
Glycidol	556-52-5	50	150	
Glycol monoethyl ether; see 2-Ethoxyethanol				

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Graphite, natural, respirable dust	7782-42-5	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Graphite, synthetic Total dust Respirable Fraction				
Guthion; see Azinphos methyl				
Gypsum Total dust Respirable fraction	13397-24-5			
Hafnium	7440-58-6		0.5	
Helium	7440-59-7	E		
Heptachlor	76-44-8		0.5	X
Heptane (n-Heptane)	142-82-5	500	2000	
Hexachloroethane	67-72-1	1	10	X
Hexachloronaphthalene	1335-87-1		0.2	X
n-Hexane	110-54-3	500	1800	
2-Hexanone (Methyl n-butyl ketone)	591-78-6	100	410	
Hexone (Methyl isobutyl ketone)	108-10-1	100	410	
sec-Hexyl acetate	108-84-9	50	300	
Hydrazine	302-01-2	1	1.3	X
Hydrogen	1333-74-0	E		
Hydrogen bromide	10035-10-6	3	10	
Hydrogen chloride	7647-01-0	(C)5	(C)7	
Hydrogen cyanide	74-90-8	10	11	X
Hydrogen fluoride (as F)	7664-39-3	3	2	
Hydrogen peroxide	7722-84-1	1	1.4	
Hydrogen selenide (as Se)	7783-07-5	0.05	0.2	
Hydrogen sulfide	7783-06-4	10	15	
Hydroquinone	123-31-9		2	
Indene	95-13-6	10	45	
Indium and compounds (as In)	7440-74-6		0.1	
Iodine	7553-56-2	(C)0.1	(C)1	
Iron oxide fume	1309-37-1		10	
Iron salts (soluble) (as Fe)	Varies with compound		1	
Isoamyl acetate	123-92-2	100	525	
Isoamyl alcohol (primary and secondary)	123-51-3	100	360	
Isobutyl acetate	110-19-0	150	700	
Isobutyl alcohol	78-83-1	100	300	
Isophorone	78-59-1	25	140	
Isopropyl acetate	108-21-4	250	950	
Isopropyl alcohol	67-63-0	400	980	
Isopropylamine	75-31-0	5	12	
Isopropyl ether	108-20-3	500	2100	
Isopropyl glycidyl ether (IGE)	4016-14-2	50	240	
Kaolin Total dust Respirable fraction	1332-58-7			
Ketene	463-51-4	0.5	0.9	
Lead, inorganic (as Pb); see §1926.62	7439-92-1			
Limestone Total dust Respirable fraction	1317-65-3			
Lindane	58-89-9		0.5	X
Lithium hydride	7580-67-8		0.025	
LPG (Liquified petroleum gas)	68476-85-7	1000	1800	
Magnesite Total dust Respirable fraction	546-93-0			
Magnesium oxide fume Total particulate	1309-48-4	15		
Malathion Total dust	121-75-5		15	X
Maleic anhydride	108-31-6	0.25		
Manganese compounds (as Mn)	7439-96-5		(C)5	
Manganese fume (as Mn)	7439-96-5		(C)5	
Marble Total dust Respirable fraction	1317-65-3			
Mercury (aryl and inorganic)(as Hg)	7439-97-6		0.1	X

# §1926.55 Appendix A

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Mercury (organo) alkyl compounds (as Hg)	7439-97-6		0.01	X
Mercury (vapor) (as Hg)	7439-97-6		0.1	X
Mesityl oxide	141-79-7	25	100	
Methane	74-82-8	E		
Methanethiol; see Methyl mercaptan				
Methoxychlor Total dust	72-43-5		15	
2-Methoxyethanol (Methyl cellosolve)	109-86-4	25	80	X
2-Methoxyethyl acetate (Methyl cellosolve acetate)	110-49-6	25	120	X
Methyl acetate	79-20-9	200	610	
Methyl acetylene (Propyne)	74-99-7	1000	1650	
Methyl acetylene propadiene mixture (MAPP)		1000	1800	
Methyl acrylate	96-33-3	10	35	X
Methylal (Dimethoxy-methane)	109-87-5	1000	3100	
Methyl alcohol	67-56-1	200	260	
Methylamine	74-89-5	10	12	
Methyl amyl alcohol; see Methyl isobutyl carbinol				
Methyl n-amyl ketone	110-43-0	100	465	
Methyl bromide	74-83-9	(C)20	(C)80	X
Methyl butyl ketone; see 2-Hexanone				
Methyl cellosolve; see 2-Methoxyethanol				
Methyl cellosolve acetate; see 2-Methoxyethyl acetate				
Methylene chloride; see §1910.1052				
Methyl chloroform (1,1,1-Trichloroethane)	71-55-6	350	1900	
Methylcyclohexane	108-87-2	500	2000	
Methylcyclohexanol	25639-42-3	100	470	
o-Methylcyclohexanone	563-60-8	100	460	X
Methylene chloride	75-09-02	500	1740	
Methylenedianiline (MDA)	101-77-9			
Methyl ethyl ketone (MEK); see 2-Butanone				
Methyl formate	107-31-3	100	250	
Methyl hydrazine (Monomethyl hydrazine)	60-34-4	(C)0.2	(C)0.35	X
Methyl iodide	74-88-4	5	28	X
Methyl isoamyl ketone	110-12-3	100	475	
Methyl isobutyl carbinol	108-11-2	25	100	X
Methyl isobutyl ketone; see Hexone				
Methyl isocyanate	624-83-9	0.02	0.05	X
Methyl mercaptan	74-93-1	0.5	1	
Methyl methacrylate	80-62-6	100	410	
Methyl propyl ketone; see 2-Pentanone				
Methyl silicate	681-84-5	(C)5	(C)30	
alpha-Methyl styrene	98-83-9	(C)100	(C)480	
Methylene bisphenyl isocyanate (MDI)	101-68-8	(C)0.02	(C)0.2	
Mica; see Silicates				
Molybdenum (as Mo) Soluble compounds Insoluble compounds Total dust	7439-98-7		5 15	
Monomethyl aniline	100-61-8	2	9	X
Monomethyl hydrazine; see Methyl hydrazine				
Morpholine	110-91-8	20	70	X
Naphtha (Coal tar)	8030-30-6	100	400	
Naphthalene	91-20-3	10	50	
alpha-Naphthylamine; see §1926.1104	134-32-7			
beta-Naphthylamine; see §1926.1109	91-59-8			
Neon	7440-01-9	E		
Nickel carbonyl (as Ni)	13463-39-3	0.001	0.007	
Nickel, metal and insoluble compounds (as Ni)	7440-02-0		1	

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Nickel, soluble compounds (as Ni)	7440-02-0		1	
Nicotine	54-11-5		0.5	X
Nitric acid	7697-37-2	2	5	
Nitric oxide	10102-43-9	25	30	
p-Nitroaniline	100-01-6	1	6	X
Nitrobenzene	98-95-3	1	5	X
p-Nitrochlorobenzene	100-00-5		1	X
4-Nitrodiphenyl; see §1926.1103	92-93-3			
Nitroethane	79-24-3	100	310	
Nitrogen	7727-37-9	E		
Nitrogen dioxide	10102-44-0	(C)5	(C)9	
Nitrogen trifluoride	7783-54-2	10	29	
Nitroglycerin	55-63-0	(C)0.2	(C)2	X
Nitromethane	75-52-5	100	250	
1-Nitropropane	108-03-2	25	90	
2-Nitropropane	79-46-9	25	90	
N-Nitrosodimethylamine; see §1926.1116	62-79-9			
Nitrotoluene (all isomers) o-isomer m-isomer p-isomer	88-72-2 99-08-1 99-99-0	5	30	X
Nitrotrichloromethane; see Chloropicrin				
Nitrous oxide	10024-97-2	E		
Octachloronaphthalene	2234-13-1		0.1	X
Octane	111-65-9	400	1900	
Oil mist, mineral	8012-95-1		5	
Osmium tetroxide (as Os)	20816-12-0		0.002	
Oxalic acid	144-62-7		1	
Oxygen difluoride	7783-41-7	0.05	0.1	
Ozone	10028-15-6	0.1	0.2	
Paraquat, respirable dust	4685-14-7; 1910-42-5; 2074-50-2		0.5	X
Parathion	56-38-2		0.1	X
Particulates not otherwise regulated				
Total dust organic and inorganic			15	
PCB; see Chlorodiphenyl (42% and 54% chlorine)				
Pentaborane	19624-22-7	0.005	0.01	
Pentachloronaphthalene	1321-64-8		0.5	X
Pentachlorophenol	87-86-5		0.5	X
Pentaerythritol Total dust Respirable fraction	115-77-5			
Pentane	109-66-0	500	1500	
2-Pentanone (Methyl propyl ketone)	107-87-9	200	700	
Perchloroethylene (Tetrachloroethylene)	127-18-4	100	670	
Perchloromethyl mercaptan	594-42-3	0.1	0.8	
Perchloryl fluoride	7616-94-6	3	13.5	
Petroleum distillates (Naphtha)(Rubber Solvent)			A <sup>3</sup>	
Phenol	108-95-2	5	19	X
p-Phenylene diamine	106-50-3		0.1	X
Phenyl ether, vapor	101-84-8	1	7	
Phenyl ether-biphenyl mixture, vapor		1	7	
Phenylethylene; see Styrene				
Phenyl glycidyl ether (PGE)	122-60-1	10	60	
Phenylhydrazine	100-63-0	5	22	X
Phosdrin (Mevinphos)	7786-34-7		0.1	X
Phosgene (Carbonyl chloride)	75-44-5	0.1	0.4	
Phosphine	7803-51-2	0.3	0.4	
Phosphoric acid	7664-38-2		1	
Phosphorus (yellow)	7723-14-0		0.1	
Phosphorus pentachloride	10026-13-8		1	
Phosphorus pentasulfide	1314-80-3		1	
Phosphorus trichloride	7719-12-2	0.5	3	

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Phthalic anhydride	85-44-9	2	12	
Picric acid	88-89-1		0.1	X
Pindone (2-Pivalyl-1,3-indandione)	83-26-1		0.1	
Plaster of Paris Total dust Respirable fraction	26499-65-0			
Platinum (as Pt) Metal Soluble Salts	7440-06-4		0.002	
Polytetrafluoroethylene decomposition products			A <sup>2</sup>	
Portland cement Total dust Respirable fraction	65997-15-1	5	15	
Propane	74-98-6	E		
Propargyl alcohol	107-19-7	1		X
beta-Propiolactone; see §1926.1113	57-57-8			
n-Propyl acetate	109-60-4	200	840	
n-Propyl alcohol	71-23-8	200	500	
n-Propyl nitrate	627-13-4	25	110	
Propylene dichloride	78-87-5	75	350	
Propylene imine	75-55-8	2	5	X
Propylene oxide	75-56-9	100	240	
Propyne; see Methyl acetylene				
Pyrethrum	8003-34-7		5	
Pyridine	110-86-1	5	15	
Quinone	106-51-4	0.1	0.4	
RDX; see Cyclonite				
Rhodium (as Rh), metal fume and insoluble compounds	7440-16-6		0.1	
Rhodium (as Rh), soluble compounds	7440-16-6		0.001	
Ronnel	299-84-3		10	
Rotenone	83-79-4		5	
Rouge Total dust Respirable fraction				
Selenium compounds (as Se)	7782-49-2		0.2	
Selenium hexafluoride (as Se)	7783-79-1	0.05	0.4	
Silica, amorphous, precipitated and gel	112926-00-8	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790-53-2	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Silica, crystalline cristobalite, respirable dust	14464-46-1	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Silica, crystalline quartz, respirable dust	14808-60-7	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Silica, crystalline tripoli (as quartz), respirable dust	1317-95-9	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Silica, crystalline tridymite, respirable dust	15468-32-3	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Silica, fused, respirable dust	60676-86-0	( <sup>2</sup> )	( <sup>2</sup> )	( <sup>2</sup> )
Silicates (less than 1% crystalline silica) Mica (respirable dust) Soapstone, total dust Soapstone, respirable dust Talc (containing asbestos): use asbestos limit: see §1926.58 Talc (containing no asbestos), respirable dust Tremolite, asbestiform; see §1926.58	12001-26-2 14807-96-6	( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> )	( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> )	( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> ) ( <sup>2</sup> )
Silicon carbide Total dust Respirable fraction	409-21-2			
Silver, metal and soluble compounds (as Ag)	7440-22-4		0.01	
Soapstone; see Silicates				
Sodium fluoroacetate	62-74-8		0.05	X
Sodium hydroxide	1310-73-2		2	
Starch Total dust Respirable fraction	9005-25-8			
Stibine	7803-52-3	0.1	0.5	
Stoddard solvent	8052-41-3	200	1150	
Strychnine	57-24-9		0.15	

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
Styrene	100-42-5	(C)100	(C)420	
Sucrose Total dust Respirable fraction	57-50-1			
Sulfur dioxide	7446-09-5	5	13	
Sulfur hexafluoride	2551-62-4	1000	6000	
Sulfuric acid	7664-93-9		1	
Sulfur monochloride	10025-67-9	1	6	
Sulfur pentafluoride	5714-22-7	0.025	0.25	
Sulfuryl fluoride	2699-79-8	5	20	
Systox; see Demeton				
2,4,5-T (2,4,5-trichlorophenoxyacetic acid)	93-76-5		10	
Talc; see Silicates				
Tantalum, metal and oxide dust	7440-25-7		5	
TEDP (Sulfotep)	3689-24-5		0.2	X
Teflon decomposition products			A2	
Tellurium and compounds (as Te)	13494-80-9		0.1	
Tellurium hexafluoride (as Te)	7783-80-4	0.02	0.2	
Temphos Total dust Respirable fraction	3383-96-8			
TEPP (Tetraethyl pyrophosphate)	107-49-3		0.05	X
Terphenyls	26140-60-3	(C)1	(C)9	
1,1,1,2-Tetrachloro-2,2-difluoroethane	76-11-9	500	4170	
1,1,2,2-Tetrachloro-1,2-difluoroethane	76-12-0	500	4170	
1,1,2,2-Tetrachloroethane	79-34-5	5	35	X
Tetrachloroethylene; see Perchloroethylene				
Tetrachloromethane; see Carbon tetrachloride				
Tetrachloronaphthalene	1335-88-2		2	X
Tetraethyl lead (as Pb)	78-00-2		0.1	X
Tetrahydrofuran	109-99-9	200	590	
Tetramethyl lead, (as Pb)	75-74-1		0.15	X
Tetramethyl succinonitrile	3333-52-6	0.5	3	X
Tetranitromethane	509-14-8	1	8	
Tetryl (2,4,6-Trinitrophenylmethylnitramine)	479-45-8		1.5	X
Thallium, soluble compounds (as Tl)	7440-28-0		0.1	X
Thiram	137-26-8		5	
Tin, inorganic compounds (except oxides) (as Sn)	7440-31-5		2	
Tin, organic compounds (as Sn)	7440-31-5		0.1	
Tin oxide (as Sn) Total dust Respirable fraction	21651-19-4			
Titanium dioxide Total dust	13463-67-7			
Toluene	108-88-3	200	750	
Toluene-2,4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14	
o-Toluidine	95-53-4	5	22	X
Toxaphene; see Chlorinated camphene				
Tremolite; see Silicates				
Tributyl phosphate	126-73-8		5	
1,1,1-Trichloroethane; see Methyl chloroform				
1,1,2-Trichloroethane	79-00-5	10	45	X
Trichloroethylene	79-01-6	100	535	
Trichloromethane; see Chloroform				
Trichloronaphthalene	1321-65-9		5	X
1,2,3-Trichloropropane	96-18-4	50	300	
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1000	7600	
Triethylamine	121-44-8	25	100	
Trifluorobromomethane	75-63-8	1000	6100	
Trimethyl benzene	25551-13-7	25	120	
2,4,6-Trinitrophenol; see Picric acid				
2,4,6-Trinitrophenylmethylnitramine; see Tetryl				

# §1926.55 Appendix A

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. <sup>d</sup>	ppm <sup>a</sup>	mg/m <sup>3</sup> <sup>b</sup>	Skin Designation
2,4,6-Trinitrotoluene (TNT)	118-96-7		1.5	X
Triorthocresyl phosphate	78-30-8		0.1	
Triphenyl phosphate	115-86-6		3	
Tungsten (as W)	7440-33-7		5	
Insoluble compounds			1	
Soluble compounds				
Turpentine	8006-64-2	100	560	
Uranium (as U)	7440-61-1		0.2	
Soluble compounds			0.2	
Insoluble compounds				
Vanadium	1314-62-1		(C)0.5	
Respirable dust (as V <sub>2</sub> O <sub>5</sub> )			(C)0.1	
Fume (as V <sub>2</sub> O <sub>5</sub> )				
Vegetable oil mist				
Total dust				
Respirable fraction				
Vinyl benzene; see Styrene				
Vinyl chloride; see §1926.1117	75-01-4			
Vinyl cyanide; see Acrylonitrile				
Vinyl toluene	25013-15-4	100	480	
Warfarin	81-81-2		0.1	
Xylenes (o-, m-, p-isomers)	1330-20-7	100	435	
Xylidine	1300-73-8	5	25	X
Yttrium	7440-65-5		1	
Zinc chloride fume	7646-85-7		1	
Zinc oxide fume	1314-13-2		5	
Zinc oxide	1314-13-2		15	
Total dust			5	
Respirable fraction				
Zirconium compounds (as Zr)	7440-67-7		5	

## Mineral Dusts

Substance	mppcf <sup>(i)</sup>
SILICA:	
Crystalline	
Quartz. Threshold limit calculated from the formula	250 <sup>(k)</sup> %SiO <sub>2</sub> +5
Cristobalite	
Amorphous, including natural diatomaceous earth	20
SILICATES (less than 1% crystalline silica)	
Mica	20
Portland Cement	50
Soapstone	20
Talc (non-asbestiform)	20
Talc (fibrous), use asbestos limit	--
Graphite (natural)	15
Inert or Nuisance Particulates: <sup>(m)</sup> (Inert or Nuisance Dusts includes all mineral, inorganic, and organic dusts as indicated by examples in TLV's Appendix D) Conversion factors mppcf X 35.3 = million particles per cubic meter = particles per c.c.	50 (or 15 mg/m <sup>3</sup> whichever is the smaller) of total dust <1% SiO <sub>2</sub>

Footnotes:

<sup>1</sup> [Reserved]

<sup>2</sup> See Mineral Dusts Table.

<sup>3</sup> Use Asbestos Limit § 1926.58.

<sup>4</sup> See §1926.58

<sup>a</sup> The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit.

<sup>\*\*</sup> As determined from breathing-zone air samples.

<sup>g</sup> Parts of vapor or gas per million parts of contaminated air by volume at 25 °C and 760 torr.

<sup>b</sup> Milligrams of substance per cubic meter of air. When entry is in this column only, the value is exact; when listed with a ppm entry, it is approximate.

<sup>c</sup> [Reserved]

<sup>d</sup> The CAS number is for information only. Enforcement is based on the substance name. For an entry covering more than one metal compound, measured as the metal, the CAS number for the metal is given—not CAS numbers for the individual compounds.

<sup>e</sup> [Reserved]

<sup>f</sup> [Reserved]

<sup>g</sup> For sectors excluded from §1926.1128 the limit is 10 ppm TWA.

<sup>h</sup> [Reserved]

<sup>i</sup> [Reserved]

<sup>j</sup> Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

<sup>k</sup> The percentage of crystalline silica in the formula is the amount determined from airborne samples, except in those instances in which other methods have been shown to be applicable.

<sup>l</sup> [Reserved]

<sup>m</sup> Covers all organic and inorganic particulates not otherwise regulated. Same as Particulates Not Otherwise Regulated.

<sup>n</sup> If the exposure limit in 1926.1026<sup>†</sup> is stayed or is not otherwise in effect, the exposure limit is a ceiling of 0.1 mg/m<sup>3</sup>.

<sup>o</sup> If the exposure limit in §1926.1026<sup>†</sup> is stayed or is not otherwise in effect, the exposure limit is 0.1 mg/m<sup>3</sup> (as CrO<sub>3</sub>) as an 8-hour TWA.

The 1970 TLV uses letter designations instead of a numerical value as follows:

A<sup>1</sup> [Reserved]

A<sup>2</sup> Polytetrafluoroethylene decomposition products. Because these products decompose in part by hydrolysis in alkaline solution, they can be quantitatively determined in air as fluoride to provide an index of exposure. No TLV is recommended pending determination of the toxicity of the products, but air concentrations should be minimal.

A<sup>3</sup> Gasoline and/or Petroleum Distillates. The composition of these materials varies greatly and thus a single TLV for all types of these materials is no longer applicable. The content of benzene, other aromatics and additives should be determined to arrive at the appropriate TLV.

E Single asphyxiants. The limiting factor is the available oxygen which shall be at least 19.5% and be within the requirements addressing explosion in Part 1926.

<sup>†</sup> Editor's Note: The CFR incorrectly references §1926.1126. The entry has been corrected to reflect the Federal Register changes dated June 23, 2006.

[39 FR 22801, June 24, 1974, as amended at 51 FR 37007, Oct. 17, 1986; 52 FR 46312, Dec. 4, 1987; 58 FR 35089, June 30, 1993; 61 FR 9249, 9250, Mar. 7, 1996; 61 FR 56856, Nov. 4, 1996; 62 FR 1619, Jan. 10, 1997; 71 FR 10381, Feb. 28, 2006; 71 FR 36009, June 23, 2006]

# HEALTH HAZARDS RESOURCES

## ***Publications***

Bertinuson, J., & Weinstein, S. (1978). *Occupational Health Hazards of Construction – A manual for Building Trades Apprentices*. U.S. Labor Occupational Health Program.

Plog, B. A., Niland, J., & Quinlan, P. J. (1996). *Fundamentals of Industrial Hygiene* (Fourth Edition). National Safety Council. Chicago, IL.

U.S. Department of Labor – Occupational Safety & Health Administration (OSHA). *OSHA Publication 3143 – Informational Booklet on Industrial Hygiene*. [www.osha.gov](http://www.osha.gov)

U.S. Department of Labor – Occupational Safety & Health Administration (OSHA). *OSHA Publication 3352 – Assigned Protection Factors for the Revised Respiratory Protection Standard*. [www.osha.gov](http://www.osha.gov)

U.S. Department of Labor – Occupational Safety & Health Administration (OSHA). *OSHA Publication 3074 – Hearing Conservation*. [www.osha.gov](http://www.osha.gov)

U.S. Department of Labor – Occupational Safety & Health Administration (OSHA). *OSHA Publication 3362 – Controlling Silica Exposures in Construction*. [www.osha.gov](http://www.osha.gov)

Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Rev. 4 (2011). Copyright © United Nations.

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## ***Phone Numbers***

Centers for Disease Control and Prevention Public Response Hotline (1-888-246-2675)

Agency for Toxic Substances and Disease Registry (1-888-422-8737)

Regional Poison Control Center (1-800-222-1222)

## A

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**Abrasive Blasting** - A process of cleaning surfaces by using material, such as sand, aluminum, or steel grit, in a stream of high pressure air.

**Action Level** - A term used by OSHA and NIOSH to express the level of toxicant that requires medical surveillance.

**Action Level (lead)** - Employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air (30 ug/m<sup>3</sup>) calculated as an 8-hour time-weighted average (TWA). If the action level is exceeded, certain OSHA regulations go into effect.

**ACGIH** - American Conference of Governmental Industrial Hygienists

**Acute Effect** - Having an immediate response due to a short period of exposure to a relatively high concentration.

**Acute Toxicity** - Refers to those adverse effects occurring following oral or dermal administration of a single dose of a substance, or multiple doses given within 24 hours, or an inhalation exposure of 4 hours.

**Administrative Control** - An exposure control measure that reduces exposure to an acceptable limit by removing the worker from exposure after a specific length of time (job rotation) or establishing work rules such as, wetting of dusts, no dry sweeping, no eating, no drinking, or no smoking, etc.

**Air-line Respirator** - A supplied air respirator where Grade "D" breathable air is delivered to the worker at the proper pressure through a flexible hose or trunk line.

**Air Monitoring** - The process of measuring the airborne concentrations of a specific chemical over a given time period.

**Air Purifying Respirator (APR)** - A respirator that removes limited concentrations of air contaminants from the breathing air. An APR does not add oxygen to the air and cannot be used in an oxygen-deficient atmosphere.

**Air Sample** - Sample of air taken for the purpose of determining an exposure based on an inhalation hazard (breathing) only.

**Allergen** - A substance that can cause an allergy. Many plant materials, and some industrial chemicals, are allergens.

**Alveoli** - Air sacs of the lungs at the end of the bronchioles where oxygen and carbon dioxide are exchanged.

**ANSI** - American National Standards Institute, a private organization that recommends safe work practices and engineering designs.

**APR** - Air Purifying Respirator

**Aquatic Toxicity** - The intrinsic property of a material to cause injury to an aquatic organism.

**Asphyxiant** - A vapor or gas that can cause loss of consciousness and death due to lack of oxygen, or a chemical that can interfere with the body's use or transport of oxygen.

**Aspiration Hazard** - Includes severe acute effects such as chemical pneumonia, varying degrees of pulmonary injury or death following aspiration. Aspiration is the entry of a liquid or solid directly through the oral or nasal cavity, or indirectly from vomiting, into the trachea and lower respiratory system. Substances and mixtures of this hazard class are assigned to one of two hazard categories this hazard class on the basis of viscosity.

**Autoignition Temperature** - The minimum temperature at which a substance ignites without application of a flame or spark. Do not heat materials to greater than 80% of this temperature.

## B

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**BEI** - Biological Exposure Index recommended by the *ACGIH* as the maximum recommended value of a substance in blood, urine, or exhaled air, at which most workers would not experience an adverse health effect.

**Biological Monitoring** - Biological monitoring consists of obtaining a sample of blood, urine, feces, hair, or expired air to determine the dose of a chemical to the body. For lead exposures, blood sampling and analysis for lead and zinc protoporphyrin levels (ZPP) is the most common form of biological monitoring. The monitoring must follow the schedule as stated in OSHA 29 CFR Part 1926.62.

**Boiling Point (BP)** - The temperature at which a liquid's vapor pressure equals the surrounding atmospheric pressure so that the liquid rapidly vaporizes. Flammable materials with low BPs generally present special fire hazards [e.g. butane, BP = -0.5°C (31°F); gasoline, BP = 38°C (100°F)]. For mixtures, a range of temperature is given.

**Breathing Zone Sample** - An air sample that is collected within the breathing zone of a person (i.e., within one foot of the nose and mouth) to determine an actual exposure level.

## C

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**C** - Ceiling Limit

**Carcinogen** - A chemical or physical agent capable of causing cancer. Such an agent is often described as carcinogenic. The ability to cause cancer is termed carcinogenicity.

**Caustic** - Something alkaline that strongly irritates, corrodes, or destroys living tissue.

**Ceiling limit (C)** - An exposure level for a chemical that should not be exceeded.

**Chelation** - A process of removing metal (i.e., lead) from the body using certain drugs. This process should only be used as a last resort in cases where body lead levels are very high.

**Chemical Pneumonitis** - Is inflammation of the lungs or breathing difficulty due to inhaling chemical fumes, or aspirating (breathing in and choking on) gastric acid from the stomach, mineral oil, gasoline, or other damaging chemicals.

**Chronic Effect** - The health effect exhibited by the body after long term exposure to relative low concentrations of a chemical.

**Classification** – (HCS) To identify the relevant data regarding the hazards of a chemical; review those data to ascertain the hazards associated with the chemical; and decide whether the chemical will be classified as hazardous according to the definition of hazardous chemical in this section. In addition, classification for health and physical hazards includes the determination of the degree of hazard, where appropriate, by comparing the data with the criteria for health and physical hazards.

**Competent Person (OSHA)** - A person designated by the employer who is capable of identifying existing and predictable health hazards in the surroundings or working conditions and who has authorization to take prompt corrective measures to correct them.

**Compliance Program** - Prior to commencement of the job, each employer shall establish and implement a written compliance program to ensure that workers are not exposed to lead above the exposure limits established by OSHA.

**Concentration** - The amount of a specific substance mixed into a given volume of air or liquid. For workplace exposures, concentration usually refers to the amount of a toxic substance mixed into air.

**Confined Space** - An area that has adequate size and shape to allow a person to enter, and has limited openings for workers to enter and exit, and is not designed for continuous human occupancy; its primary function is other than human occupancy.

**Consumer Product Safety Commission** - (CPSC) is charged with protecting the public from unreasonable risks of serious injury or death from consumer products. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard or can injure children.

**Corrosive** - A chemical that causes visible destruction or irreversible alterations in human skin tissue, or other material, at the place of contact.

**Cumulative Trauma Disorder** - A disorder caused by one or more of the following: repetitive excessive motion of a body part, excessive force, or awkward body posture.

## D

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**Demolition** - The wrecking or taking out of any load-supporting structural member and any related razing, removing, or stripping of lead containing products.

**Density** - The relative weight of a gas or vapor compared to air, which has an arbitrary value of one (1). If a density is less than one it will generally rise in air. If the density is greater than one it will generally sink in air.

**Disposal** - Hazardous particles (lead) and dust removed from the job site must be packaged, tested, and disposed of according to federal, state, or local waste regulations.

**DOL** - Department of Labor

**DOT** - Department of Transportation

## E

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**Elastomeric Facepiece** - A respirator made from a rubber type material in which it may be cleaned, disinfected and reused.

**ELSI** - End of Service Life Indicator

**Employee Exposure** - The exposure to chemical by the routes of inhalation, ingestion, or skin absorption, or through broken skin.

**Engineering Control** - A method of controlling exposures by a mechanical means, such as ventilation systems.

**Entry Supervisor** – Means the person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit required confined space, for authorizing entry and overseeing entry operations, and for terminating entry.

**EPA** - Environmental Protection Agency

**Epidemiology** - The scientific study of the pattern of disease in a population of people.

**End of Service Life Indicator (ESLI)** - A color changing indicator to identify when a respirator cartridge needs to be replaced.

**Exposure Assessment** - Each employer who has a workplace or operation covered by OSHA's Lead in Construction standard shall initially determine if any employee is exposed to lead at or above the action level based on air monitoring or objective historical data.

**Explosive** - A material that produces a sudden, almost instantaneous release of pressure, gas, and heat when subjected to abrupt shock, pressure, or high temperature.

**Explosive Limit** - The range of concentrations (% by volume in air) of a flammable gas or vapor that can result in an explosion from ignition. Usually given as Upper and Lower Explosive Limits (*UEL* and *LEL*).

**Exposure Limit** - The concentration of a contaminant to which it is believed that workers can be exposed with minimal adverse health effects.

## F

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**Feasible** - Capable of being done.

**FF** - Full-face Respirator

**Fiber** - Means a particulate form of asbestos, 5 micrometer or longer, with a length-to-diameter ratio of at least 3 to 1.

**Filters** - Used in respirator cartridges to remove dusts or particulates from the breathing air.

**Flammable** - Capable of being easily ignited, burning intensely, or having a rapid rate of flame spread.

**Flammable Liquid** - Is a liquid with a flash point of not more than 93 °C. Substances and mixtures of this hazard class are assigned to one of four hazard categories on the basis of the flash point and boiling point.

**Flammable Gas** - Is one that has a flammable range in air at 20 °C and a standard pressure of 101.3 kPa. Substances and mixtures of this hazard class are assigned to one of two hazard categories.

**Flashpoint** - The minimum temperature at which a liquid gives off a vapor in sufficient concentration to ignite.

**Full-face Respirator** - A respirator with a facepiece that covers from under the chin to the forehead. May be attached to an air purifying or air supplied respirator.

**Fume** - An airborne dispersion of minute solid particles arising from the heating of a solid (such as molten metal, welding).

## G

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**Gas** - A formless fluid that occupies the space of its enclosure. It can settle to the bottom or top of an enclosure when mixed with other materials. It can be changed to its liquid or solid state only by increased pressure and/or decreased temperature.

**Grade “D” Breathing Air** - The grade of air required by OSHA to be provided to supplied air respirators. It has requirements for the minimum percent of oxygen, maximum amount of contaminants, such as oil mists, or carbon monoxide, percentage of humidity and other purity requirements.

**General Ventilation** - A system consisting of natural or mechanically induced, uncontaminated or clean air movement to mix with and dilute contaminants in a work area.

**Germ Cell Mutagenicity** - An agent giving rise to an increased occurrence of mutations in populations of cells and/or organisms. Substances and mixtures in this hazard class are assigned to one of two hazard categories. Category 1 has two subcategories.

**Global Harmonization System** - A worldwide initiative to promote standard criteria for classifying chemicals according to their health, physical and environmental hazards.

## H

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**Half-face Respirator** - A respirator with a facepiece that covers from under the chin to the bridge of the nose.

**Hazard Category** - The division of criteria within each hazard class, e.g., oral acute toxicity and flammable liquids include four hazard categories. These categories compare hazard severity within a hazard class and should not be taken as a comparison of hazard categories more generally.

**Hazard Class** - The nature of the physical or health hazards, e.g., flammable solid, carcinogen, oral acute toxicity.

**Hazard not otherwise classified (HNOC)** - An adverse physical or health effect identified through evaluation of scientific evidence during the classification process that does not meet the specified criteria for the physical and health hazard classes addressed in this section. This does not extend coverage to adverse physical and health effects for which there is a hazard class addressed in this section, but the effect either falls below the cut-off value/concentration limit of the hazard class or is under a GHS hazard category that has not been adopted by OSHA (e.g., acute toxicity Category 5).

**Hazard Communication** - Requires chemical manufacturers and importers to assess the hazards associated with the materials in their workplace (29 CFR 1910.1200). Safety Data Sheets, labeling, and training are all results of this law.

**Hazardous Chemical, Material** - In a broad sense, any substance or mixture of substances having properties capable of producing adverse effects on the health or safety of a human. Included are substances that are carcinogens, toxic, irritants, corrosives, sensitizers, and agents that damage the lungs, skin, eyes, mucous membranes, etc.

**Hazardous Materials Identification System (HMIS)** - A type of labeling system used for identifying hazardous materials. The name of the material and related information about target organs and effects, health hazards, physical hazards, and route of entry is included.

**Hazardous Waste** - A substance that has been discarded or otherwise designated as a waste material that contains the potential to damage the health and well-being of people and the environment.

**HCS** - Hazard Communication Standard

**Heat Stress** - A physical disorder caused with excessive exposure to heat. There are four forms of heat stress: heat rash, heat cramps, heat exhaustion, and heat stroke (sunstroke).

**HEPA** - High Efficiency Particulate Air

**Hepatotoxins** - Chemicals which produce liver damage

**High-efficiency Particulate Air (HEPA) Filtration** - High-efficiency particulate air filtration found in respirators, air cleaners and vacuum systems capable of filtering 0.3 micrometer particles with 99.97% efficiency, for use in contaminated environments.

**Histoplasmosis** - Infection due to the *Histoplasma capsulatum* fungus; grows as a mold in the soil, and infection results from breathing in airborne particles. Soil contaminated with bird or bat droppings may have a higher concentration of histoplasma.

**Housekeeping** - All surfaces shall be maintained as free as practical of accumulations of lead. HEPA vacuuming or other methods should be used that minimize the likelihood of lead becoming airborne.

**HMIS** - Hazardous Materials Identification System

## I

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**IDLH** - Immediately Dangerous to Life or Health

**IH** - Industrial Hygienist

**Immediately Dangerous to Life or Health (IDLH)** - A situation where exposure to a hazardous atmosphere results in serious injury or death in a matter of minutes, or causes serious delayed effects.

**Imminent Danger** - A workplace hazard that puts you at immediate serious risk of death or serious physical harm. It may be a safety hazard such as an unstable trench or exposed electrical wire that could cause a serious or fatal accident immediately under present conditions. It also may be a health hazard such as toxic substances or dangerous fumes, dusts, or gases that could cause death or irreversible physical harm, shorten life, or reduce physical or mental performance.

**Incompatible** - Describes materials that could cause dangerous reactions and the release of energy from direct contact with one another.

**Industrial Hygienist (IH)** - A professional qualified by education, training, and experience to recognize, evaluate, and develop controls for occupational health hazards.

**Inerting** - Means the displacement of the atmosphere in a space by a noncombustible gas (such as nitrogen or carbon dioxide) to such an extent that the resulting atmosphere is noncombustible.

**Ingestion** - The route of exposure in which a toxic substance is eaten or swallowed thus introducing it to the digestive system.

**Inhalation** - A route of exposure in which a toxic substance is breathed thus introducing it to the respiratory system.

**Irritant** - A substance which can cause an inflammatory response or reaction of the eye, skin, or respiratory system.

## L

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**Latency Period** - Time that elapses between exposure and first manifestations of disease or illness. Latency periods can range from minutes to decades, depending on hazardous material and disease produced.

**Lead** - Lead means metallic lead, all inorganic lead compounds, and organic lead soaps. Excluded from this definition are all other organic lead compounds.

**Lead Poisoning** - When there are health effects attributed to excessive amounts of lead in the body.

**Lethal dose (LD)** - An indication of the lethality of a given substance.

**LD<sub>50</sub>** - 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 LD<sub>50</sub> is one way to measure the short-term poisoning potential (acute toxicity) of a material.

**LEL** - Lower Explosive Level

**LFL** - Lower Flammable Limit

**Local Exhaust Ventilation** - A ventilation system that captures and removes the contaminant at the point where it is produced before the contaminant can escape into the work area.

**Lower Flammable Limit, Lower Explosive Limit** - Refers to the lowest concentration of gas or vapor (% by volume in air) that burns or explodes if an ignition source is present at ambient temperatures.

## M

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**Metal Fume Fever** - A flu-like condition resulting from the inhalation of fumes of heated metals.

**Maximum Use Level (MUL)** - The level of a specific contaminant that, if exceeded, will cause a worker to be exposed above the PEL because of leakage in a respirator.

**Mesothelioma** – Cancer of the membranes that line the chest and abdomen.

**mg/m<sup>3</sup>** - Milligrams per Cubic Meter

**MSHA** - Mine Safety Health Administration

**MUL** - Maximum Use Level

**Mutagen** - A chemical or physical agent able to change or damage the genetic material in cells.

## N

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**NEA** - Negative exposure assessment

**Negative exposure assessment (NEA)** - A demonstration by the employer, that employee exposure during an operation is found to be consistently below the PEL.

**Neurotoxin** - A material that affects the nerve cells and may produce emotional or behavioral abnormalities.

**NFPA** - National Fire Protection Association

**NIOSH** - National Institute for Occupational Safety and Health

**Non-Flammable** - Incapable of easy ignition. Does not burn, or burns very slowly. Also, a DOT hazard class for any compressed gas other than a flammable one.

**Nuisance Particulates** - Dusts that do not produce significant organic disease or toxic effect from "reasonable" concentrations and exposures.

## O

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**Odor Threshold** - The lowest concentration of a substance in air that can be smelled. For a given chemical, different people usually have very different odor thresholds.

**Organic Chemicals** - A large, important class of chemical compounds. The molecules of organic compounds contain carbon atoms.

**OSHA** - Occupational Safety and Health Administration

**OSHA Act** - Occupational Safety and Health Act of 1970

**Oxidizer** - The DOT defines an oxidizer or oxidizing material as a substance that yields oxygen readily to stimulate the combustion (oxidation) of organic matter.

**Oxidizing Liquids** - Liquids that, while in it is not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the combustion of other material. Substances and mixtures of this hazard class are assigned to one of three hazard categories.

**Oxidizing Solids** - Solids that, while it is not necessarily combustible, may, generally by yielding oxygen, cause or contribute to the combustion of other material. Substances and mixtures of this hazard class are assigned to one of three hazard categories.

**Organic Peroxides** - Organic liquids or solids that contain the bivalent -O-O- structure and may be considered a derivative of hydrogen peroxide, where one or both of the hydrogen atoms have been replaced by organic radicals. The term also includes organic peroxide formulations (mixtures). Substances and mixtures of this hazard class are assigned to one of seven 'Types', A to G.

## P

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**PAPR** - Powered Air Purifying Respirator

**PEL** - Permissible Exposure Limit

**Permissible Exposure Limit (PEL)** - A legal standard set by OSHA for the maximum concentration of a chemical in the air. OSHA PELs are based on an 8-hour time weighted average (TWA) exposure.

**Personal Protective Equipment (PPE)** - Anything that is worn to reduce the level of exposure to a substance or reduce the chance of injury.

**Personal Sampling** - An air sample taken with a sampling pump directly attached to the worker, with the collection device placed in the worker's breathing zone.

**Pictogram** - A composition that may include a symbol plus other graphic elements, such as a border, background pattern, or color, that is intended to convey specific information about the hazards of a chemical. Eight pictograms are designated under this standard for application to a hazard category.

**PF** - Protection Factor

**PFT** - Pulmonary Function Test

**Physical Hazard** - <sup>1</sup>Hazards that induce a negative effect on the human body but also do not originate from a traumatic event such as a fall, electrocution or blunt force trauma. <sup>2</sup>Means a chemical for which there is scientifically valid evidence that it is a combustible liquid, a compressed gas, explosive, flammable, and organic peroxide, an oxidizer, pyrophoric, unstable (reactive) or water-reactive.

**Physician or Licensed Health Care Professional (PLHCP)** – An individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by 29 CFR 1910.134 (e).

**Powered Air Purifying Respirator** - A type of air purifying respirator that uses a battery-powered blower to force filtered air through a hose into the respirator facepiece. The PAPR typically has a full-face mask.

**PPE** - Personal Protective Equipment

**ppm** - A unit of concentration; parts of contaminant per million parts of air (volume per unit volume).

**Pressure Demand** - A type of supplied air respirator that delivers a specific pressure to the facepiece. Whenever a drop in pressure occurs within the face piece (i.e., when the wearer inhales), a valve opens allowing air to flow into the facepiece. The facepiece is always positive, so that if a leak occurred, air would flow out, contaminated air would not flow in.

**Protection Factor (PF)** - A mathematical way of measuring the effectiveness of a respirator. It is the ratio of the concentration of contamination outside the mask to the concentration of contamination inside the mask.

**Protective clothing** - Garments worn by workers to keep gross contamination off the body.

**psi** - Pounds per Inch

**Pulmonary Edema** - Filling of the lungs with fluid, which produces coughing and difficulty breathing.

**Pulmonary Function Test (PFT)** - A test, conducted with a spirometer, that determines if the lungs are expanding and contracting normally, and if there is enough air moving into and out of the lungs.

**Pyrophoric Gas** - A chemical in a gaseous state that will ignite spontaneously in air at a temperature of 130 degrees F (54.4 degrees C) or below.

**Pyrophoric Liquid** - Is a liquid that, even in small quantities, is liable to ignite within five minutes after coming into contact with air. Substances and mixtures of this hazard class are assigned to a single hazard category.

**Pyrophoric Solid** - Is a solid that, even in small quantities, is liable to ignite within five minutes after coming into contact with air. Substances and mixtures of this hazard class are assigned to a single hazard category.

## Q

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**QLFT** - Qualitative Fit Test

**QNFT** - Quantitative Fit Test

**Qualitative Fit Test (QLFT)** - A test that can be performed to test the fit of a respirator to the wearer. Irritant smoke, amyl acetate (banana oil), or saccharin spray are examples of test agents used for the qualitative fit test.

**Qualified Person** - One who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

**Quantitative Fit Test (QNFT)** - A test that gives an exact measure of fit of a particular respirator to a particular wearer. The concentration of a substance is measured outside and inside a respirator and a ratio is determined.

## R

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**Reactivity** - A substance's tendency to undergo chemical reaction either by itself or with other material with the release of energy. Undesirable effects such as pressure buildup, temperature increase, or formation of noxious, toxic, or corrosive by-products may occur because of the substance's reactivity to heating, burning, direct contact with other materials, or other conditions in use or in storage.

**Recommended Exposure Limit** - An occupational exposure limit that has been recommended by the United States National Institute for Occupational Safety and Health (NIOSH) to the Occupational Safety and Health Administration (OSHA).

**REM** - A measure of the dose of any ionizing radiation to body tissue in terms of its estimated biological effect relative to a dose of 1 roentgen (r) of X-rays (1 millirem (mrem) = 0.001 rem).

**Reproductive Health Hazard/Toxin** - includes adverse effects on sexual function and fertility in adult males and females, as well as developmental toxicity in offspring. Substances and mixtures with reproductive and/or developmental effects are assigned to one of two hazard categories, 'known or presumed' and 'suspected'. Category 1 has two subcategories for reproductive and developmental effects. Materials, which cause concern for the health of breastfed children, have a separate category, Effects on or Via Lactation.

**Respirable** - Any particle small enough to reach the lungs when inhaled, i.e., breathable.

**Respirator** - A facial mask with filter cartridges designed to prevent inhalation of lead dusts and fumes by workers. Respirators must meet the requirements of NIOSH. Selection of respirators depends upon the level of exposure to airborne lead.

**Respirator Program** - A written and implemented program, established by an employer, which provides for the safe use of respirators on their job sites.

**Respiratory Protection** - Required when engineering and administrative controls do not reduce worker exposures below the permissible exposure limit. Employers are required to supply respirators that meet the NIOSH requirements to all affected employees at no cost. Employers must also have a written respiratory protection program.

**Respiratory Sensitizer** - A substance that induces hypersensitivity of the airways following inhalation of the substance. Substances and mixtures in this hazard class are assigned to one hazard category.

**Routes of Entry** - Ways a substance may enter the body. The routes of entry are inhalation, ingestion, injection and absorption.

## S

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**Safety Data Sheet (SDS)** - OSHA has established guidelines for descriptive data that should be concisely provided on a data sheet to serve as the basis for written hazard communication programs. The thrust of the law is to have those who make, distribute, and use hazardous materials responsible for effective communication.

**SAR** - Supplied Air Respirator

**SCBA** - Self-contained Breathing Apparatus

**Self-contained Breathing Apparatus (SCBA)** - A type of supplied air respirator that provides the highest degree of protection. Tanks of compressed grade "D" breathing air are worn on the back and supply the respirator.

**Self-reactive Substances** - Thermally unstable liquids or solids liable to undergo a strongly exothermic thermal decomposition even without participation of oxygen (air). This definition excludes materials classified under the GHS as explosive, organic peroxides or as oxidizing.

**Self-heating Substances** - Solids or liquids, other than a pyrophoric substance, which, by reaction with air and without energy supply, is liable to self-heat. Substances and mixtures of this hazard class are assigned to one of two hazard categories.

**Shot Blasting** - Process of cleaning metal or other surfaces using small steel shot in a high pressure air stream.

**Simple Asphyxiant** - A substance or mixture that displaces oxygen in the ambient atmosphere, and can thus cause oxygen deprivation in those who are exposed, leading to unconsciousness and death.

**Single use Respirators** - Commonly known as "disposable dust masks." This type of respirator offers minimal protection and is not acceptable when working with asbestos; also often referred to as a N95 (a type of disposable filtering facepiece).

**Skin Corrosion** - means the production of irreversible damage to the skin following the application of a test substance for up to 4 hours. Substances and mixtures in this hazard class are assigned to a single harmonized corrosion category.

**Skin Sensitizer** means a substance that will induce an allergic response following skin contact. The definition for "skin sensitizer" is equivalent to "contact sensitizer". Substances and mixtures in this hazard class are assigned to one hazard category.

**Solvents** - A liquid, solid, or gas that dissolves another solid, liquid, or gaseous solute, resulting in a solution that is soluble in a certain volume of solvent at a specified temperature.

**Specific Target Organ Toxicity (STOT)** – A hazard category that describes any impaired function to a body organ.

**Substitution** - A control measure in which a non-hazardous or less hazardous chemical is substituted for a hazardous chemical.

**Supplied Air Respirator (SAR)** - A respirator that delivers breathing air from a compressor through a supply hose connected to the worker's face piece (half face or full face).

## T

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**Target Organ Effects** - Chemically-caused effects from exposure to a material on specific listed organs and systems such as liver, kidneys, nervous system, lungs, skin and eyes.

**TC** - Testified and Certified

**Teratogen** - Something that can increase the risk of birth defects in humans or animals. The ability to cause birth defects is called teratogenicity.

**Tested and Certified (TC)** - The approval of filter cartridges by NIOSH for a specific application.

**Threshold Limit Value (TLV®)** - Levels of contaminants established by the American Conference of Governmental Industrial Hygienists (ACGIH®) to which it is believed that workers can be exposed to with minimal adverse health effects.

**Time Weighted Average (TWA)** - The average concentration of a substance over an 8-hour work shift

**TLV** - Threshold Limit Value

**Toxic** - A substance that has an adverse effect on one's health.

**Toxicity Characteristic Leaching Procedure (TCLP)** - A laboratory method used to determine whether lead removal debris is considered a hazardous waste and therefore falls under the EPA hazardous waste regulations.

**Toxicology** - Toxicology is the science that studies the poisonous or toxic properties of a substance. The basic assumption of toxicology is that there is a relationship among the dose (amount), the concentration at the affected site, and the resulting effects.

**Toxic Substance** - Any chemical or material that: 1) has evidence of an acute or chronic health hazard and 2) is listed in the NIOSH *Registry of Toxic Effects of Chemical Substances* (RTECS), provided that the substance causes harm at any dose level; causes cancer or reproductive effects in animals at any dose level; has a median lethal dose (LD50) of less than 500 mg/kg of body weight when administered orally to rats; has a median LD50 of less than 1000 mg/kg of body weight when administered by continuous contact to the bare skin of albino rabbits; or has a median lethal concentration (LD50) in air of less than 2000 ppm by volume of gas vapor, or less than 20 mg/L of mist, fume, or dust when administered to albino rats.

**TWA** - Time Weighted Average

**Type C Supplied Air Respirator** - A respirator that supplies air to the wearer from an outside source, such as a compressor or compressed air tank.

**Tyvek®** - A durable paper-based material used in the manufacture of disposable protective clothing, such as the coveralls used in lead abatement.

## U

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**Upper Flammable Limit, Upper Explosive Limit** - The highest concentration of a material in air that produces an explosion or fire, or that ignites when it contacts an ignition source (high heat, electric arc, spark, or flame). Any concentration above the UFL in air is too rich to be ignited.

**USEPA** - United States Environmental Protection Agency

**µg** - Microgram; one millionth of a gram; 453 grams in a pound, 28,310,000 micrograms in one ounce.

## V

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**Vapor** - The gaseous state of a material normally encountered as liquid.

**Vapor Density** - The weight of a vapor or gas compared to the weight of an equal volume of air is an expression of the density of the vapor or gas.

**VOC** - Volatile organic compounds. Used in coatings and paint because they evaporate very rapidly.

## W

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**WBGT** - The Wet Bulb Globe Temperature (WBGT) is a composite temperature used to estimate the effect of temperature, humidity, and solar radiation on humans.

## X

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**X-ray Fluorescence (XRF) Analyzer** - A portable instrument that measures lead concentration on a surface, generally in milligrams per square centimeter (mg/cm<sup>2</sup>).

## Z

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**Zinc Protoporphyrin (ZPP) Test** - A biological test for lead exposure that measures the amount of zinc protoporphyrin in blood.