

Group Discussion – Gasoline

Physical Description: Clear liquid with a characteristic odor.

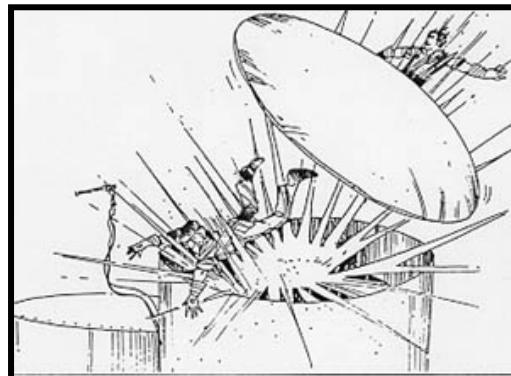
Gasoline – Physical Properties			
Vapor Density: 3 – 4 (air = 1)	LFL: 1.4%	NFPA Fire Rating: 3 NFPA Health Rating: 1 NFPA Reactivity Rating: 0 NFPA Special Instruction: N/A	
Flash Point: -45°F	UFL: 7.6%		
Globally Harmonized System Label:			

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



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



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 one 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)

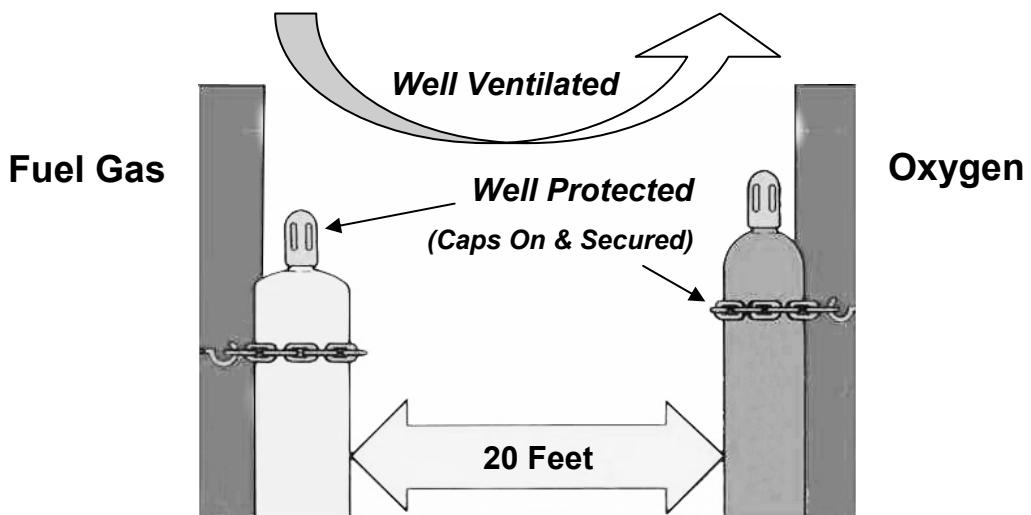


Picture of compressed gas cylinders in use; close proximity of a trench.

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.

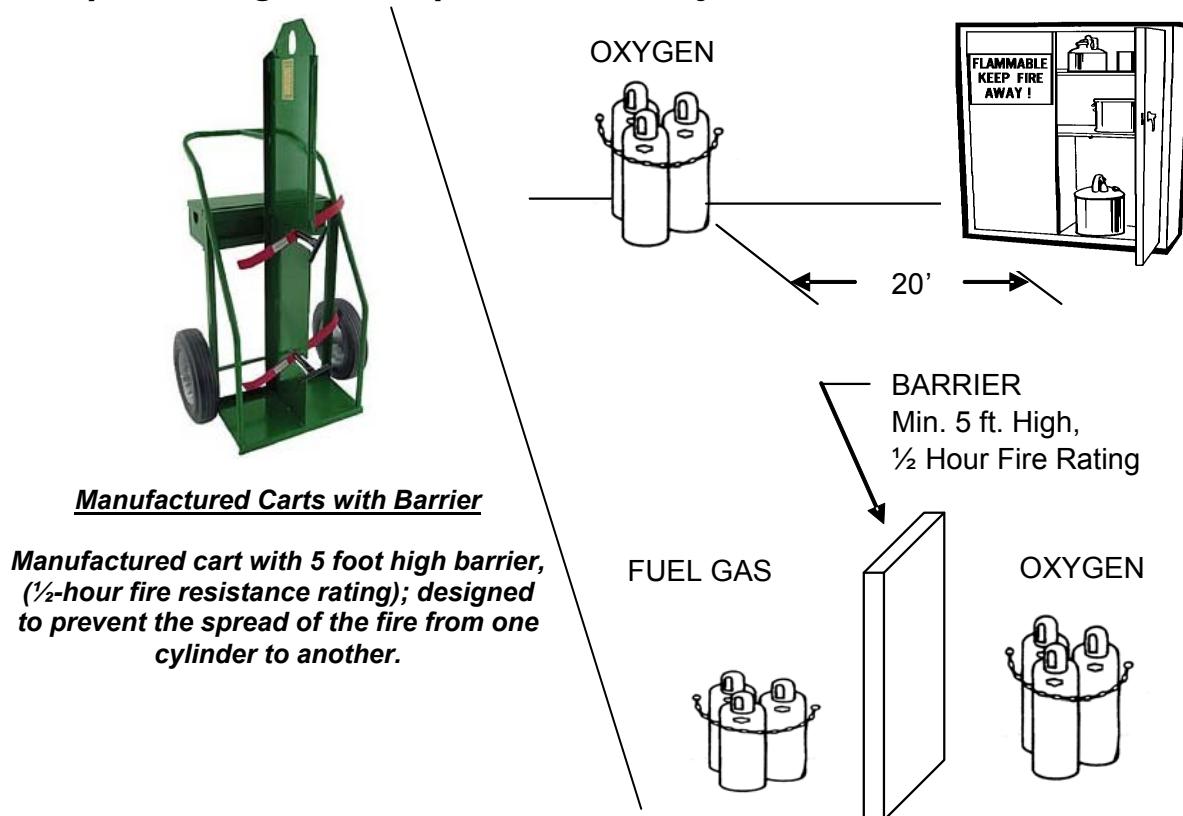
29 CFR 1926.350(a)(10)



Compressed Gas Cylinders – “In Storage”

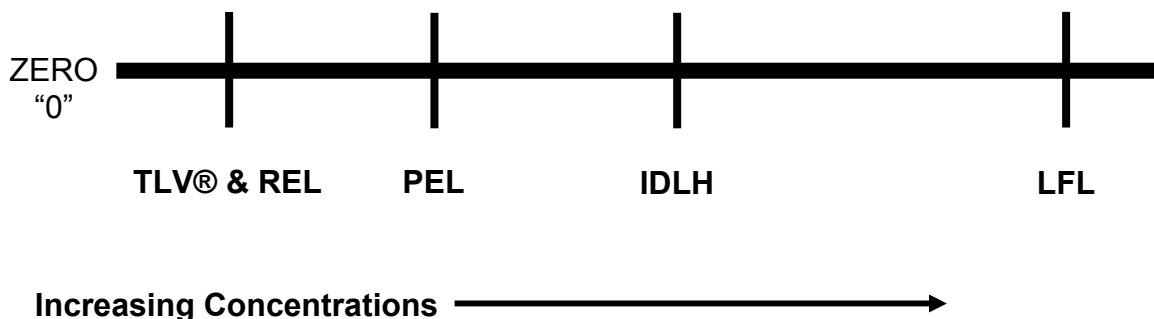
- Gas cylinders must be secured at all times to prevent tipping.
- Use appropriate material, such as chain, plastic coated wire cable, commercial straps, etc., to secure cylinders.
- Cylinders must be segregated in hazard classes while in storage. Oxidizers (oxygen) must be separated from flammable gases, 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



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.



Toxic Substance	TLV® & REL (ppm)	PEL (ppm)	IDLH (ppm)	LFL % (ppm)	NFPA 704M
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 ₂ 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_2) 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).

O_2 Content	Effects and Symptoms
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...

Health Hazard	a. Are quickly seen, usually after exposures to fairly high levels or concentrations of hazardous materials.
Acute Effects	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).
Chronic Effects	c. Lower Flammable Limit
Local Effects	d. Any condition or activity that threatens a person's well-being.
Systemic Effects	e. An adverse health effect that takes place at the point or area of contact.
IDLH (acronym)	f. Usually develops slowly, over a long period of time.
Hazardous Atmosphere	g. Immediately Dangerous to Life & Health
LFL (acronym)	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).

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!

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)**

Gases, Vapors, Fumes, Dust/Fibers & Mists

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

Form	Description	Examples
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).	<i>Welding gases (e.g., acetylene, nitrogen)</i>
		<i>Carbon Monoxide, CO</i>
		<i>Hydrogen Sulfide, H₂S</i>
		<i>Methane, CH₄</i>
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).	<i>Solvents (e.g., paint thinner, glue solvents, spot removers)</i>
		<i>Gasoline</i>
		<i>Paints & coatings</i>
Fumes	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 ³) or (µg/m ³).	<i>Lead (as a fume)</i>
		<i>Cadmium</i>
		<i>Hexavalent Chromium (CrVI) – Stainless steel</i>
		<i>Zinc (galvanized metals)</i>
Dusts - Fibers	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 ³) or (µg/m ³). Fibers (asbestos) are measured in fibers per cubic centimeter (f/cc).	<i>Asbestos</i>
		<i>Silica (concrete)</i>
		<i>Lead (as a dust)</i>
Mists	Tiny droplets of liquid suspended in the air. Mists are measured in milligrams or micrograms per cubic meter of air (mg/m ³) or (µg/m ³).	<i>Lubricants</i>
		<i>Paints & 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.

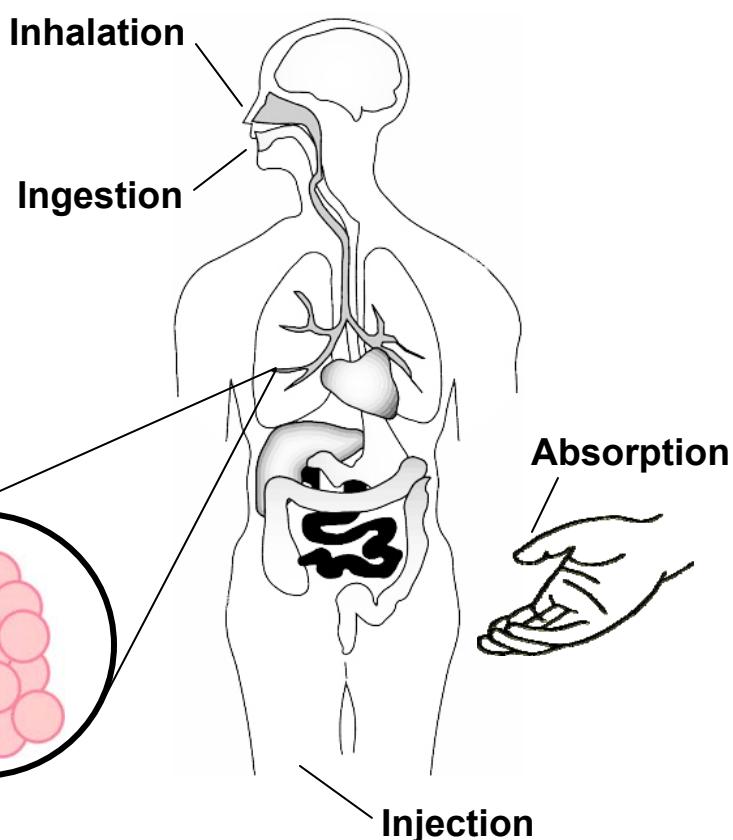
Injection occurs when a sharp object punctures the skin, allowing a chemical or infectious agent to enter your body. For example, injection can occur when a contaminated object such as a rusty nail punctures the skin.

Respiratory System (Inhalation)

The respiratory system is the major route of exposure for airborne chemicals. Once air contaminants are inhaled into your respiratory system, they may harm the tissues of the respiratory tract or lungs; cause serious scarring (local effect); and/or be dissolved in the blood and transported throughout the body (systemic effect).

The most serious damage is caused by contaminants that penetrate deep into the lower regions of the lung (alveoli).

Alveoli

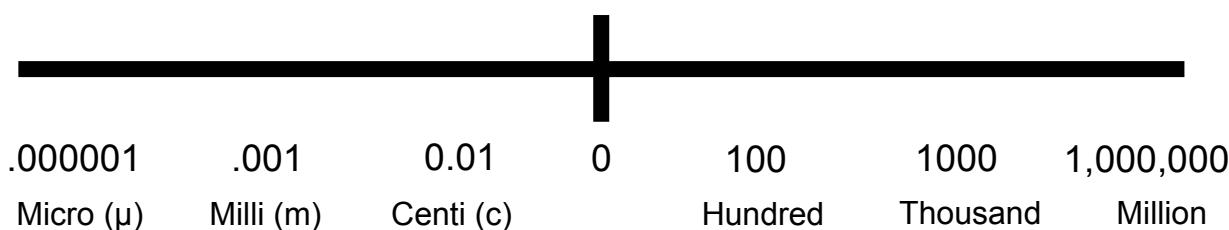


To describe the amount of a chemical, ***units of concentration*** such as parts per million (ppm), milligrams per cubic meter of air (mg/m³), micrograms per cubic meter of air (μg/m³) and fibers per cubic centimeter of air (f/cc) are most often used.

Units of Concentration

(ppm) Parts per Million	(mg/m ³) Milligrams per Cubic Meter of Air	(μg/m ³) Micrograms per Cubic Meter of Air	(f/cc) 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. 1×10^{-6} or .000001 10,000 ppm = 1% volume of air <i>Example (PEL)... Carbon Monoxide (CO) (50 ppm)</i>	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 ³). 1 milligram (mg) = 1/1,000 gram = (0.001 gram) One cubic meter (m ³) = 35.31 cubic feet (f ³) <i>Example (PEL)... Iron Oxide Fume (10 mg/m³)</i>	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 ³). 1 microgram (μg) = 1/1,000,000 gram = (0.000001 gram) One cubic meter (m ³) = 35.31 cubic feet (f ³) <i>Example (PEL)... Lead (50 μg/m³)</i>	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 1 micron (μm) = 1/1,000,000 meter One cubic centimeter (cc) = 0.061 cubic inches <i>Example (PEL)... Asbestos (0.1 f/cc)</i>

Scale of Numbers



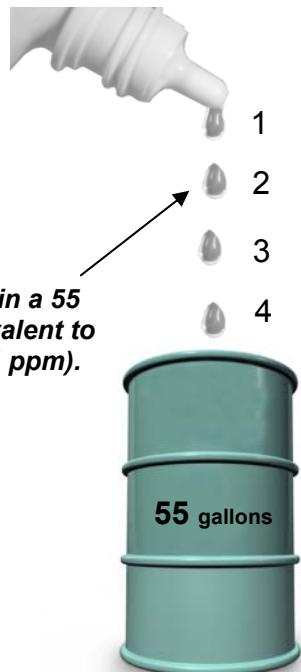
Parts per Million (ppm)

(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).



Milligrams per Cubic Meter of Air (mg/m³) & Micrograms per Cubic Meter of Air (µg/m³)

Weight / Volume

Example:

[One (1) packet of artificial sweeter is 1 gram]



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 mg/m³).

(µg/m³)

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 µg/m³).



50 artificial sweetener packets in the volume of the Empire State Building is equivalent to 50 µg/m³ (OSHA PEL for Lead).

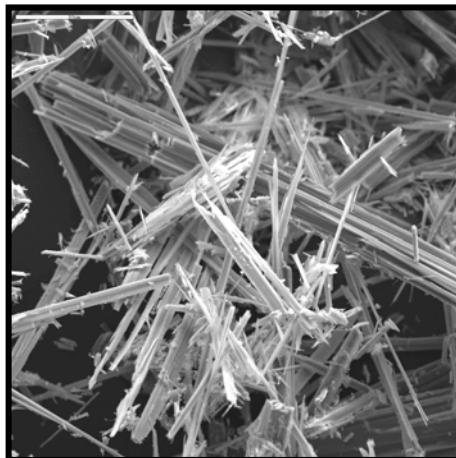
Fibers per Cubic Centimeter (f/cc)

[Amount (Number of Fibers) / Volume]

Fiber – Means a particulate form of asbestos, 5 micrometer (μm) 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 μm 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.

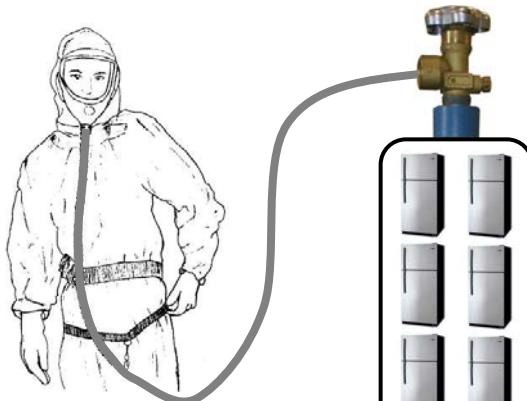


*Close-up photo of asbestos fiber;
notice razor sharp particles.*

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 (μm) in diameter.

Respirable dust is less than 10 microns (μm) in diameter!

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

Human hair is between 80 – 120 microns (μm) in diameter.

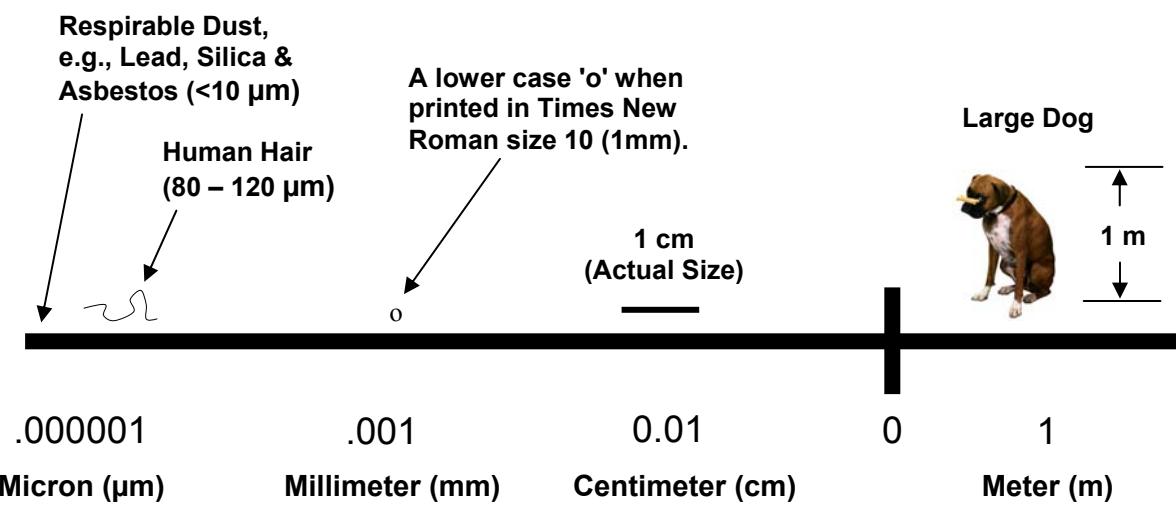
Some exposures in construction, such as toxic fumes, dusts and mists occur from particles that are less than 10 microns (μm) in diameter; these exposures are invisible.

Examples of respirable (invisible) fume or dust:

- Silica
- Lead
- Asbestos
- Hexavalent Chromium



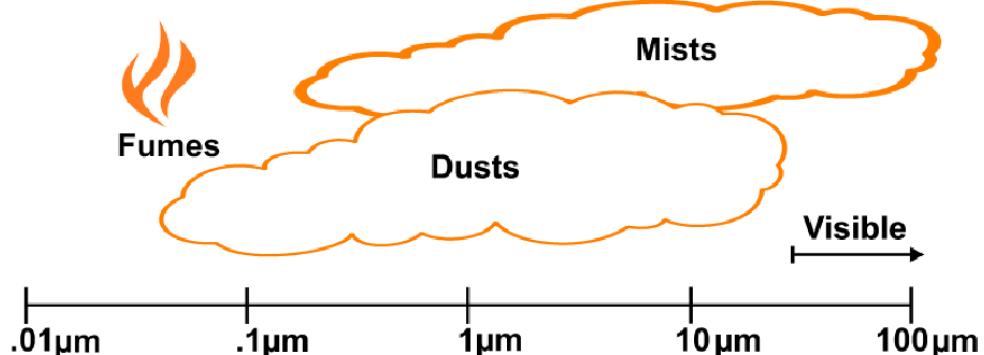
Human hair is between 80 – 120 microns (μm) in diameter.



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.

Particle Diameters



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

1 Red Blood Cell = 7μm

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**?

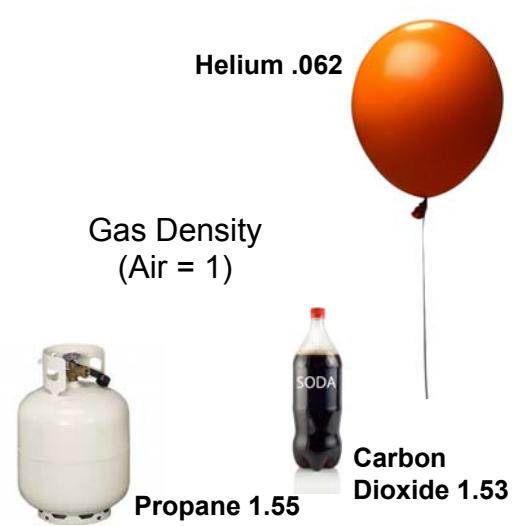


Compressed gas cylinders on cart (upright & secured)

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 raise 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.

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



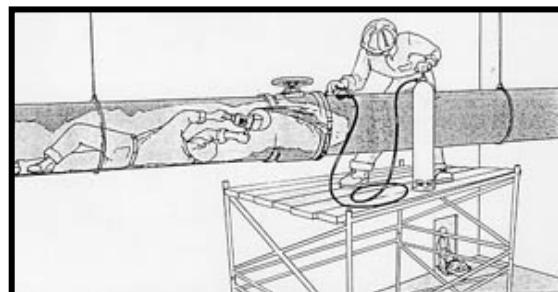
The air we breathe is mostly made up of:

Nitrogen, N₂ (78%)
Oxygen, O₂ (20.9%)

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



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

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

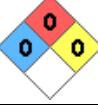
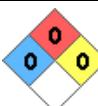
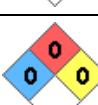
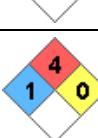
Simple Asphyxiants

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	PEL¹ (ppm)	IDLH² (ppm)	NFPA 704M	
Carbon Dioxide, CO ₂	1.53	NA	5000	40,000	Fire: 0 Health: 0 Reactivity: 0 Specific Hz: NA	
Nitrogen, N	.97	NA	E ³	NA	Fire: 0 Health: 0 Reactivity: 0 Specific Hz: NA	
Argon, Ar	1.38	NA	E ³	NA	Fire: 0 Health: 0 Reactivity: 0 Specific Hz: NA	
Methane*, CH ₄ 	.55	5.3%	E ³	5300*	Fire: 4 Health: 1 Reactivity: 0 Specific Hz: NA	

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

¹ Permissible Exposure Limit

² Immediate Dangerous to Life and Health

³ 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

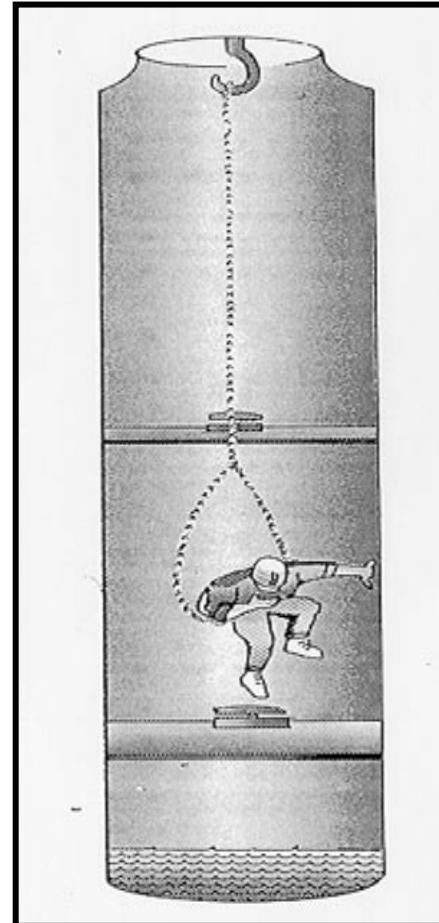
An employee sitting in a looped chain was lowered approximately 17 feet into a 21-foot deep manhole. Twenty seconds later he started gasping for air and fell from the chain seat face down into the accumulated water at the bottom of the manhole. An autopsy determined oxygen deficiency as the cause of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

*To see complete OSHA Fatal Fact #39, go to
www.osha.gov*

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.
- Instruction 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

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% O₂ by volume of air.

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



Temporary Heating Devices & Asphyxiation

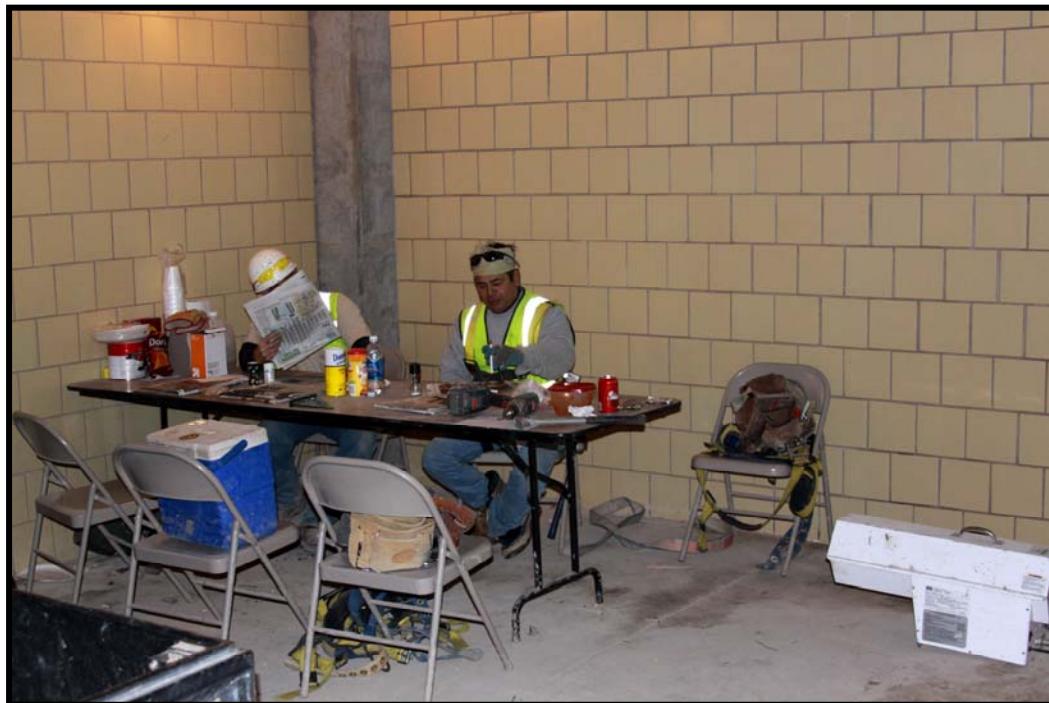
To avoid asphyxiation while using temporary heating devices, follow these OSHA rules:

- 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”



Carbon monoxide prevents oxygen transport by combining with hemoglobin.

Hydrogen Sulfide – Rotten Eggs



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

Chemical Asphyxiants						
Asphyxiant (Gas)	Gas Density	LFL	PEL¹ (ppm)	IDLH² (ppm)	NFPA 704M	
Carbon Monoxide, CO 	.97	12.5%	50	1,200	Fire: 4 Health: 3 Reactivity: 0 Specific Hz: NA	
Hydrogen Sulfide, H ₂ 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

¹ Permissible Exposure Limit

² 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!

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

% Volume of Air	ppm	Health Effects
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.12	1200	Headache, dizziness and nausea in 20 min.; collapse, unconsciousness, possibly death in 2 hr.



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.

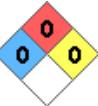
Nitrogen Dioxide – Corrosive and irritating to the eyes, skin, and mucous membranes. Inhalation may result in chemical pneumonitis and pulmonary edema.

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 ¹)	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

¹ 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.

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

NOTE: NIOSH regards whole diesel fuel 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

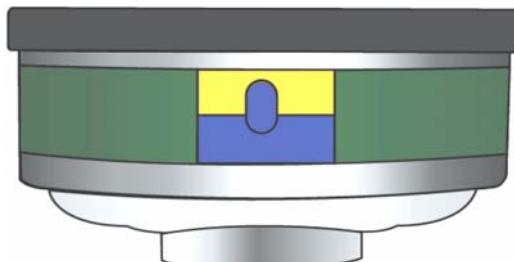
End of Service Life Indicator (ESLI)

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...

$$10,000 \text{ ppm} = 1\% \text{ volume of air}$$

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 liquids **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 raise 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.

Vapor Density
(Air = 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.

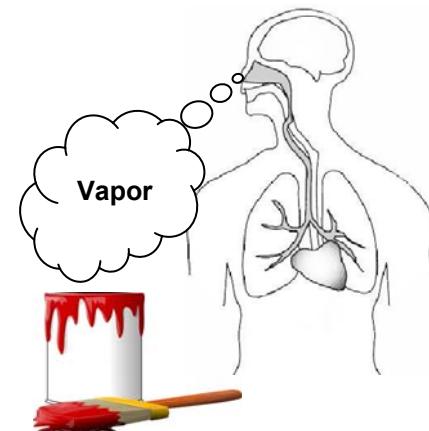
Flammable Liquids	
Category	Criteria
1	Flash point < 23°C (73°F) and initial boiling point ≤ 35°C (95°F)
2	Flash point < 23°C (73°F) and initial boiling point > 35°C (95°F)
3	Flash point ≥ 23°C (73°F) and ≤ 60°C (140°F)
4	Flash point ≥ 60°C (140°F) and ≤ 93°C (200° F)

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*).

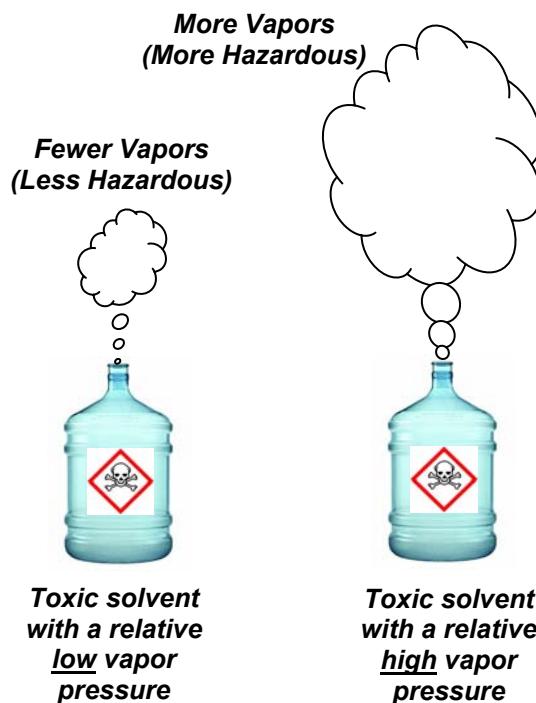


Solvents have relatively low flash points and some have high vapor pressure values.

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.

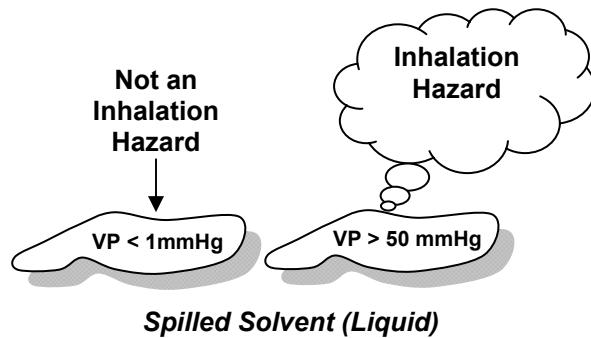
One unit of measurement to describe a substance's relative vapor pressure is “mmHg” (millimeter of mercury); the unit of pressure equal to the pressure exerted by liquid mercury one-millimeter-high column at a standard temperature.



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]



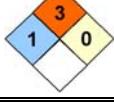
North 7700 Series Half-Face Respirator equipped with organic vapor acid gas cartridge (yellow)

Solvents Commonly Used in Construction

Alcohols	All alcohols are flammable. Alcohols affect the body by irritating the skin, eyes, nose and throat. Commonly found in paints and varnishes.	Amyl and isopropyl (rubbing) alcohol are irritating and can cause headache, nausea and drowsiness. High exposures to vapors in enclosed space can result in death.
Aromatic Hydrocarbons	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.	Benzene 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). Toluene 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. Xylene 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.
Aliphatic Hydrocarbons	Less harmful than the aromatic hydrocarbons. But they can still cause dermatitis and drowsiness.	Petroleum Naphtha , found in coal tar and paints, is a mixture of chemicals, including benzene. Also called petroleum distillates. Ethylene Dichloride is most commonly found in paint and varnish removers. Its vapors can irritate the eyes and throat, and cause nausea and vomiting.
Chlorinated Hydrocarbons	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.	Carbon Tetrachloride ; completely avoid! Even small concentrations of this material can damage the liver and kidneys. Methyl Chloroform (1,1,1-trichloroethane) is considered safer than other chlorinated solvents. It can still damage the liver, though less severely than carbon tetrachloride. Trichloroethylene 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. Methylene Chloride 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. Tetrachloroethane 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.

Solvents Commonly Used in Construction

Ketones	<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>Acetone 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>
Carbon Disulfide	<p>Carbon Disulfide 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>
Turpentine	<p>Turpentine 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>
Butadiene	<p>Butadiene 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>
Adhesives & Resins	<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>Epoxy Resins 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 can 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>Naphthalene 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>Polyurethanes 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>

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 produces 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 (mg/m^3) or ($\mu\text{g/m}^3$).

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?

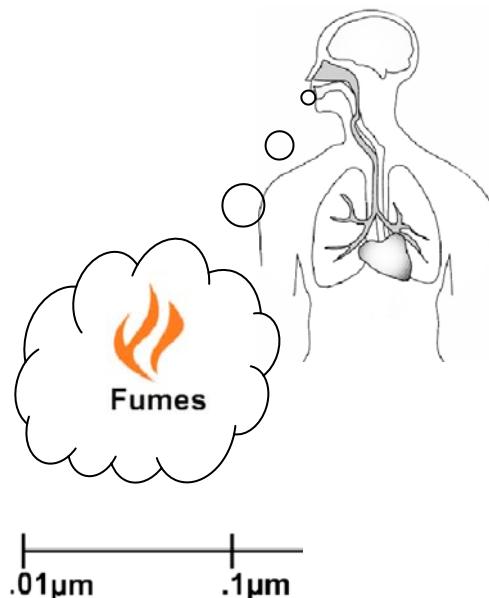
Fumes are generated by heat; either by burning, welding, cutting and heating. At a certain temperature, a solid is vaporized – then as it cools, it forms a small particle; these particles are respirable.

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 (μm)] 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*

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.

Asphalt Hazards

	Flammable	Some asphalt products are highly flammable.
	Irritant & Sensitizer	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.
	Toxic	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.
	Carcinogen	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.

Naphtha (Coal Tar) Hazards		
	Flammable	The National Fire Protection Association (NFPA) has determined coal tar naphtha to be a moderate fire hazard.
	Irritant & Sensitizer	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.
	Toxic	Exposures to high concentrations would result in central nervous system depression. <i>Naphtha</i> has a Permissible Exposure Limit (PEL) of 100 ppm and an IDLH of 1000 ppm.
	Carcinogen	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.

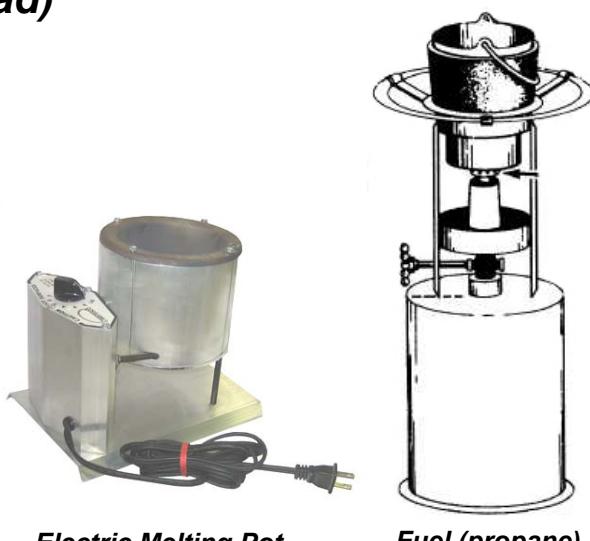
Major Elements of OSHA's Lead Standard (29 CFR 1926.62):

- Permissible exposure limit (PEL) = 50 µg/m³
- Action level (AL) = 30 µg/m³
- 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
(Wenesco'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 µg/m³
- Action level (AL) = 2.5 µg/m³
- 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 volatizes 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.

Particulate Air Filter Use Description			
Oil Designation Efficiency	P	R	N
95	Oil Proof Low Efficiency	Oil resistant Low Efficiency	Not Oil Proof Low Efficiency
99	Oil Proof Medium Efficiency	Oil resistant Medium Efficiency	Not Oil Proof Medium Efficiency
100	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 (mg/m^3) or ($\mu\text{g/m}^3$).

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:

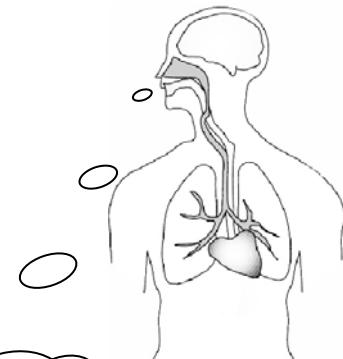
- What is the particle size of the dust and/or fiber?
- How toxic is the dust and/or fiber (PEL, TLV, REL & IDLH)?
- How does the dust or fiber affect the body?
- Is the dust or fiber regulated by OSHA?



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

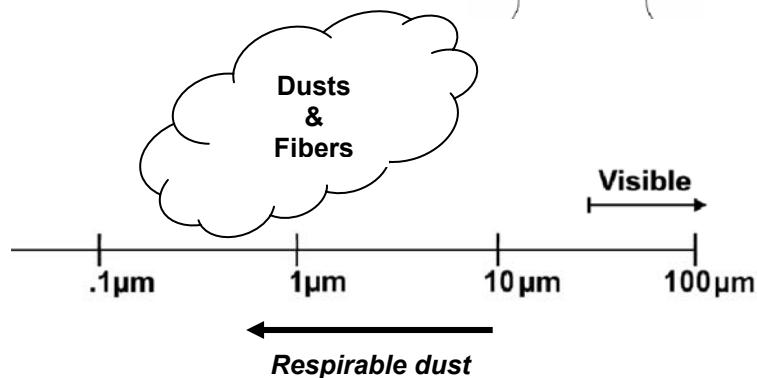
How do dust & fibers affect the body?

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.



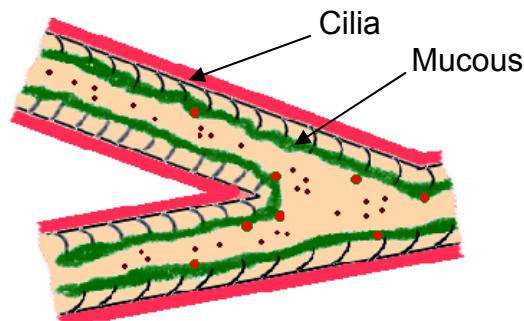
Remember...

Respirable dust, particles that are less than 10 microns (μm) 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.



Quartz is the second most abundant mineral in the Earth's crust. It's made up of silicone and oxygen (SiO_2).

Potential Hazards of Crystalline Silica

	Flammable; if dust concentrations obscure vision to 5 feet or less.
	Irritant; silica can irritate the eyes (may cause abrasion of the cornea).
	Toxic; Respirable crystalline silica (quartz) can cause silicosis, a fibrosis (scarring) of the lungs.
	Carcinogen; 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



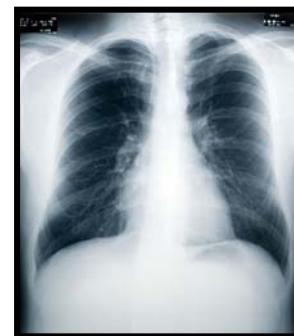
Concrete cutting with no engineering control or PPE!

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.

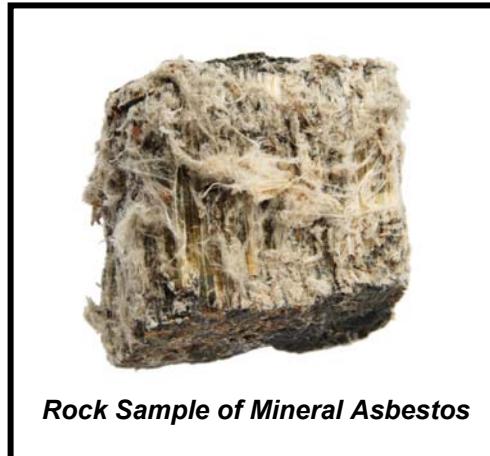
The National Institute of Occupational Safety and Health (NIOSH) defines a **Type CE respirator** as a Type C supplied-air respirator equipped with additional devices designed to protect the wearer's head and neck against impact and abrasion from rebounding abrasive material, and with shielding material 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.



Rock Sample of Mineral Asbestos

NOTE: Asbestos is measured by the number of fibers per volume of air; fibers per cubic centimeter (f/cc) see, page 90.

Potential Hazards of Asbestos	
	Flammable; if dust concentrations obscure vision to 5 feet or less.
	Irritant; Asbestos can irritate the eyes (may cause abrasion of the cornea).
	Toxic; 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.
	Carcinogen; 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.

<i>There is no cure for asbestosis; a doctor can only help you manage your symptoms.</i>

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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.

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/cm² or more of lead or 0.5 percent or more lead by weight."

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.

Fiberglass Insulation					
OSHA PEL (Nuisance Dust)	ACGIH TLV	NIOSH REL	NIOSH IDLH	NFPA 704M	
15 mg/m ³	10 mg/m ³	3 f/cc	N/A	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

Hazard	Efficiency	Comments
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 (mg/m^3) or ($\mu\text{g/m}^3$).

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.

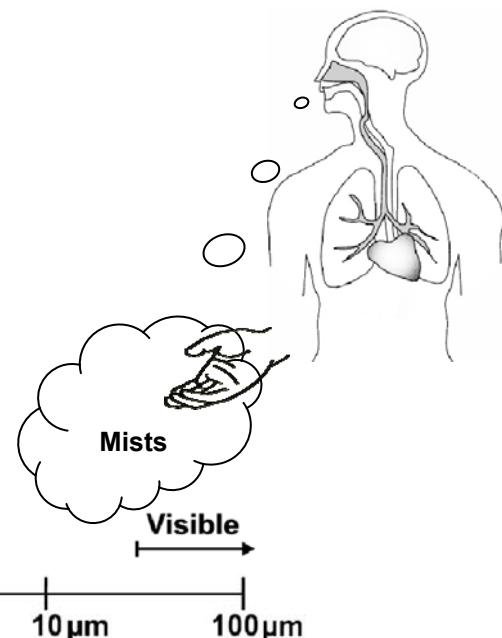


How do mists affect the body?

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).



AO Safety 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 <small>Globally Harmonized System</small>
Carcinogen	Chemical or physical agent capable of causing cancer.	<ul style="list-style-type: none"> Asbestos Silica Benzene 	
Corrosive	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"> Hydrochloric acid Sulfuric acid 	
Toxic & Highly Toxic	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"> Carbon Monoxide Hydrogen sulfide Phosgene 	
Irritant	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"> Ammonia Alkaline dusts and mists Ozone Concrete 	
Sensitizer	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"> Hexavalent Chromium Di-isocyanates Paints Saw dusts Certain woods 	
Affects a Target Organ ▪ Specific Target Organ Toxicity (STOT)	Liver, kidney, nervous system, blood, lung, reproductive organs, skin & eyes	<ul style="list-style-type: none"> Lead Cadmium Silica Asbestos 	

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.

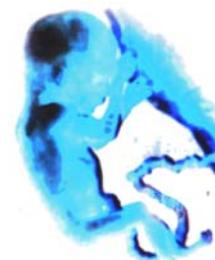
A **mutation** is defined as a permanent change in the amount or structure of the genetic material in a cell. The terms mutagenic or mutagen are used to refer to those chemicals that cause an increased occurrence of mutations in populations of cells and/or organisms.

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.

Target Organ	Signs & Symptoms	Chemicals (Examples)
Hepatotoxins: Chemicals which produce liver damage.	<ul style="list-style-type: none"> ▪ Jaundice ▪ Liver enlargement 	<ul style="list-style-type: none"> ▪ Carbon Tetrachloride ▪ Nitrosamines
Nephrotoxins: Chemicals which produce kidney damage.	<ul style="list-style-type: none"> ▪ Edema ▪ Proteinuria 	<ul style="list-style-type: none"> ▪ Halogenated Hydrocarbons ▪ Uranium
Neurotoxins: Chemicals which produce their primary toxic effects on the nervous system .	<ul style="list-style-type: none"> ▪ Narcosis ▪ Behavioral changes ▪ Decrease in motor functions 	<ul style="list-style-type: none"> ▪ Mercury ▪ Carbon Disulfide
Agents which act on the blood or hematopoietic system : Decrease hemoglobin function; deprive the body tissues of oxygen.	<ul style="list-style-type: none"> ▪ Cyanosis ▪ Loss of consciousness 	<ul style="list-style-type: none"> ▪ Carbon Monoxide ▪ Cyanides
Agents which damage the lung : Chemicals which irritate or damage pulmonary tissue.	<ul style="list-style-type: none"> ▪ Cough ▪ Tightness in chest ▪ Shortness of breath 	<ul style="list-style-type: none"> ▪ Silica ▪ Asbestos
Reproductive toxins: Chromosomal damage (mutations) Effects on fetuses (teratogenesis)	<ul style="list-style-type: none"> ▪ Birth defects ▪ Sterility 	<ul style="list-style-type: none"> ▪ Benzene ▪ Lead ▪ Mercury
Cutaneous hazards: Chemicals which affect the dermal layer of the body (skin).	<ul style="list-style-type: none"> ▪ Defatting of the skin ▪ Rashes ▪ Irritation 	<ul style="list-style-type: none"> ▪ Ketones ▪ Chlorinated Compounds
Eye hazards: Chemicals which affect the eye or visual capacity.	<ul style="list-style-type: none"> ▪ Conjunctivitis ▪ Corneal damage 	<ul style="list-style-type: none"> ▪ Organic solvents ▪ Acids

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.

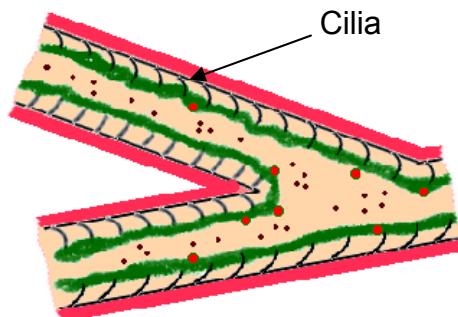
An example of synergism is the increased risk of developing lung cancer caused by exposures to both cigarette smoking and asbestos. By either smoking one pack of cigarettes per day or being heavily exposed to asbestos, you may increase your risk of lung cancer to five to ten times higher than someone 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 paralyses 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)).

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.

SDS Example – Group Discussion

(Review SDS Provided by Instructor)

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		
PRODUCT IDENTIFIER		
CODE _____	HAZARD PICTOGRAMS 	
Product Name _____		
SUPPLIER IDENTIFICATION		
Company Name _____	SIGNAL WORD Danger	
Street Address _____		
City _____		HAZARD STATEMENT
Postal Code _____		Highly flammable liquid and vapor. May cause liver and kidney damage.
Country _____		
Emergency Phone Number _____		
PRECAUTIONARY STATEMENTS		
Keep container tightly closed. Store in cool, well ventilated place that is locked.		
Keep away from heat/sparks/open flame. No smoking.		
Only use non-sparking tools.		
Use explosion-proof electrical equipment.		
Take precautionary measure against static discharge.		
Ground and bond container and receiving equipment.		
Do not breathe vapors.		
Wear Protective gloves.		
Do not eat, drink or smoke when using this product.		
Wash hands thoroughly after handling.		
Dispose of in accordance with local, regional, national, international regulations as specified.		
In Case of Fire: use dry chemical (BC) or Carbon dioxide (CO ₂) fire extinguisher to extinguish.		
First Aid		
If exposed call Poison Center.		
If on skin (on hair): Take off immediately any contaminated clothing. Rinse skin with water.		
SUPPLEMENTAL INFORMATION		
Directions for use _____ _____		
Fill weight: _____	Lot Number _____	
Gross weight: _____	Fill Date: _____	
Expiration Date: _____		

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:

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.

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^3), micrograms per cubic meter of air ($\mu\text{g}/\text{m}^3$) 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.

Notes

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

Heat Cramps	<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>
Heat Exhaustion	<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>
Heat Stroke	<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

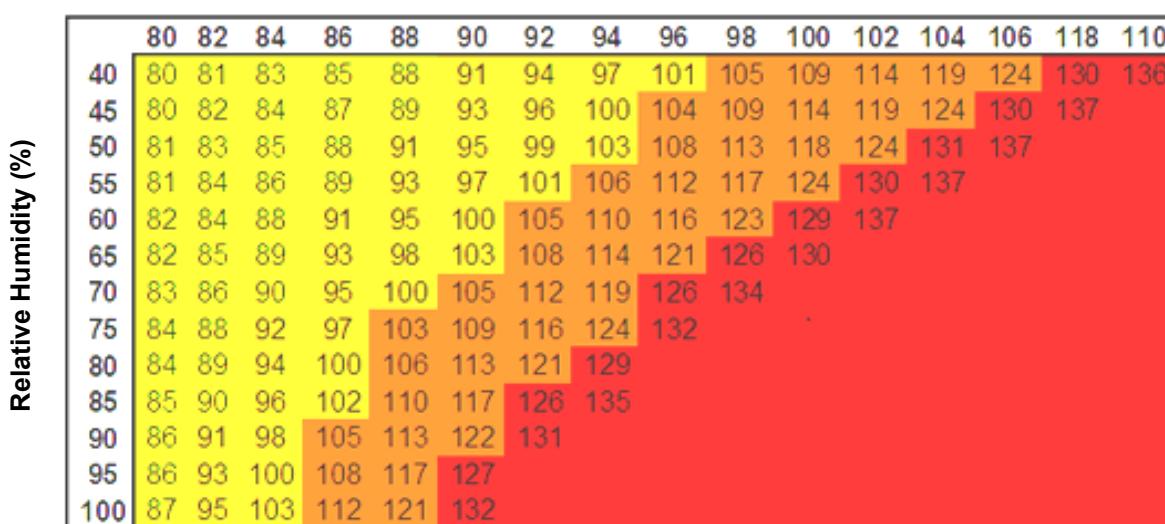


Temperature Hazard Example...
Enclosed spaces, such as attics, can
be a temperature extreme hazard
(hot).

NOAA's National Weather Service

(National Oceanic and Atmospheric Administration)

Heat Index Temperature (°F)

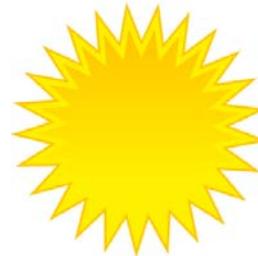


Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

 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.

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.

First Aid (Hypothermia)

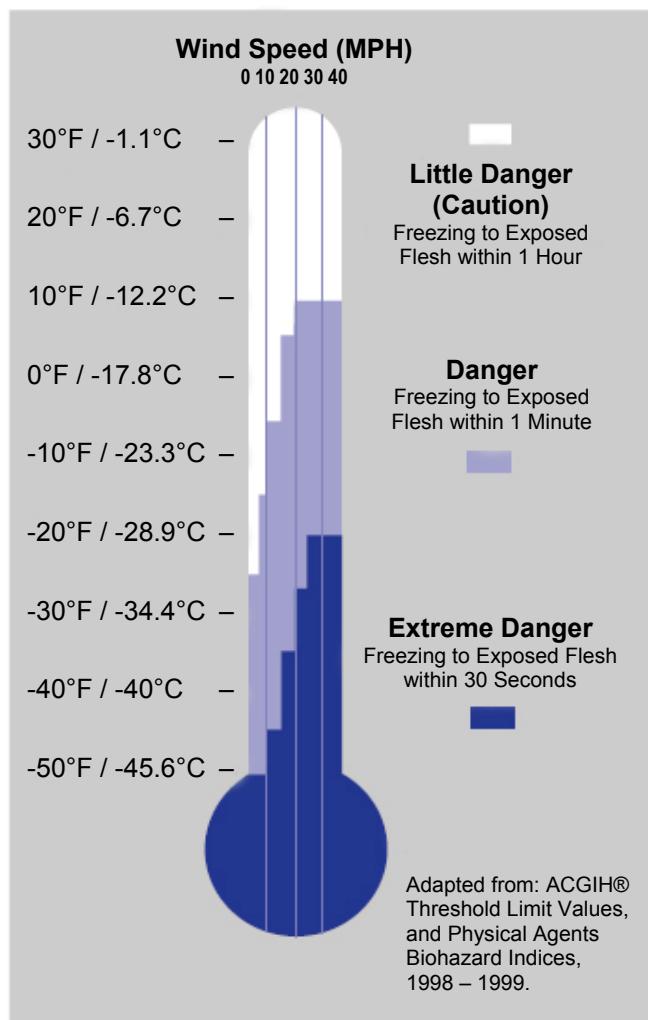
- If any of the symptoms of hypothermia are observed, the victim should immediately be taken to shelter (e.g., heated office, trailer, car or truck).
- Remove wet clothing and wrap victim in warm covers or provide him/her with warm dry clothing.
- Keep the victim awake if possible.
- Provide victim with 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.



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.

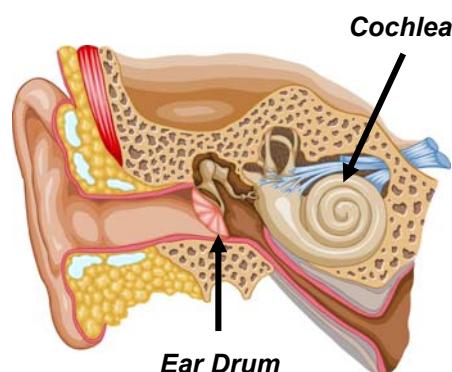
Anything you can do to limit your exposure to loud noise—by moving away from the sound or wearing earplugs or earmuffs—will help prevent tinnitus and/or hearing loss.



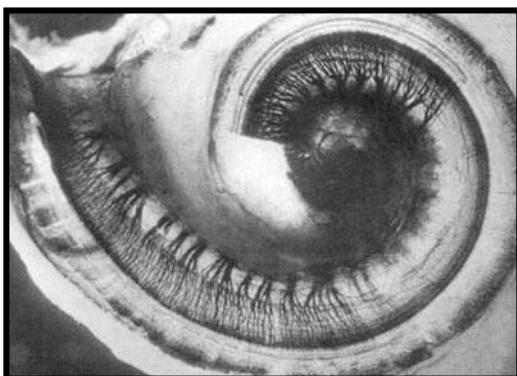
The Inner Ear

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.



NIOSH – REL for Noise...

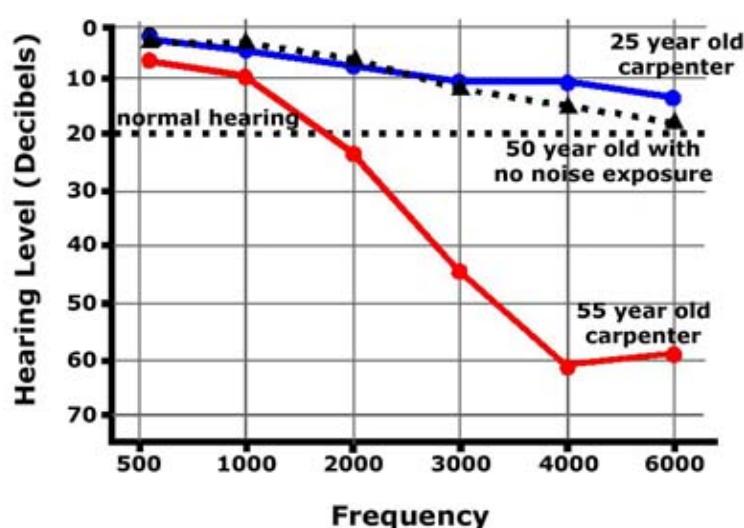
NIOSH has established a Recommended Exposure Limit (REL) for noise at 85 decibels, A-weighted, as an 8-hr Time-Weighted Average -TWA - (85 dBA as an 8-hr TWA).

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 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

The average 25-year old carpenter has the ears of a 50-year old person who has not been exposed to noise.



Source: eLCOSH

Average Sound Levels in Construction	
Tool	Sound Level dB(A)
Hammer Drill	114 112 109 108 107 106 100 96 86 85 – 90
Pile Driver	
Chain Saw	
Chop Saw	
Impact Wrench	
Powder Actuated Tool	
Circular Saw	
Jack Hammer	
Grinder	
Welding Machine	
Equipment Operator & Task	Sound Level dB(A)
Heavy-Duty Bulldozer	97 – 107 91 – 104 85 – 103 90 – 98 80 – 89 78 – 90 59 – 87
Vibrating Road Roller	
Asphalt Road Roller	
Crawler Crane > 35 ton (non-insulated cab)	
Crawler Crane > 35 ton (insulated cab)	
Rubber-Tired Crane > 35 ton (non-insulated cab)	
Rubber-Tired Crane > 35 ton (insulated cab)	
Average dB(A) for Some Construction Trades / Activities	
110	
105	
100	
95	
90	
85	
Carpenter	89
Masonry	91
Framer	93
Forming	94
Sheet Metal	96
Iron Worker	106
Boilermaker	108
Operator	91

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...

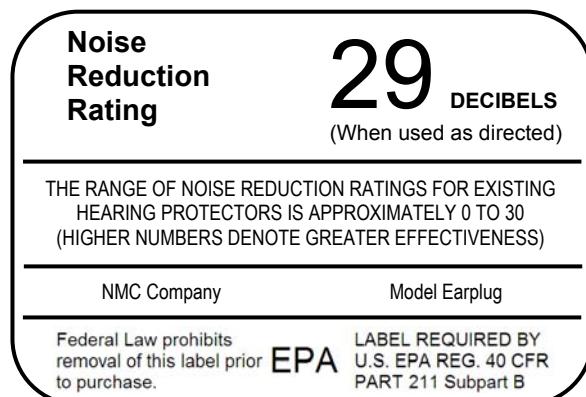
- Know your hazard. Whenever possible, measure the noise levels in your environment on a frequent basis to determine exactly what the hazards are. Determine, if any, off-the-job exposures to noise.
- Trust the annual audiogram. Rely on this information to gauge any hearing loss from year to year.
- Select 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*).

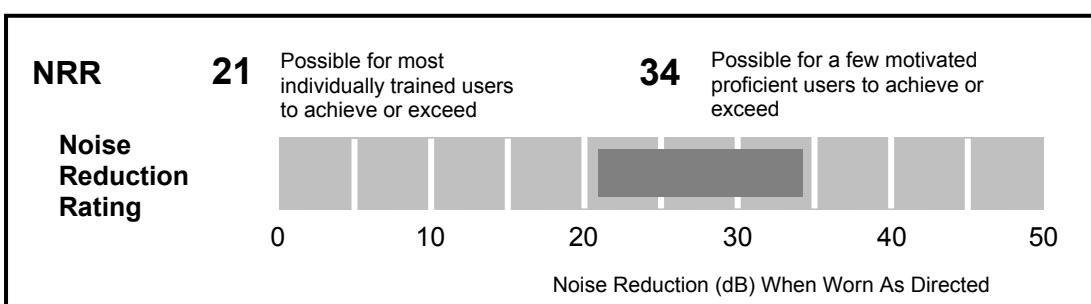
Noise Reduction Ratings (NRR)...

- 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.

$$\mathbf{NRR - 7}$$

For example, ear plugs with a listed NRR of 29...



$$\mathbf{29 - 7 = 22}$$

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)...

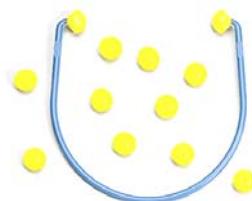
Earmuffs	Subtract 25% from the manufacturer's adjusted NRR
Formable Ear Plugs	Subtract 50% from the manufacturer's adjusted NRR
All Other Ear Plugs (Canal Caps)	Subtract 70% from the manufacturer's adjusted NRR



Earmuffs



Formable Ear Plugs



Canal Caps

Dual Hearing Protection

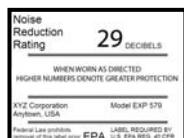
Workers whose 8-hour time weighted average exposures exceed 100 decibels should wear double hearing protection (wearing earplugs and earmuffs simultaneously).

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

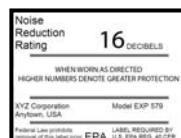
To calculate the dual hearing protection using the noise reduction rating, take the higher NRR and add five (5) to the field adjusted NRR (listed NRR – 7 + 5); the extra five (5) is all that is added for the second device.

Example of dual protection calculation using noise reduction rating (NRR)...



22

(Adjusted NRR)



+ 5 = 27

(Dual Protection NRR)

Formable Ear Plugs
Listed NRR = 29

Adjusted NRR (29 – 7) = 22

Earmuffs
Listed NRR = 16

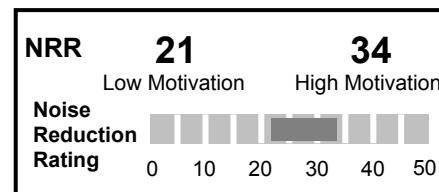
Adjusted NRR for Dual Protection = 5

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)

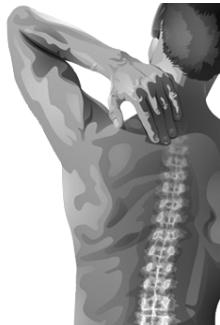
When using the proposed range noise reduction rating (NRR); select the appropriate NRR based on user motivation (low or high) and add five (5) – no subtraction of 7 required. For example, formable ear plugs with range NRR of 21 through 34, a highly motivated user will add 5 to 34 (34 + 5 = 39). A minimally 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 be 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.



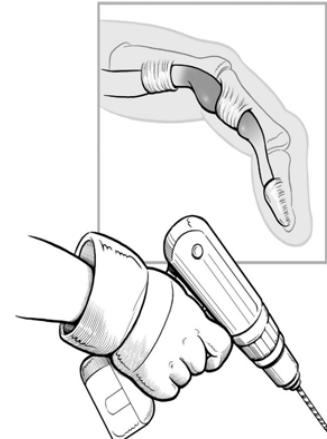
Thoracic outlet syndrome involves the compression of nerves from the spine and blood vessels from the heart that go to the muscles in the arms. Performing overhead tasks for extended periods of time and bending over can cause this condition. Like carpal tunnel syndrome, symptoms of thoracic outlet syndrome 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.

The major types of radiation emitted during radioactive decay are **alpha particles**, **beta particles**, and **gamma rays**.



**Symbol for
Radiation**

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.

Alpha Particles

Alpha particles are energetic, positively charged 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.

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.

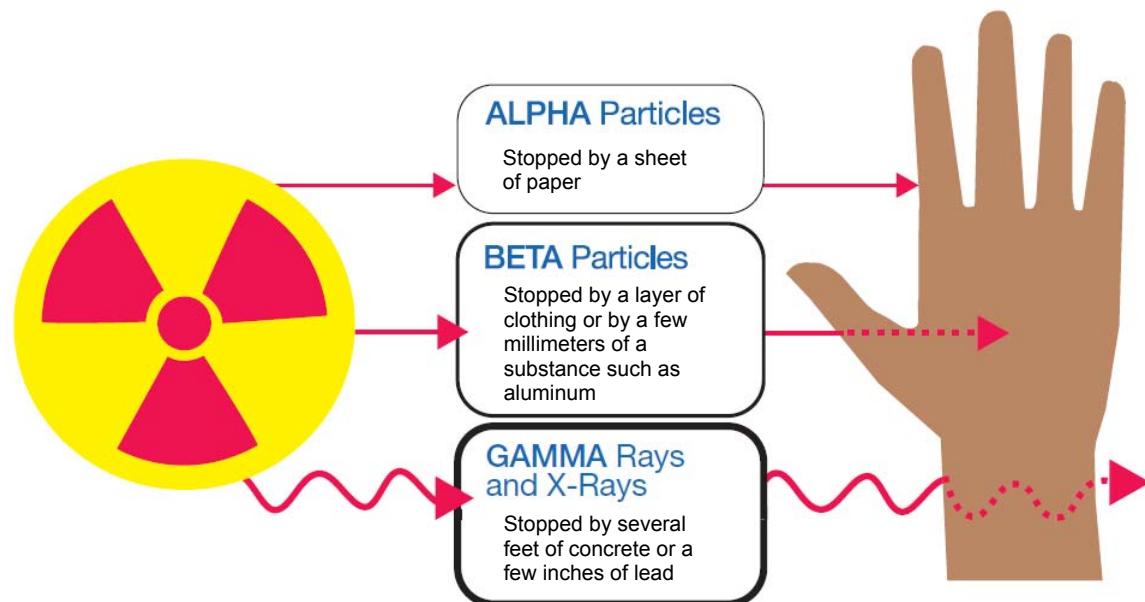
One source of gamma rays in the environment is naturally-occurring potassium-40. Man-made sources include cobalt-60 and cesium-137. Gamma rays are a radiation hazard for the entire body. While gamma rays can easily pass completely through the human body, a fraction will always be absorbed by tissue.

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.

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 ²)	Attenuation	
	Optical density (O.D.)	Attenuation factor
10-2	5	10 ⁵
10-1	6	10 ⁶
1.0	7	10 ⁷
10.0	8	10 ⁸



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).



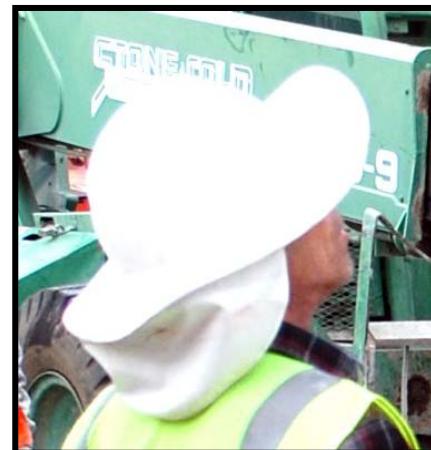
Construction Industry Requirements for Filter Lens Shade Numbers for Protection against Radiant Energy

<i>Welding Operation</i>	<i>Shade Number</i>
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).

UV Index	Description	Sun Protection Actions
0 – 2	Low	<p>Minimal sun protection required for normal activity.</p> <p>Wear sunglasses on bright days. If outside for more than one hour, cover up and use sunscreen.</p> <p>Reflections off snow can nearly double UV strength. Wear sunglasses and apply sunscreen.</p>
3 – 5	Moderate	<p>Take precautions - cover up, wear a hat, sunglasses and sunscreen especially if you will be outside for 30 minutes or more.</p> <p>Look for shade near midday when the sun is strongest.</p>
6 – 7	High	<p>Protection required - UV radiation damages the skin and can cause sunburn.</p> <p>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.</p>
8 – 10	Very High	<p>Extra precautions required - unprotected skin will be damaged and can burn quickly.</p> <p>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.</p>
11+	Extreme	<p>The UV Index can reach 14 or more in the tropics and southern U.S.</p> <p>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.</p> <p>White sand and other bright surfaces reflect UV radiation and increase UV exposure.</p>

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

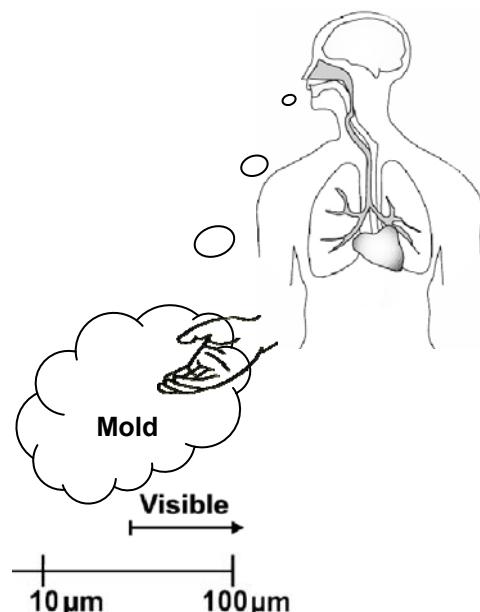
Mycotoxins can cause serious health effects in almost anybody. These agents have toxic effects ranging from short-term irritation to immuno-suppression and possibly cancer. Therefore, when toxigenic molds are found further evaluation is recommended.

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 μm) 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 ½ 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 (μm), and microconidia (small spores) range from 2 to 5 μm in diameter. Yeast cells of *H. capsulatum* have oval to round shapes and diameters ranging from 1 to 5 μm .

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

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*.



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).



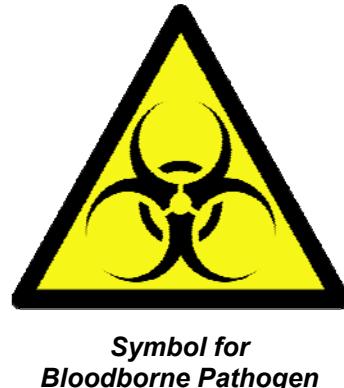
Full Facepiece, Elastomeric, Air Purifying Respirator – any combination of N, R & P with efficiency 95, 99 or 100.

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:

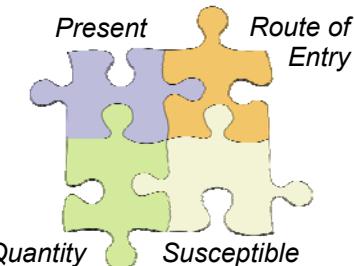
- Hepatitis B Virus (HBV)
- Hepatitis C Virus (HCV)
- Human Immunodeficiency Virus (HIV)



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.

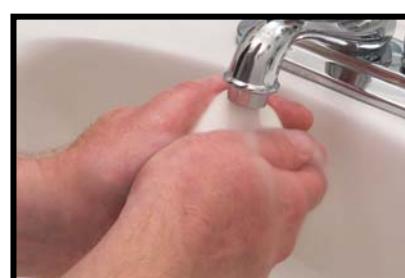


Hepatitis C is a serious disease of the liver.

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 dropping:

- 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

Notes

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.

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

<i>Host Employer (Owner)</i>	<i>Controlling Contractor</i>	<i>Sub-Contractors</i>
<ul style="list-style-type: none"> ➤ Perform an engineering survey to determine the presence of hazardous materials before accepting bids for work. ➤ Carefully review all bids for appropriate procedures and allowances for the safe handling, use and disposal of hazardous materials. ➤ 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. ➤ 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. ➤ Certain health standards require owner to notify presence and location of hazardous substances (e.g., asbestos). 	<ul style="list-style-type: none"> ➤ Has general supervisory authority over the worksite, including the power to correct safety and health violations or require others to correct them. ➤ Must exercise reasonable care to prevent and detect violations on the site. ➤ Award sub-contract to only those employers who provide detailed safety and health plans outlining specific engineering and administrative controls. ➤ Coordinate entry operations into newly constructed or existing confined spaces. ➤ Provide adequate hygiene facilities (e.g., toilets, hand washing stations, etc...). ➤ Provide required medical services and first aid supplies. 	<ul style="list-style-type: none"> ➤ Perform hazard analyses on jobs and tasks. ➤ Identify worker exposures to hazardous substances ➤ Implement feasible engineering and administrative controls. ➤ Provide personal protective equipment when required. ➤ Train employees on how to recognize and avoid unsafe conditions on the job-site and regulations that apply to their jobs. ➤ Assign a competent person to perform frequent and regular inspections of the job-site.

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.

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 Glove Selection Chart

Chemical Resistance Selection Chart for Protective Gloves

Chemical	Neoprene	Latex/Rubber	Butyl	Nitrile
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
Diocetyl 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

Chemical Glove Selection Chart

Chemical	Neoprene	Latex/Rubber	Butyl	Nitrile
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

Chemical	Neoprene	Latex/Rubber	Butyl	Nitrile
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

Particulate Air Filter Use Description

Oil Designation	P	R	N
Efficiency			
95	Oil Proof Low Efficiency	Oil resistant Low Efficiency	Not Oil Proof Low Efficiency
99	Oil Proof Medium Efficiency	Oil resistant Medium Efficiency	Not Oil Proof Medium Efficiency
100	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... →

Respiratory Protection Program for Contractors

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... →

Respiratory Protection Program for Contractors

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®), 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: _____

Job site/Space I.D.: _____

Equipment to be worked on: _____

Stand-by personnel: _____

Date and Time Expires: _____

Job Supervisor: _____

Work to be performed: _____

1. Atmospheric Checks: Time _____
 Oxygen _____ %
 Explosive _____ % L.F.L.
 Toxic: CO _____ ppm
 H₂S _____ 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 (H₂S)
 Toxic _____ ppm < 35 ppm (CO)
 Tester's signature: _____

6. Communication procedures: _____

7. Rescue procedures: _____

8. Entry, standby, and back up persons: Yes No
 Successfully completed required training? Is it current? () ()

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.

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. ^d	ppm ^a	mg/m ³ ^b	Skin Designation
Ammonia	7664-41-7	50	35	
Ammonium sulfamate	7773-06-0			
Total dust			15	
Respirable fraction			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 ^g ; see §1926.1128	71-43-2			
Benzidine; see §1926.1110	92-87-5			
p-Benzozquinone; see Quinone				
Benzo(a)pyrene; see Coal tar pitch volatiles				
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	1303-86-2			
Total dust			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 ₃); see §1910.1026 ^{n,t}	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	1317-65-3			
Total dust				
Respirable fraction				
Calcium oxide	1305-78-8		5	
Calcium sulfate	7778-18-9			
Total dust			15	
Respirable fraction			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

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. ^d	ppm ^a	mg/m ³ ^b	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	

§1926.55 Appendix A

Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. ^d	ppm ^a	mg/m ³ ^b	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 chlorhydrin				
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 ^o				
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. ^d	ppm ^a	mg/m ³ ^b	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				
Didbutyl phosphate	107-66-4	1	5	
Didbutyl 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 Xyldine				
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	

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Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. ^d	ppm ^a	mg/m ³ ^b	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			
Ethyldene chloride; see 1,1-Dichloroethane				
N-Ethylmorpholine	100-74-3	20	94	X
Ferbam Total dust	14484-64-1		15	
Ferrovanadium 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 ³	
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. ^d	ppm ^a	mg/m ³ ^b	Skin Designation
Graphite, natural, respirable dust	7782-42-5	(²)	(²)	(²)
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

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Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. ^d	ppm ^a	mg/m ³ ^b	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	72-43-5			
Total dust			15	
2-Methoxyethanol (Methyl cellosolve)	109-86-4	25	80	X
2-Methoxethyl 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	583-60-8	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. ^d	ppm ^a	mg/m ³ ^b	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-Nitrophenyl; 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)		5	30	X
o-isomer	88-72-2			
m-isomer	99-08-1			
p-isomer	99-99-0			
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	115-77-5			
Total dust				
Respirable fraction				
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 ³	
Phenol	108-95-2	5	19	X
p-Phenylenediamine	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	

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Threshold Limit Values of Airborne Contaminants for Construction (continued)

Substance	CAS. No. ^d	ppm ^a	mg/m ³ ^b	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	26499-65-0			
Total dust				
Respirable fraction				
Platinum (as Pt)	7440-06-4			
Metal Soluble Salts			0.002	
Polytetrafluoroethylene decomposition products			A ²	
Portland cement	65997-15-1			
Total dust		5	15	
Respirable fraction				
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	(²)	(²)	(²)
Silica, amorphous, diatomaceous earth, containing less than 1% crystalline silica	61790-53-2	(²)	(²)	(²)
Silica, crystalline cristobalite, respirable dust	14464-46-1	(²)	(²)	(²)
Silica, crystalline quartz, respirable dust	14808-60-7	(²)	(²)	(²)
Silica, crystalline tripoli (as quartz), respirable dust	1317-95-9	(²)	(²)	(²)
Silica, crystalline tridymite, respirable dust	15468-32-3	(²)	(²)	(²)
Silica, fused, respirable dust	60676-86-0	(²)	(²)	(²)
Silicates (less than 1% crystalline silica) Mica (respirable dust)	12001-26-2	(²) (²) (²)	(²) (²) (²)	(²) (²) (²)
Soapstone, total dust				
Soapstone, respirable dust				
Talc (containing asbestos); use asbestos limit; see §1926.58	14807-96-6	(²)	(²)	(²)
Talc (containing no asbestos), respirable dust				
Tremolite, asbestosiform; see §1926.58				
Silicon carbide	409-21-2			
Total dust				
Respirable fraction				
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	9005-25-8			
Total dust				
Respirable fraction				
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. ^d	ppm ^a	mg/m ³ ^b	Skin Designation
Styrene	100-42-5	(C)100	(C)420	
Sucrose	57-50-1			
Total dust				
Respirable fraction				
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 Dermeton				
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	
Temephos	3383-96-8			
Total dust				
Respirable fraction				
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)	21651-19-4			
Total dust				
Respirable fraction				
Titanium dioxide	13463-67-7			
Total dust				
Toluene	108-88-3	200	750	
Toluene-2,4-diisocyanate (TDI)	584-84-9	(C)0.02	(C)0.14	
o-Tolidine	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. ^d	ppm ^a	mg/m ³ ^b	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			
Insoluble compounds			5	
Soluble compounds			1	
Turpentine	8006-64-2	100	560	
Uranium (as U)	7440-61-1			
Soluble compounds			0.2	
Insoluble compounds			0.2	
Vanadium	1314-62-1			
Respirable dust (as V ₂ O ₅)			(C)0.5	
Fume (as V ₂ O ₅)			(C)0.1	
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	
Xylylidine	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			
Total dust			15	
Respirable fraction			5	
Zirconium compounds (as Zr)	7440-67-7		5	

Mineral Dusts

Substance	mppcf ⁱ
SILICA:	
Crystalline	
Quartz. Threshold limit calculated from the formula	$\frac{250^{(k)}}{\%SiO_2+5}$
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: ^(m)	50 (or 15 mg/m ³ whichever is the smaller) of total dust <1% SiO ₂
(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.	

Footnotes:

¹ [Reserved]

² See Mineral Dusts Table.

³ Use Asbestos Limit § 1926.58.

⁴ See § 1926.58.

^{*} The PELs are 8-hour TWAs unless otherwise noted; a (C) designation denotes a ceiling limit.

^{**} As determined from breathing-zone air samples.

^a Parts of vapor or gas per million parts of contaminated air by volume at 25 °C and 760 torr.

^b 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.

^c [Reserved]

^d 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.

^e [Reserved]

^f [Reserved]

^g For sectors excluded from §1926.1128 the limit is 10 ppm TWA.

^h [Reserved]

ⁱ [Reserved]

^j Millions of particles per cubic foot of air, based on impinger samples counted by light-field techniques.

^k 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.

^l [Reserved]

^m Covers all organic and inorganic particulates not otherwise regulated. Same as Particulates Not Otherwise Regulated.

ⁿ If the exposure limit in 1926.1026^t is stayed or is not otherwise in effect, the exposure limit is a ceiling of 0.1 mg/m³.

^o If the exposure limit in §1926.1026^t is stayed or is not otherwise in effect, the exposure limit is 0.1 mg/m³ (as CrO₃) as an 8-hour TWA.

The 1970 TLV uses letter designations instead of a numerical value as follows:

^A [Reserved]

^{A²} 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.

^{A³} 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 Simple 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.

^t 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

Bertinuison, 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

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

U.S. Department of Labor – Occupational Safety & Health Administration (OSHA). *OSHA Publication 3074 – Hearing Conservation*. www.osha.gov

U.S. Department of Labor – Occupational Safety & Health Administration (OSHA). *OSHA Publication 3362 – Controlling Silica Exposures in Construction*. www.osha.gov

Globally Harmonized System of Classification and Labeling of Chemicals (GHS). Rev. 4 (2011). Copyright © United Nations.

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

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/m³) 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

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

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

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 raise 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

Elastomeric Facepiece - A respirator made from a rubber type material in which it may be cleaned, disinfected and reused.

ESLI - 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

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

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

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

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

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.

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

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

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/m³ - 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

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 bum, or bums 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

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 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

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 - ¹Hazards 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. ²Means 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

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

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

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

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

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

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

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

X-ray Fluorescence (XRF) Analyzer - A portable instrument that measures lead concentration on a surface, generally in milligrams per square centimeter (mg/cm^2).

Z

Zinc Protoporphyrin (ZPP) Test - A biological test for lead exposure that measures the amount of zinc protoporphyrin in blood.

Post-Test **Personal Protection Equipment**

NAME: _____

DATE: _____

1) Employers are responsible for:

- a. Performing a "hazard assessment" of the workplace to identify and control physical and health hazards.
 - b. Identifying and providing appropriate PPE for employees.
 - c. Training employees in the use and care of the PPE.
 - d. Maintaining PPE, including replacing worn or damaged PPE.
 - e. Periodically reviewing, updating and evaluating the effectiveness
 - f. All of the above.
-

2) An employer shall provide, at no cost to the employee, the initial issue of the type of PPE that is suitable for the work to be performed:

- a. True
 - b. False
-

3) Which of the following is not considered a common safety hazard:

- a. Flying sawdust particles
 - b. Hair entanglement
 - c. Broken fingernail
 - d. Splash of extremely hot water
 - e. Wet floor
-

4) Eye protection should be:

- a. Durable
 - b. Not interfere with vision.
 - c. Kept in good repair.
 - d. All of the above
-

5) An employer is required to assess the workplace to determine if hazards that necessitate the use of personal protective equipment are present or are likely to be present only if an injury occurs.

- a. True
 - b. False
-

Post-Test
Personal Protective Equipment

NAME: _____

DATE: _____

6) The primary objective of PPE is to protect employees by creating a barrier against workplace hazards:

- a. True
 - b. False
-

7) Safety glasses used in conjunction with a face-shield provide the greatest level of protection when using grinding equipment:

- A. True
 - B. False
-

8) Safety glasses should be approved and marked with:

- A. ANSI; Z-87
 - B. LOTO; W-40
 - C. NORM; L-20
 - D. ROW; Y-78
-

9) Before requiring an employee to use PPE, an employer must provide training in the following:

- a. When PPE is necessary
 - b. The type of PPE required
 - c. How to wear PPE properly
 - d. The limits of the PPE
 - e. Proper care, maintenance, useful life, and disposal of PPE
 - f. All of the above
-

10) Safety footwear must meet standards set by ANSI and...:

- a. American Society for Testing and Materials (ASTM)
 - b. International Chemical Workers Union (ICWU)
 - c. National Fire Protection Association (NFPA)
 - d. National Safety Commission (NSC)
-

Post-Test
Personal Protection Equipment

NAME: _____

DATE: _____

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- a. True
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-

Post-Test
Personal Protective Equipment

NAME: _____

DATE: _____

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Confined Space Training

Confined Space Training

Disclaimer

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It does not necessarily reflect the views or policies of the U.S. Department of Labor, nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. Government.

Confined Space Training

Welcome

- What is a Confined Space
- When does it become Permit Required?
- What are the Hazards
- Training

Confined Space Training

Module-1

- What is a Confined Space
- When does it become Permit Required?
- What are the Hazards
- Training

What is a Confined Space

According to OSHA
29 CFR 1910.146b

A Confined Space is defined as:

1. Large enough and so configured that a worker can bodily enter it, and
2. Has limited or restricted means of entry or exit, and
3. Is not designated for continuous worker occupancy.

What is a Confined Space - Part 2

According to OSHA

29 CFR 1910.146b

A confined space is:

1.

2.

3.

NOTE: What is considered ENTRY?

If you break the plane of a confined space, you have entered the confined space!

Confined Space Training

Module-1b Permit Required?

- What is a Confined Space
- When does it become Permit Required?
- What are the Hazards
- Training

When does it become Permit Required?

Permit Required Confined Space has one or more of the following characteristics:

- ▶ 1. Contains or has the potential to contain a hazardous atmosphere;
- ▶ 2. Contains a material that has the potential for engulfing an entrant;
- ▶ 3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by sloped/tapered floors.

When does it become Permit Required? - Part 2

Example of a permit-required confined space.



When does it become Permit Required? - Part 3

- ▶ **Permit-required** confined space entry
- ▶ Permit is required whenever there is a hazard
- ▶ Or potential hazard

CONFINED SPACE ENTRY PERMIT							
ENTRY SUPERVISOR: COMPLETE AND INITIAL FORM (PLEASE PRINT)							
Entry Supervisor:							
Department(s) Involved:							
Location of Space: (be specific)							
Work to be Accomplished:							
Authorized Entrant(s):							
Authorized Attendant(s):							
Entry Date(s) & Time(s):							
(Permit is limited to one project at location of space)							
PERMIT SPACE HAZARDS (See Space ID List)							
<input type="checkbox"/> ATMOSPHERIC <input type="checkbox"/> Oxygen Deficiency <input type="checkbox"/> Oxygen Enrichment <input type="checkbox"/> Explosive (Gas/Vapor) <input type="checkbox"/> Carbon Monoxide <input type="checkbox"/> Hydrogen Sulfide <input type="checkbox"/> Other Toxic gases/vapors _____							
<input type="checkbox"/> ENGULFMENT <input type="checkbox"/> CONFIGURATION (ENTRAPMENT) <input type="checkbox"/> MECHANICAL <input type="checkbox"/> ELECTRICAL <input type="checkbox"/> SUBSTANCE HAZARDOUS TO SKIN OR EYES <input type="checkbox"/> HEAT STRESS <input type="checkbox"/> OTHER POTENTIAL HAZARDS (e.g. radiation, noise, etc) _____							
CONTROLS (Check all that apply)							
<input type="checkbox"/> ATMOSPHERIC TESTING (Required) <input type="checkbox"/> Continuous <input type="checkbox"/> Periodic (Give interval) _____							
<input type="checkbox"/> VENTILATION <input type="checkbox"/> Continuous forced air <input type="checkbox"/> Local Exhaust <input type="checkbox"/> Natural							
<input type="checkbox"/> ISOLATION <input type="checkbox"/> Lockout/Tagout (Specify) _____							
<input type="checkbox"/> Blanking/Blinding <input type="checkbox"/> Double Block & Bleed <input type="checkbox"/> Line Breaking/Misalign <input type="checkbox"/> Other							
<input type="checkbox"/> PURGE / FLUSH / CLEAN <input type="checkbox"/> BARRICADES / COVER REMOVAL							
TOOLS / EQUIPMENT (Check mandatory items)							
<input type="checkbox"/> AIR MONITOR <input type="checkbox"/> Tripod w/ mechanical winch <input type="checkbox"/> Explosion proof lighting <input type="checkbox"/> Intrinsically Safe Tools & Electrical Equip. GFCI <input type="checkbox"/> Ladders <input type="checkbox"/> FIRE EXTINGUISHER <input type="checkbox"/> Water <input type="checkbox"/> ABC							
<input type="checkbox"/> Other _____							
RESCUE PROCEDURES BEFORE Attempting Non-Entry Rescue Call Emergency Number First!							
EMERGENCY PHONE #		Back-up emergency #					
STATE: "This is a Confined Space Emergency" NEVER ENTER SPACE to attempt rescue.							
Have you called Maintenance Dispatch before entry? <input type="checkbox"/> YES <input type="checkbox"/> NO / Additional entries <input type="checkbox"/> YES <input type="checkbox"/> NO							
Is pre-entry set-up of emergency equipment required? <input type="checkbox"/> YES <input type="checkbox"/> NO							
If not, where is location of rescue equipment?							
EQUIPMENT (Check mandatory items)							
<input type="checkbox"/> Safety Glasses <input type="checkbox"/> Face Shield <input type="checkbox"/> Other: (specify) _____							
<input type="checkbox"/> Rubber <input type="checkbox"/> Slip Prevention <input type="checkbox"/> Steel toes <input type="checkbox"/> Other: (specify) _____							
<input type="checkbox"/> Leather <input type="checkbox"/> Cotton <input type="checkbox"/> Other: (specify) _____							
<input type="checkbox"/> Harness & Lifelines <input type="checkbox"/> Supplied air <input type="checkbox"/> Other: (specify) _____							
<input type="checkbox"/> Anchors: (specify) <input type="checkbox"/> Anchor points: (specify) _____							
DATE _____ (verified all conditions are met before entry)							
<input type="checkbox"/> H ₂ S ppm (hydrogen sulfide) 10 ppm <input type="checkbox"/> Explosive dust <input type="checkbox"/> Other < LFL 5 Ft. Visibility							
In/out	Att. Initials	Time In/out	Att. Initials				
Project completed <input type="checkbox"/> YES <input type="checkbox"/> NO							
Project cancelled <input type="checkbox"/> YES <input type="checkbox"/> NO _____							
Entry Supervisor (Initial) _____							

Confined Space Training

Module-3

- What is a Confined Space
- When does it become Permit Required?
- What are the Hazards
- Training

What are the Hazards?

Potential Hazards in Confined Spaces

- Asphyxiating - Oxygen Deficiency
 - <19.5% or >23.5% oxygen concentration
- CO₂
 - CO₂ is toxic in higher concentrations:
 - 1% (10,000 ppm) will make some people feel drowsy.
 - Concentrations of 7% to 10% cause dizziness, headache, visual and hearing dysfunction, and unconsciousness within a few minutes to an hour.

- Toxic Materials
 - Carbon Monoxide
 - Hydrogen Sulphide
 - Welding fumes
 - Corrosives
- Mechanical Hazards
 - Mixers
 - Crushers
 - Engulfment
 - Soil around an excavation
 - Grain in a silo
 - Powdered material in a bin

What are the Hazards? - Part 2

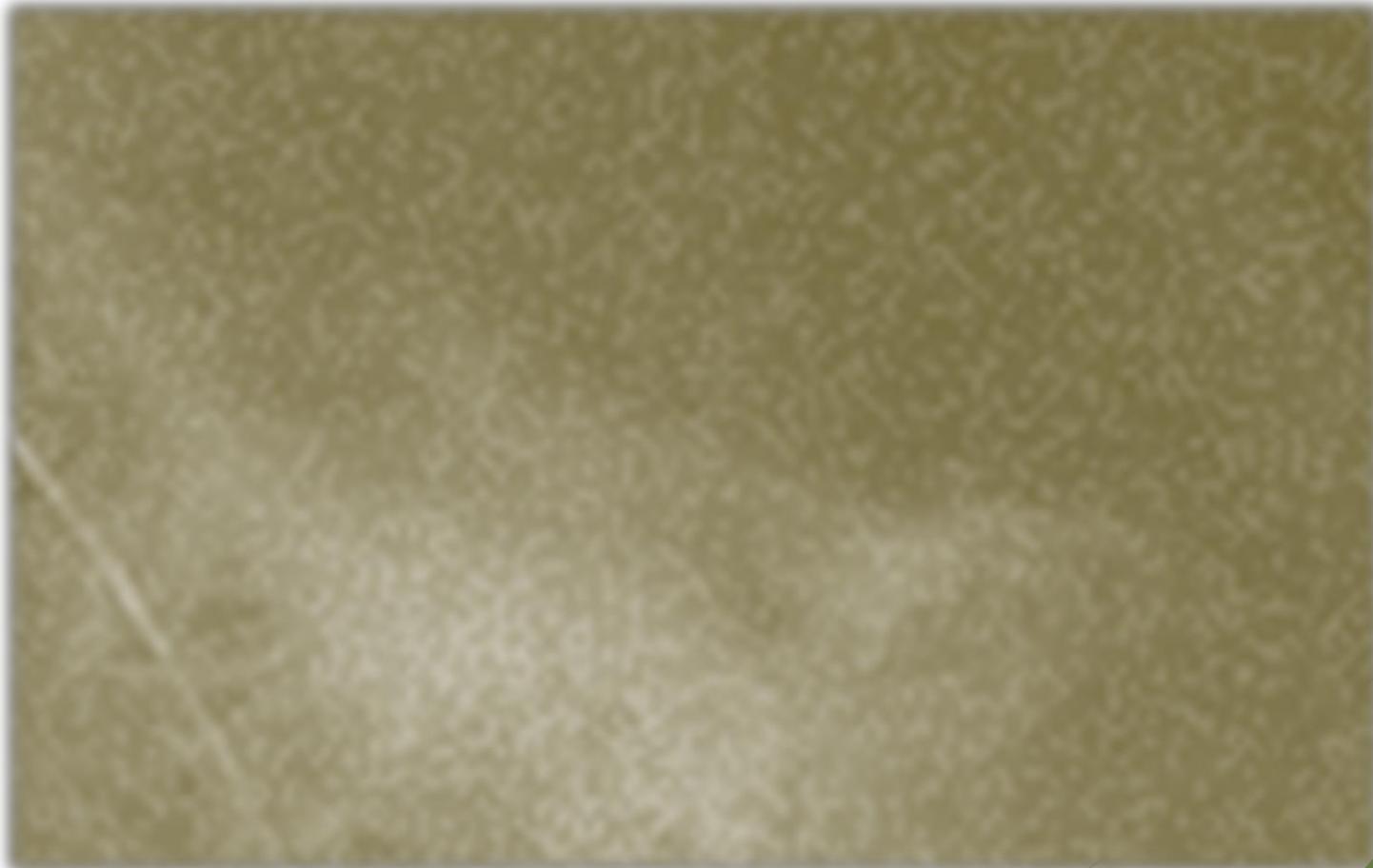
► Potential Hazards in Confined Spaces

- **Asphyxiating - Oxygen Deficiency**
 - <19.5% or >23.5% oxygen concentration
- **CO₂**
 - CO₂ is toxic in higher concentrations:
 - 1% (10,000 ppm) will make some people feel drowsy.
 - Concentrations of 7% to 10% cause dizziness, headache, visual and hearing dysfunction, and unconsciousness within a few minutes to an hour.

- **Toxic Materials**
 - Carbon Monoxide
 - Hydrogen Sulphide
 - Welding fumes
 - Corrosives
- **Mechanical Hazards**
 - Mixers
 - Crushers
- **Engulfment**
 - Soil around an excavation
 - Grain in a silo
 - Powdered material in a bin

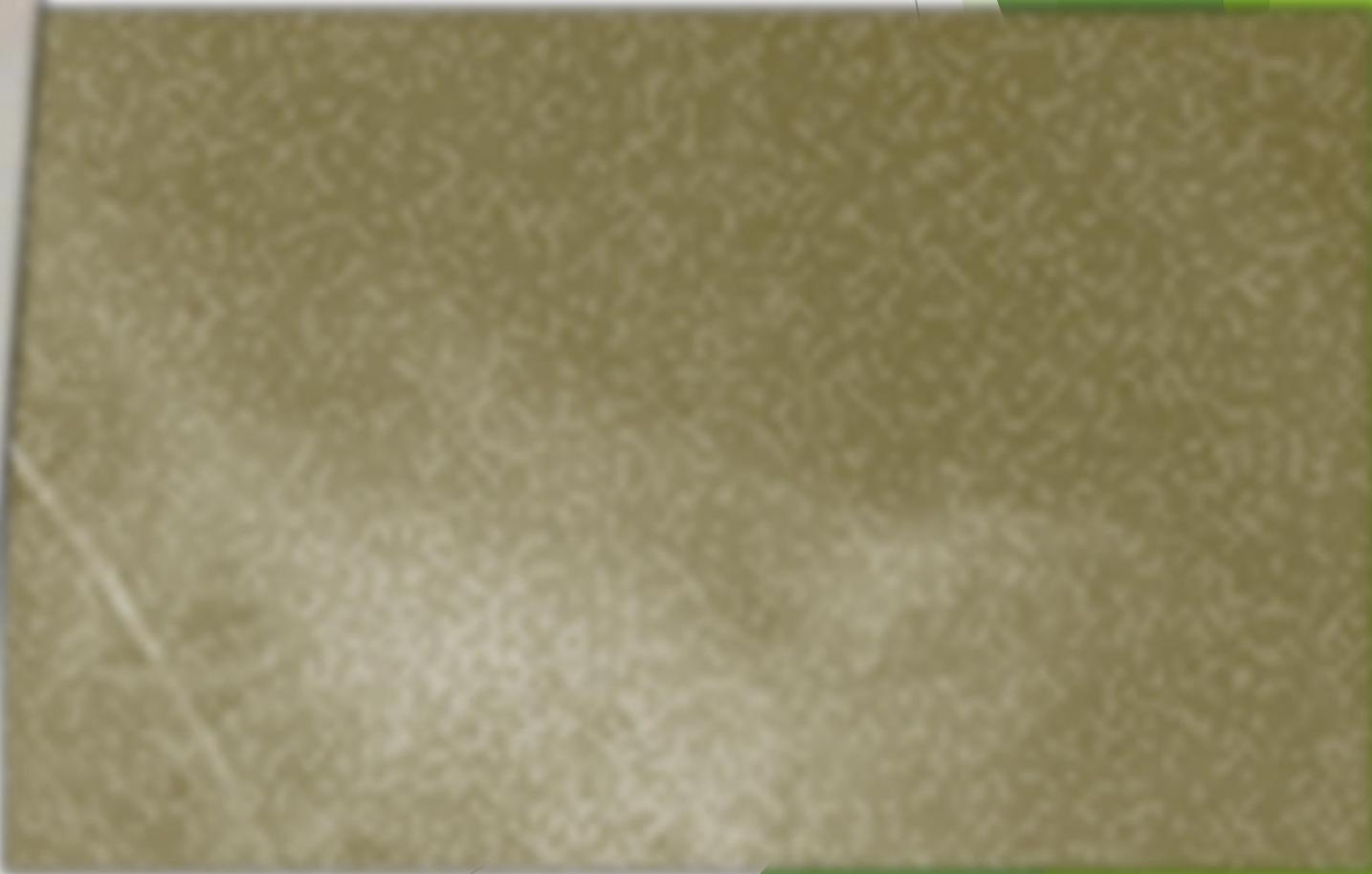
Gasses

What are the Hazards? - Part 3



Combustibility

What are the Hazards? - Part 4



Engulfment

What are the Hazards? - Part 5



Mechanical

What are the Hazards? - Part 6



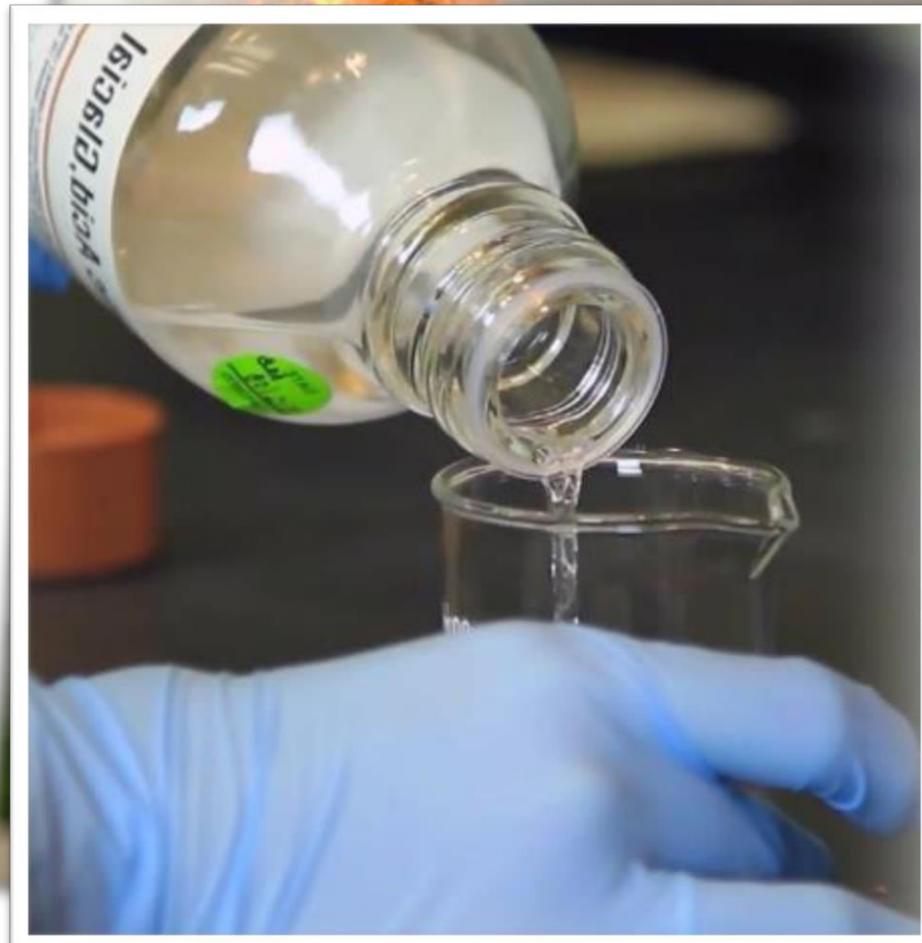
Biological

What are the Hazards? - Part 7



Chemical

What are the Hazards? - Part 8



Extreme Temperatures

What are the Hazards? - Part 9



Hazards from Animals

What are the Hazards? - Part 10



Confined Space Training

Module-4

- What is a Confined Space
- When does it become Permit Required?
- What are the Hazards
- Training

Confined Space Training

► OSHA 1910.146(g) Training

The employer shall provide training so that all employees whose work is regulated by this section acquire the understanding, knowledge, and skills necessary for the safe performance of the duties assigned under this section.

Confined Space Training - Part 2

► OSHA 1910.146(g) Training

Training shall be provided to each affected employee:

- ✓ Before the employee is first assigned duties under this section;
- ✓ Before there is a change in assigned duties;
- ✓ Whenever there is a change in permit space operations that presents a hazard about which an employee has not previously been trained;
- ✓ Whenever the employer has reason to believe either that there are deviations from the permit space entry procedures.

Confined Space Training - Part 3

Confined Space Entry

► Entry:

The action by which a person passes through an opening into a permit-required confined space; Entry includes ensuing work activities in that space and is considered to have occurred as soon as any part of the entrant's body breaks the plane of an opening into the space.

Confined Space Training - Part 4

Confined Space Personnel

► Authorized Entrant

Enters the confined space

► Authorized Attendant

Stands watch outside the entry point of the space

► Entry Supervisor

Oversees entry, ensures conformity to permit & acceptable conditions for entry

Confined Space Training - Part 5

Confined Space Personnel

► Authorized Entrant

The employee who will physically enter the confined space to perform the work.



Confined Space Training - Part 6

Confined Space Personnel

► Authorized Attendant

The employee who remains outside the confined space and;

- monitors the entrant(s)
- guards the space against unauthorized entry
- warns the entrants of any unusual conditions
- and summons the rescue personnel if needed.



Confined Space Training - Part 7

Confined Space Personnel

► Entry Supervisor

The employee who remains outside the confined space and;

- warns the entrants of any unusual conditions
- Completes Permits,
- ensures conformity to permit & acceptable conditions for entry



Confined Space Training - Part 8

Confined Space Permits



Confined Space Training - Part 9

Confined Space Permits

- Required for work in any space with a hazard.
- Establishes the hazards.
- Arranges for protection.



Confined Space Training - Part 10

Confined Space Permits

CONFINED SPACE ENTRY PERMIT

ENTRY SUPERVISOR: COMPLETE AND INITIAL FORM (PLEASE PRINT)

Entry Supervisor:	
Department(s) Involved:	
Location of Space: (be specific)	
Work to be Accomplished:	
Authorized Entrant(s):	
Authorized Attendant(s):	
Entry Date(s) & Time(s):	

(Permit is limited to one project at location of space)

PERMIT SPACE HAZARDS (See Space ID List)

<input type="checkbox"/> ATMOSPHERIC	
<input type="checkbox"/> Oxygen Deficiency	
<input type="checkbox"/> Oxygen Enrichment	
<input type="checkbox"/> Explosive (Gas/Vapor)	
<input type="checkbox"/> Carbon Monoxide	
<input type="checkbox"/> Hydrogen Sulfide	
<input type="checkbox"/> Other Toxic gases/vapors	

<input type="checkbox"/> ENGULFMENT	
<input type="checkbox"/> CONFIGURATION (ENTRAPMENT)	
<input type="checkbox"/> MECHANICAL	
<input type="checkbox"/> ELECTRICAL	
<input type="checkbox"/> SUBSTANCE HAZARDOUS TO SKIN OR EYES	
<input type="checkbox"/> HEAT STRESS	
<input type="checkbox"/> OTHER POTENTIAL HAZARDS (e.g. radiation, noise, etc.)	

COMMUNICATION PROCEDURES USED BY ENTRANT(S) and ATTENDANT(S) (Check all that apply)

<input type="checkbox"/> Visual	<input type="checkbox"/> Rope
<input type="checkbox"/> Voice	<input type="checkbox"/> Radio
<input type="checkbox"/> Other (specify)	

Contact Rescue Service
with what method? _____
(Radio's, cell phone, in-house phone, etc.)

HOT WORK PERMIT NEEDED
 SDS (Reviewed)

RESCUE PROCEDURES BEFORE Attempting Non-Entry Rescue Call Emergency Number F

EMERGENCY PHONE # _____ Back-up emergency # _____

STATE: "This is a Confined Space Emergency" NEVER ENTER SPACE to attempt rescue.

Have you called Maintenance Dispatch before entry? YES NO / Additional entries YES NO

Is pre-entry set-up of emergency equipment required? YES NO

If not, where is location of rescue equipment? _____



PERSONAL PROTECTIVE EQUIPMENT (Check mandatory items)					
<input type="checkbox"/> EYE PROTECTION	<input type="checkbox"/> Safety Glasses	<input type="checkbox"/> Face Shield	<input type="checkbox"/> Other: (specify)		
<input type="checkbox"/> HEARING PROTECTION					
<input type="checkbox"/> PROTECTIVE CLOTHING	(specify)				
<input type="checkbox"/> BOOTS	<input type="checkbox"/> Rubber	<input type="checkbox"/> Slip Prevention	<input type="checkbox"/> Steel toes	<input type="checkbox"/> Other: (specify)	
<input type="checkbox"/> GLOVES	<input type="checkbox"/> Rubber	<input type="checkbox"/> Leather	<input type="checkbox"/> Cotton	<input type="checkbox"/> Other: (specify)	
<input type="checkbox"/> HARD HAT					
<input type="checkbox"/> RESPIRATOR	<input type="checkbox"/> Air Purifying	<input type="checkbox"/> Supplied air	<input type="checkbox"/> Other: (specify)		
<input type="checkbox"/> FALL PROTECTION/ RETRIEVAL EQUIPMENT (Non-entry rescue)	<input type="checkbox"/> Safety Harness & Lifelines	<input type="checkbox"/> Anchor points: (specify)			
<input type="checkbox"/> OTHER: (specify)	<input type="checkbox"/> Mechanical: (specify) <input type="checkbox"/> Other: (specify)				

ADDITIONAL INSTRUCTIONS

--	--

(Primary) ATTENDANT (Print & Initial) _____ DATE _____ (verified all conditions are met before entry)

ATMOSPHERIC TESTS (Check the appropriate ones) (Bump test on Air Monitor is required prior to using)

O ₂ (oxygen)	LEL (Lower Explosive)	CO ppm (carbon monoxide)	H ₂ S ppm (hydrogen sulfide)	Explosive dust	Other
19.5 - 23.5	< 10% LEL	35 ppm	10 ppm	< LFL 5 Ft. Visibility	

Time Initials Test results BEFORE space preparation

Time Initials Test results After space preparation

RECHECKS

ENTRANT(s) (print name & initials)

	Time In/out	Att. Initials	Time In/out	Att. Initials	Time In/out	Att. Initials
	/		/		/	
	/		/		/	
	/		/		/	
	/		/		/	
	/		/		/	
	/		/		/	

ENTRY SUPERVISOR (Print & Initial) _____ DATE _____ Project completed YES NO _____

Project cancelled YES NO _____

Entry Supervisor (Initial)

Confined Space Training - Part 12

Confined Space Permits

Atmosphere Testing Must Be Performed

- ▶ Prior to every entry when the space is vacant;
- ▶ After a 10-minute ventilation period (if ventilation is necessary);
- ▶ At least hourly for permit-required confined spaces. NOTE: A good practice is to re-test the atmosphere after breaks or having been out of the confined space for a period of time.
- ▶ More frequently, if conditions or suspicions warrant.

Confined Space Training - Part 13

Confined Space Permits

Atmosphere Testing Must Be Performed

- ▶ Prior to every entry when the space is vacant;
- ▶ After a 10-minute ventilation period (if ventilation is necessary);
- ▶ At least hourly for permit-required confined spaces. NOTE: A good practice is to re-test the atmosphere after breaks or having been out of the confined space for a period of time.
- ▶ More frequently, if conditions or suspicions warrant.

Confined Space Training - Part 14

Evacuation & Rescue

- Procedures clearly spelled-out.
- Rescue teams made available, Means of contact provided.
- Appropriate equipment available; retrieval systems for non-entry rescue; vertical >5 ft.
- In-house rescue teams are OPTIONAL!
- Dial 911 & notify of confined space emergency, you may attempt retrieval at that point.

Confined Space Training - Part 15

Training: Must Be Certified In Writing

- ✓ for each affected employee
- ✓ before first assignment & with changes
- ✓ deviations from space entry procedures
- ✓ shall establish employee proficiency

Confined Space Training - Review

REVIEW



Knowledge Check

1. What is a Confined Space?

Knowledge Check - Part 2

1. What is a Confined Space?

A **Confined Space** is defined as:

- Large enough and so configured that a worker can bodily enter it, and
- Has limited or restricted means of entry or exit, and
- Is not designated for continuous worker occupancy.

Knowledge Check - Part 3

2. What is a Permit Required Confined Space?

Knowledge Check - Part 4

2. What is a Permit Required Confined Space?

Permit Required Confined Space has one or more of the following characteristics:

- ▶ 1. Contains or has the potential to contain a hazardous atmosphere;
- ▶ 2. Contains a material that has the potential for engulfing an entrant;
- ▶ 3. Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by sloped/tapered floors.

Knowledge Check - Part 5

3. Who are the Qualified workers?

Knowledge Check - Part 6

3. Who are the Qualified workers?

- ▶ ***The Supervisor*** - trained, competent, fills in permits, supervises the work & terminates the entry if needed or when completed
- ▶ ***The Entrant*** - trained & authorized to enter. Performs the work.
- ▶ ***The Attendant*** - trained & authorized

Knowledge Check - Part 7

4. What is the primary reason for using a retrieval system for work within a Permit Required Confined Space?

Knowledge Check - Part 8

4. What is the primary reason for using a retrieval system for work within a Permit Required Confined Space?

- ▶ To allow the attendant to perform a Non-Entry Rescue if problems develop during the entry.

NOTE: Because of the inherent dangers of this work, Only a Trained and Authorized Rescue Team can enter to assist the Entrant (worker)

Additional Resources

- ▶ OSHA website: <http://www.osha.gov> and OSHA offices: Call or Write (800-321-OSHA)
- ▶ Compliance Assistance Specialists in the area offices
- ▶ National Institute for Occupational Safety and Health (NIOSH) - OSHA's sister agency
- ▶ OSHA Training Institute Education Centers
- ▶ Public libraries

Work Zone Employee Safety

Internal Traffic Control Plans

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What is an INTERNAL Traffic Control Plan (ITCP)?

- Plan for coordinating the flow of construction vehicles, equipment, and workers operating within the work space
 - For improved safety within the work zone
- A typical ITCP addresses
 - Parking issues within the work space
 - Safe entry and exit of heavy equipment, trucks and workers to and from the work space
 - Interactions of heavy equipment, trucks, and on-foot workers

ANSI A10.47 – 2015 on ITCP

- Employers shall develop traffic control plans for inside their work zones
- This plan shall be communicated to all employees
- The onsite supervisor/safety person shall modify the plan
- The ITCP should include the following elements:
 1. A diagram showing travel routes for construction equipment and employees
 2. A plan for communicating changes in the ITCP

Developing an ITCP

- Development and implementation of an ITCP should be required for most jobs
- Must accommodate changing requirements in various stages of construction
- Should incorporate all relevant input/feedback from employees
- Must be developed in coordination with the overall traffic control plan

Principles of an ITCP

- Basic principles of ITCP for conflicting movements
 - Separation by space
 - Separation by time
 - Controls
- Schematic diagrams needed for movement of construction workers, vehicles and equipment in the work space

Steps in developing an ITCP

- Identify project and scope
- Determine the construction sequence during the project (should be reviewed daily and updated)
- Determine locations of safe movements
- Determine vehicle and equipment movement
- Determine safe movement for workers
- Assess potential internal traffic conflicts
- Id individuals who need to understand the ITCP
- Develop the plan
- Communicate responsibilities

Responsibilities of Superintendent/Project Manager

- PRIMARY ROLE:
OVERSIGHT
 - Oversee ITCP Implementation
 - Ensure Subcontractor Coordination and “Buy-in”
 - Assign personnel to carry out the plan



Responsibilities of Supervisor and Lead Person



- **PRIMARY ROLE: IMPLEMENTATION**
 - Plan and implement the ITCP site
 - Responsible for coordination among personnel and subcontractors at the construction site
 - Ensure changes are made to ITCP as site conditions change

Responsibilities of Workers on Foot

- PRIMARY ROLE:
**UNDERSTAND, COMPLY and
CORRECT DEFICIENCIES**
 - Learn the elements of ITCPs and how to comply
 - Understand the hazards of working around equipment
 - Take responsibility for personal safety; apply safety training lessons



Responsibilities of Truck Boss



- PRIMARY ROLE:
**COMMUNICATE WITH
OTHER DRIVERS**
 - Share ITCP instruction on where drivers should operate
 - Assist in communicating safe site procedures with all truck drivers

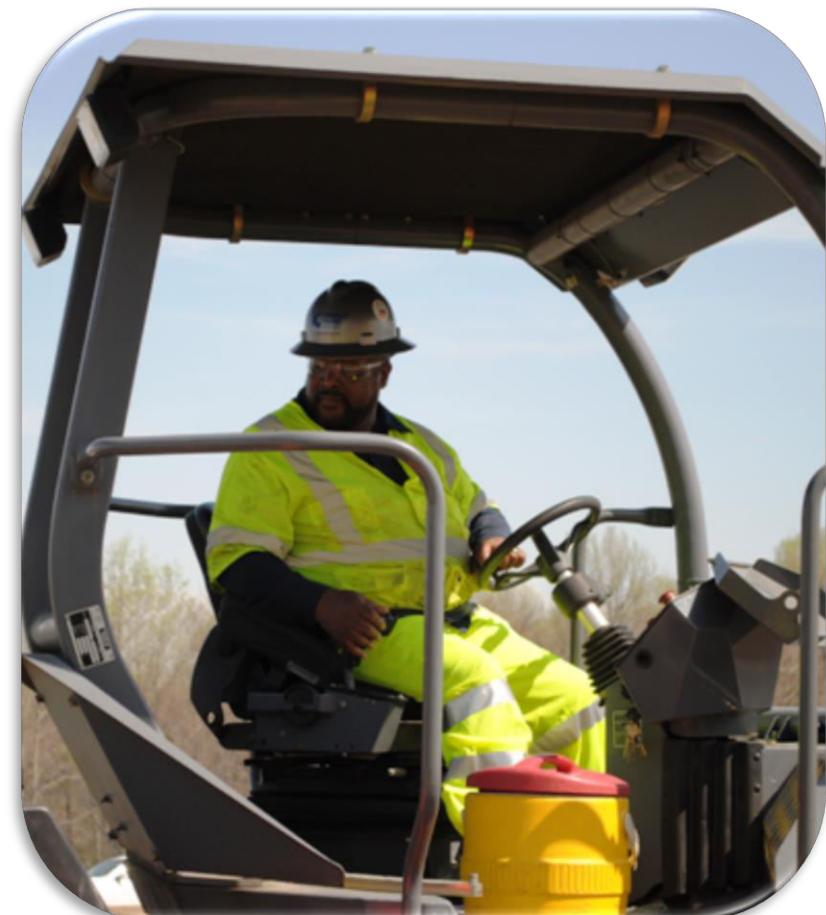
Responsibilities of Truck Drivers



- PRIMARY ROLE: KEEP A SAFE DISTANCE FROM WORKERS ON FOOT
 - Receive ITCP instruction on where they should operate
 - Receive navigation assistance (spotters) when appropriate
 - Never operate into a blind area without checking for pedestrians

Responsibilities of Equipment Operators

- PRIMARY ROLE: KNOW THE LOCATION OF WORKERS ON FOOT
 - Do not move until the blind area is checked or a spotter is designated
 - Know blind area for equipment you are operating
 - Stay out of areas designated for workers on foot
 - Do a 360° “walk-around” before moving equipment



Responsibilities of Spotters

- **PRIMARY ROLE: SAFE BACKING**
 - Ensure operator knows where you are and will be located; make eye contact
 - Ensure workers know your responsibilities and wait for permission to enter area
 - Receive training in safe spotting procedures and know the signals
 - Stay in continuous communication with operator and remain visible at all times



Elements of an ITCP

- Typically, an ITCP should cover
 - Roles and responsibilities of parties
 - Site specific information
 - Communication plan
 - Schematic diagrams
 - Hazard assessments
 - Training of site personnel on ITCP
 - Effectiveness evaluation

Elements of an ITCP – Project Specific Information

- Contact information (company personnel, emergency services, etc.)
- Location, time table, and scope of project
- On-site equipment and personnel
- Interface between internal and external traffic control plans

Elements of an ITCP – Hazard Assessment and Control

- Checklist of site specific hazards and mitigation methods
- Reporting system for incidents and near misses
- Safe procedures for traffic control in work space
- Anticipated traffic volumes, speeds, and speed limits
- Specifications for lighting
- Safe speed limits, clearances from high voltage power lines, blind corners , warnings of drop-off hazards, etc.

Elements of an ITCP – Communication Plan

- Designated channels for communication
- Communications between workers on foot and in vehicles
- Designation of personnel to monitor communications between vehicle and equipment operators

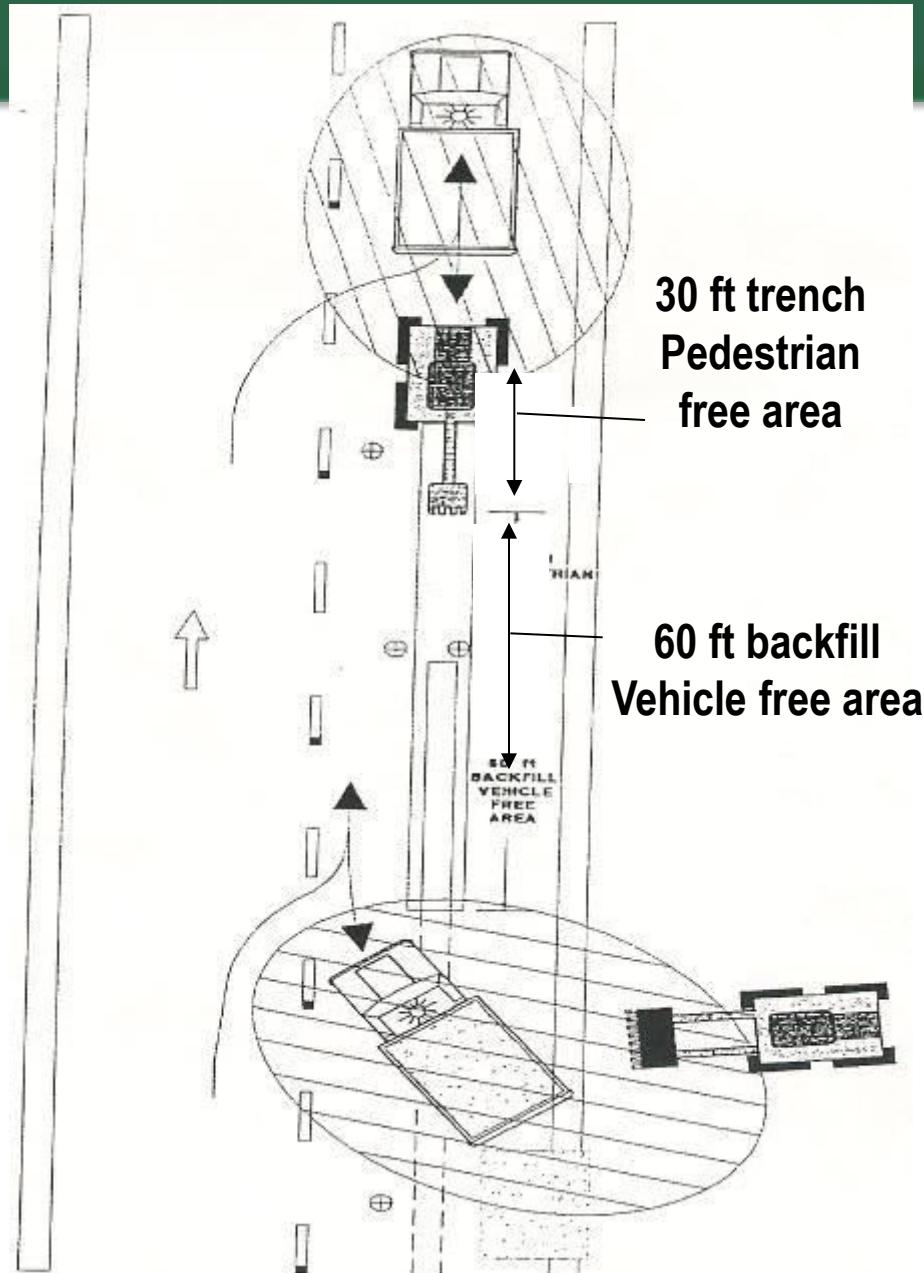
Elements of an ITCP – ITCP Diagrams

- Typically include
 - Standard symbols
 - A layout of the work space
 - Locations of proximate traffic control devices (e.g. drums, cones, etc.)
 - Areas around equipment and operations prohibited to on-foot workers

Elements of an ITCP – Diagrams

- Also, diagrams showing
 - Locations for staging, storing and servicing materials and equipment
 - Locations of visitor and worker parking areas
 - Dimensions and locations of lateral buffer zones
 - Description of internal signage and all internal traffic control devices

Ingress/Egress



Sample Internal Traffic Control
Plan for
Trenching Work in a Highway
Work Zone

Elements of an ITCP - Training

- Training is essential for all personnel
- Orientation of truck drivers to work space activities and ITCP
- Training delivered through
 - General's safety meeting
 - Tool box safety meetings
 - Distribution of site-specific safety materials (e.g. a copy of ITCP, safety guidelines)
 - Self-paced e-training (not recommended)

Elements of an ITCP – Effectiveness Evaluation

- Comprehensive approach
 - Review of ITCP during normal work zone inspections
 - Review and analyze incidents, near misses, and potential hazards
 - Retain schematic drawings and other documents for future use

Steps in developing

- Identify project and scope
- Determine the construction sequence during the project
- Determine locations of safe movements
- Determine vehicle and equipment movement to and from each operation
- Determine safe movement for workers
- Assess potential internal traffic conflicts
- Id individuals who need to understand the ITCP
- REMEMBER – as the job progress these will have to be updated

Conflicting Movements of Trucks, Equipment and Workers

- Conflicts create potential for accidents
- Conflicts between
 - Trucks and trucks
 - Trucks and equipment
 - Trucks and on-foot workers
 - Equipment and on-foot workers
 - Equipment and equipment
 - Overhead hazards

Conflicting Movements of Trucks and Equipment

- Minimize conflicting interactions as much as possible
 - Separation by space
 - Separation by time
- Determine the locations of and design various internal movements
 - Entry and exit locations for trucks and equipment
 - Truck and equipment routes within work space
 - Other activity locations and pedestrian paths (e.g., rest room locations, site office, etc.)

Conflicting Movements of Trucks

- Separation by space
 - Use channelizing devices, such as barriers
 - Separate activities (e.g., excavating, grading, staging, etc.)
- Separation by time
 - Schedule work with safety in mind
 - Arrival and departure of trucks
 - Loading and unloading
- Combination of both approaches

Conflicting Movements of Trucks and Workers

- Properly design the elements of internal traffic control that cause conflicts
 - Safe entry and exit points
 - Speed change lanes
 - Deceleration lane
 - Acceleration lane
 - Turning radius
 - Traffic control devices

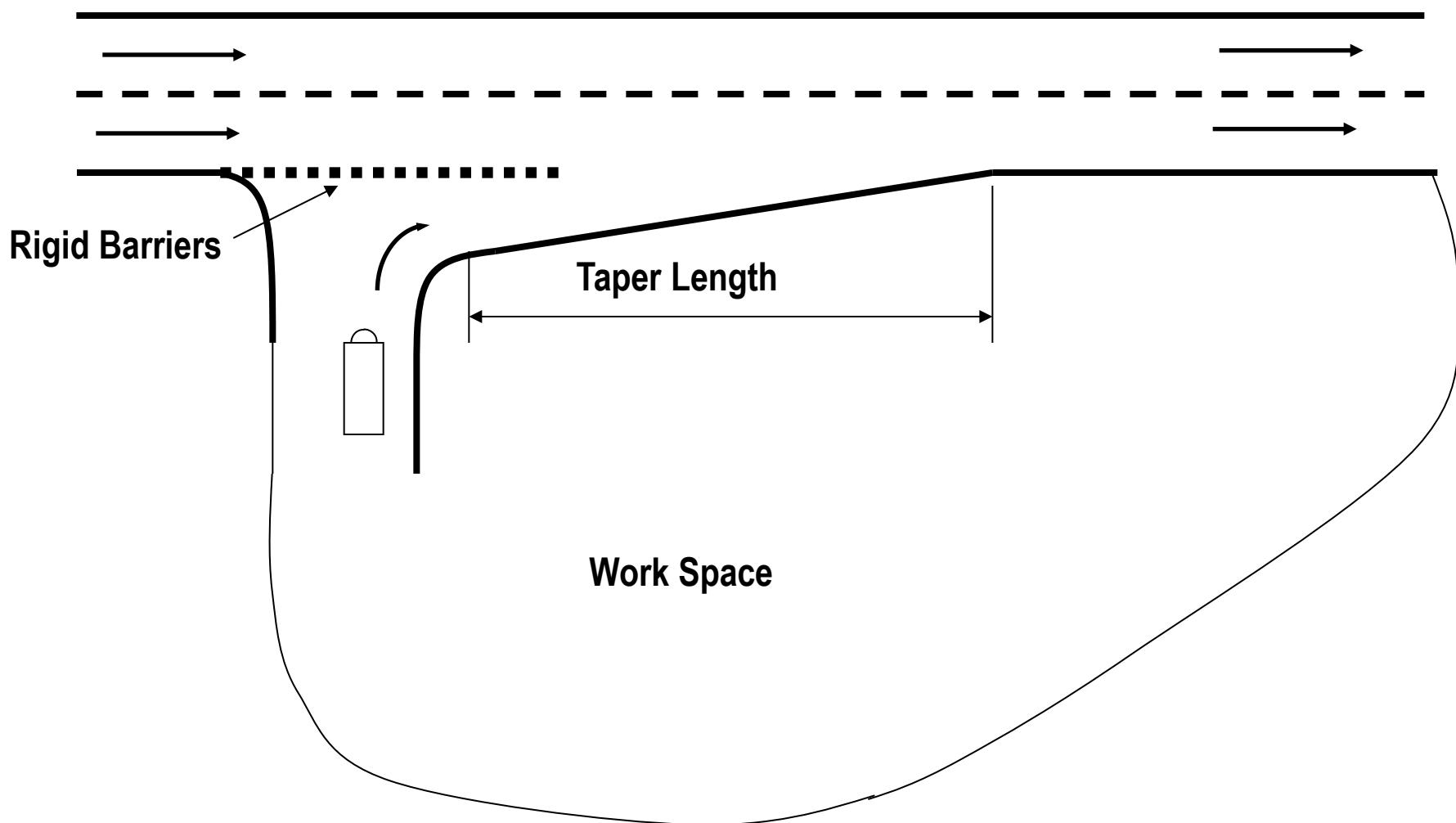
Conflicting Movements of Trucks

- Design of entry and exit points
 - Consideration of roadway size and type
 - Locations of existing driveways
 - Access design and management

Conflicting Movements

- Design of deceleration and acceleration lanes
 - Length of speed change lanes
 - Speed of trucks
 - Terminal speed at entry/exit point
 - Cruise/operating speed (speed of roadway traffic)
 - Separate entry and exit points to reduce conflicts

Acceleration Lanes



A Typical Diagram Showing an Acceleration Lane

Turning Radius and Geometry

- Turning radius at entry and exit points
 - Varies with the type of vehicles
 - Off tracking
 - Larger vehicles - larger off tracking
 - Off tracking can cause injuries/fatalities
- Turning radii must be designed by a qualified person
 - Geometric design specialist
- Perform trial runs

Turning Radius

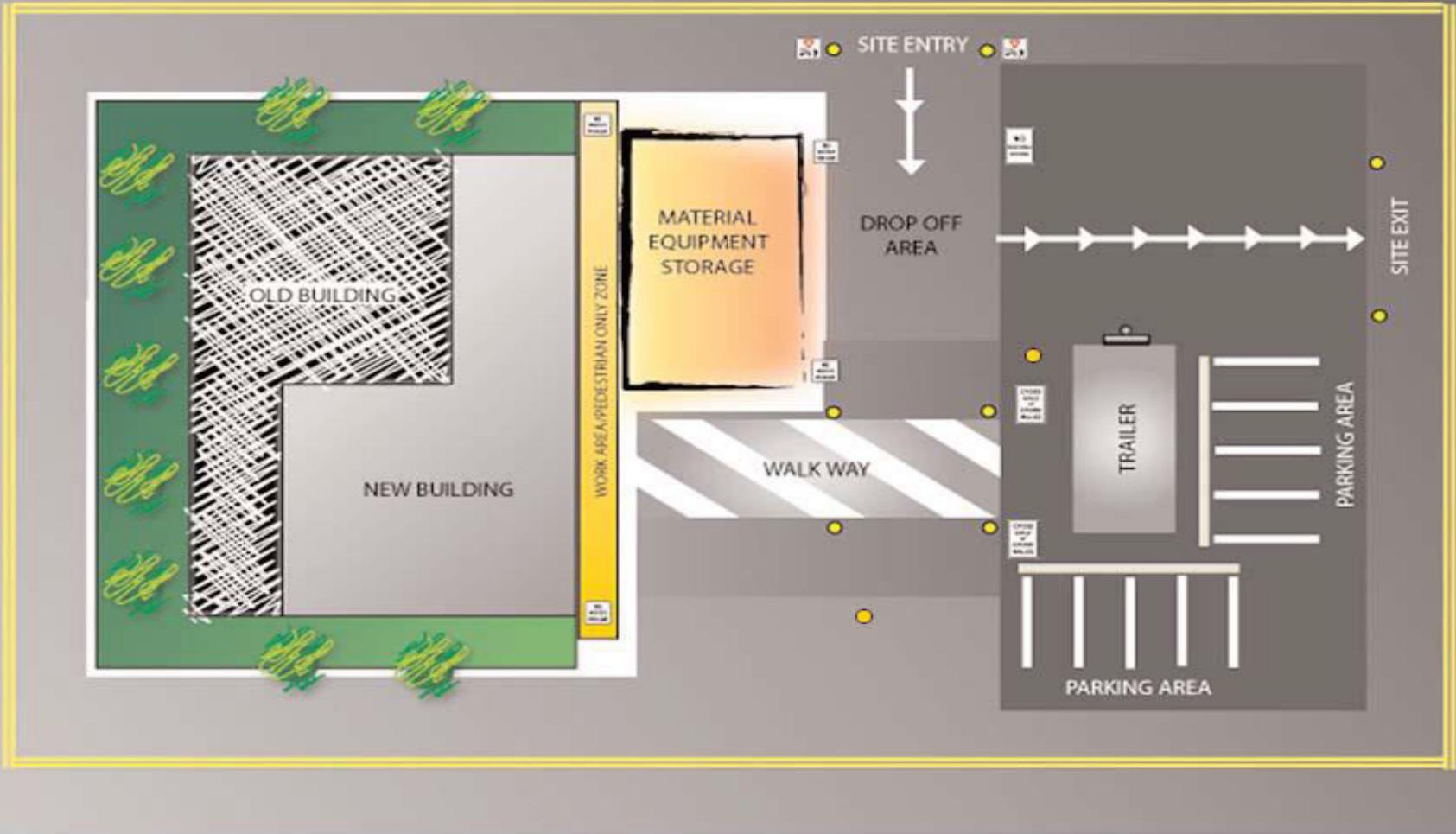


**Turning radius for trucks should be designed
properly**

Conducting a Trial Run for ITCP

Company Foreman and Safety Reps meet

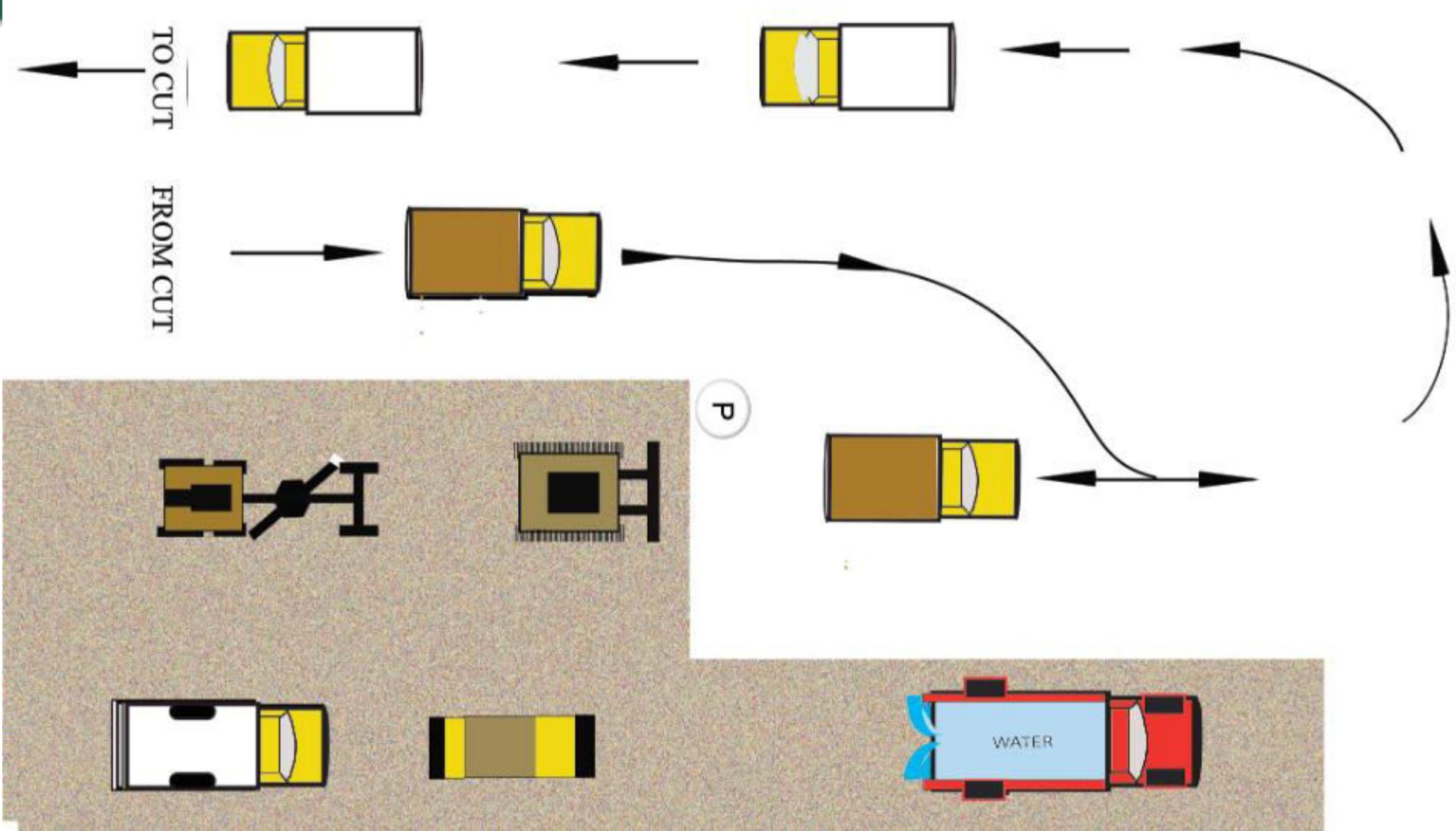
- Job Hazard Analysis for jobs to be done, next day or future
- Walk thru areas that need ITCP
- Use equipment that will be in the area to test traffic pattern
- Draft and agree on plan
- Educate all workers on plan
- Set up control area



Safety Points

- Vehicle traffic flow is separated from pedestrian traffic
- Pedestrian worker free areas have been designated
- Storage locations for material and equipment are designates
- Worker and visitor parking areas are designated away from vehicular traffic

Vehicle Movement



Summary

- Injury potential is extremely high in highway and street construction work zones
- Half of highway and street construction workers are killed by construction trucks and equipment
- Development of Internal Traffic Control Plans is essential for safe operations inside the work space
- It is imperative to eliminate conflicting movements of trucks, equipment and workers
- Most of the construction site hazards also exist inside the work space

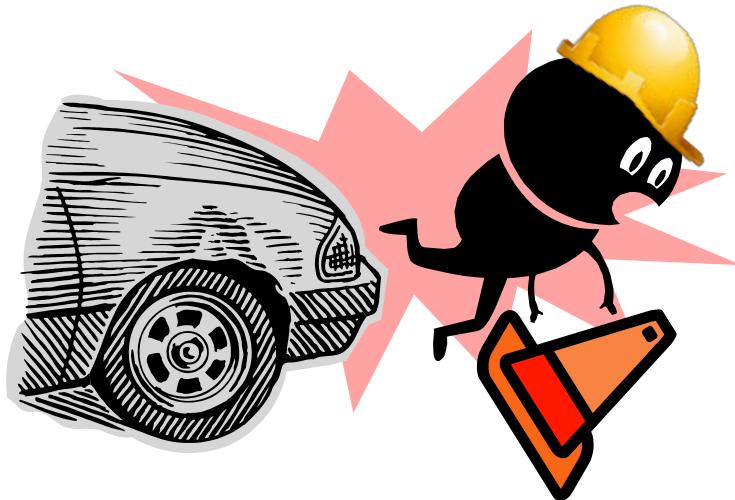
WHY INTERNAL TRAFFIC CONTROL?

ITCPs Protect Workers on Foot

- Workers on foot are those employees who perform most of their duties outside vehicles and equipment. They are particularly vulnerable to being struck by equipment. Every person on the site has the responsibility to be vigilant and work safely
- Require all workers to wear Hi-viz apparel

Two “Struck-By” Hazards

- Workers Killed by Motorists
- Workers Killed by Construction Trucks and Equipment



MORE WORKERS ARE KILLED BY CONSTRUCTION VEHICLES THAN BY MOTORISTS

Work Zone Crashes

Work Zone Crash Frequency

- On average, in 2015:
 - A work zone crash occurred once every **5.4** minutes
 - Every day, **70** work zone crashes occurred that resulted in at least one injury
 - Every week, **12** work zone crashes occurred that resulted in at least one fatality

Crash Severity

- In 2015 the distribution of work zone crashes by severity included:
 - 73.0% (70,499) of work zone crashes were Property Damage Only (PDO)
 - 26.4% (25,485) of work zone crashes involved at least one injured party
 - 0.7% (642) of work zone crashes involved at least one fatality
 - This distribution is very similar to non-work zone crashes.

Construction Vehicles are the Greatest Hazard

- Compliance with the MUTCD and OSHA regulation is a necessary
- The interaction between workers on foot and construction trucks and equipment is the single biggest hazard
- There are several hazards workers should be aware of to enable them to protect themselves against work zone hazards



Vehicles Frequently Enter and Exit

- The constant movement of vehicles can create hazards
- ITCPs can communicate the need to keep entry and exit points free
- Start each day with a risk assessment discussion with workers and subcontractors (including employees)



Workers on Foot Labor in Close Proximity to Large Vehicles

Note the size of workers on foot in relation to the size of the construction equipment and vehicles.



Blind Spots

- Blind Spots are the locations around equipment



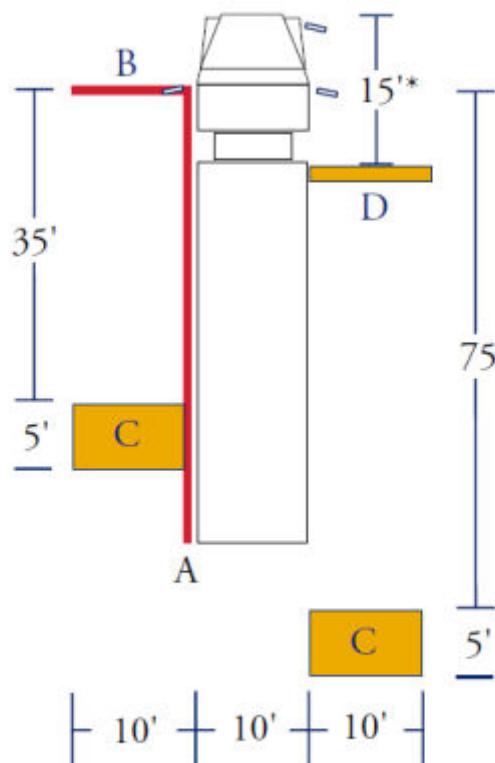
Behind the Vehicle



Outside Mirror Range

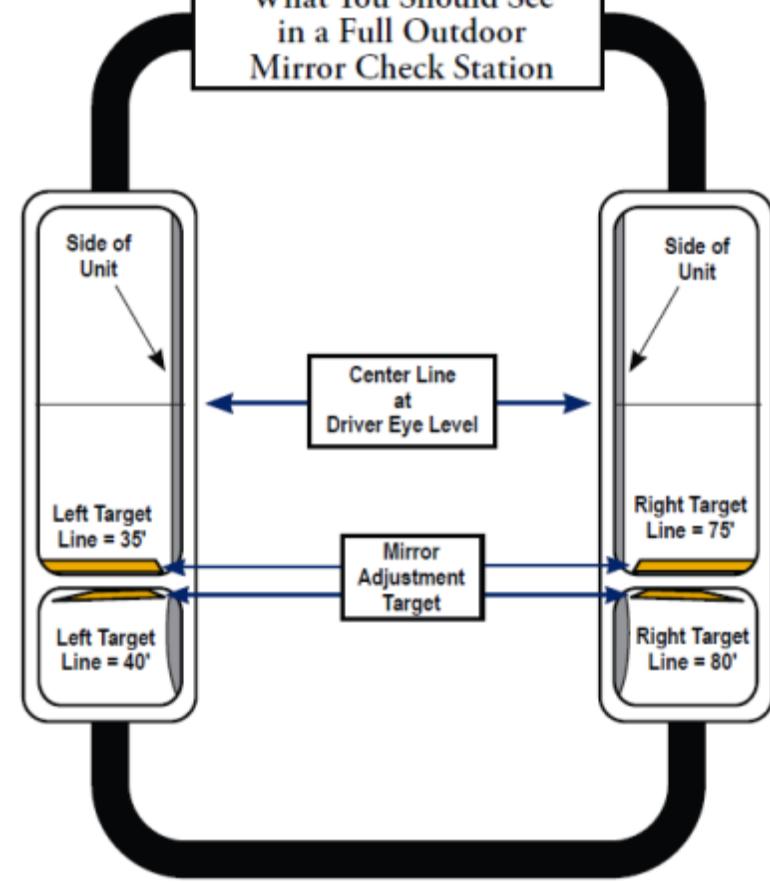
Mirror Check Station

Setting up a Mirror Check Station



* Measurement for fender mounted convex mirror is from mirror.

What You Should See in a Full Outdoor Mirror Check Station



Workers Are Vulnerable in Blind Spots



SITUATIONAL AWARENESS – INCIDENT PREVENTION

- Stay focused
 - *Mind on Task*
- Keep your eyes and ears open
 - *Eyes on Task, Line of Fire, Balance/Traction/Grip*
- Identify & assess new hazards as you see them
- Be aware of change and stop to re-assess
 - *THINK BIG PICTURE*
- Communicate with the team and others
- If in doubt stop the job and re-assess

- Perception
 - Gathering or collecting information
- Comprehension
 - Interpreting information
- Projection
 - Anticipating future status

What is a “hazard”?

An unsafe condition or practice
that could cause an injury or illness
to an employee.

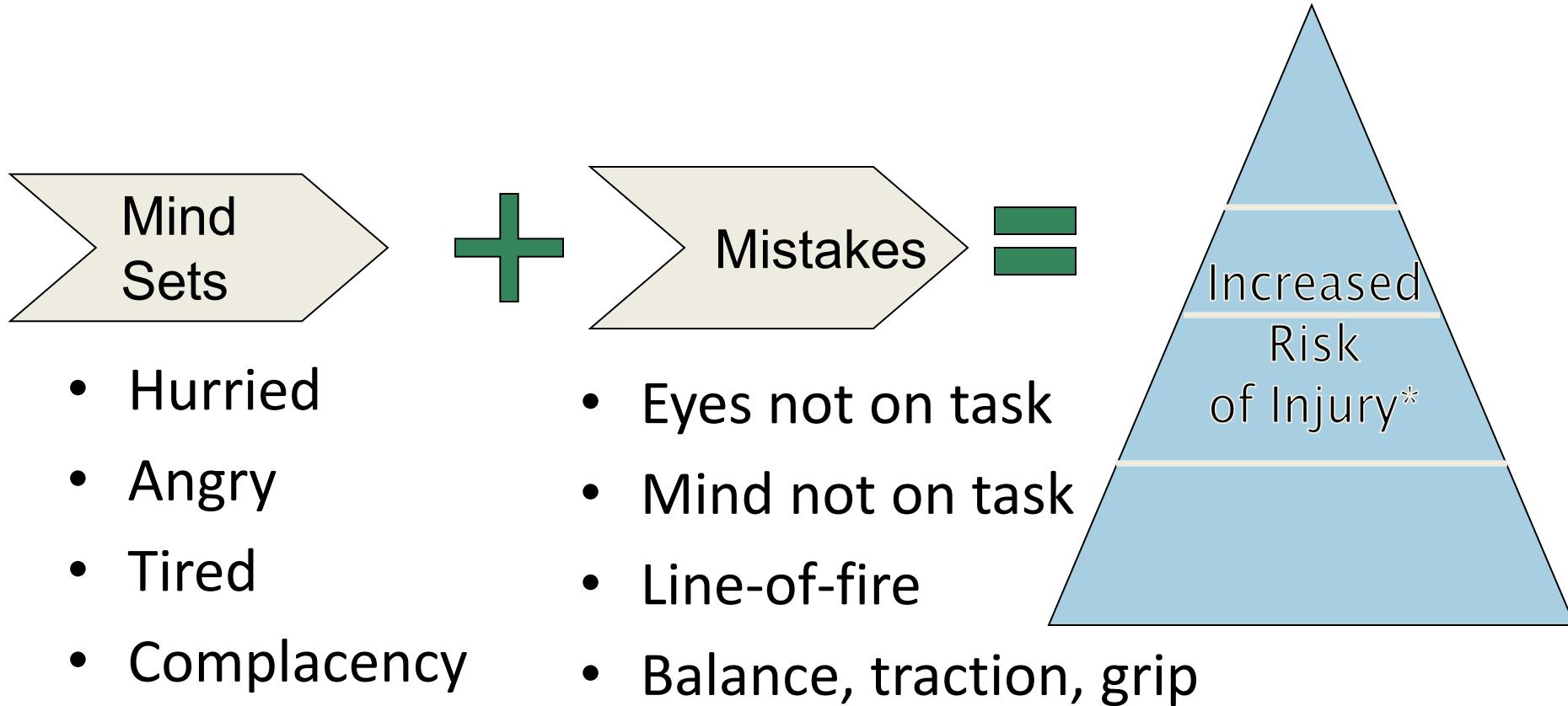


*How can a person be a
walking hazardous
condition?*

Mistakes / Errors

- When employees make mistakes increasing the risk of injury it is usually because they were either rushing, frustrated, fatigued or complacent.

CONDITIONS



* Over 90% of all injuries at home, at work or on the road are caused by these error patterns.

States of Mind

- Hurried - When you exceed the pace at which you normally perform the task
- Angry - Caused by relationships inside and outside of the workplace
- Tired - Too tired to do the job safely
- Complacency - Familiar enough with the hazards to become considerably less concerned over time

Critical Mistakes

- Anyone can get hurt if they are not looking at what they are doing/paying attention
- While this may appear to sound like “common sense”, unfortunately common sense is not always common practice

Eyes not looking at what you're doing

Not looking where you are going or what is coming your way. Includes not moving your eyes before moving your body or not being able to see where you are stepping, where your hands are reaching into, etc.

Not thinking of the job

Not concentrating on the job. Being unaware of dangers. Forgetting things, making more errors than usual, going on “auto-pilot”, “drifting away”.

- What time do I get the kids?
- Why can’t I break 100 for 18 holes?

Standing in the Line-of-Fire

Being conscious of where you are or where you are going in relation to the direction of the hazard.

- If the driver doesn't see me, where does the vehicle go?
- Which way will the drunk drive?

Balance/Traction/Grip

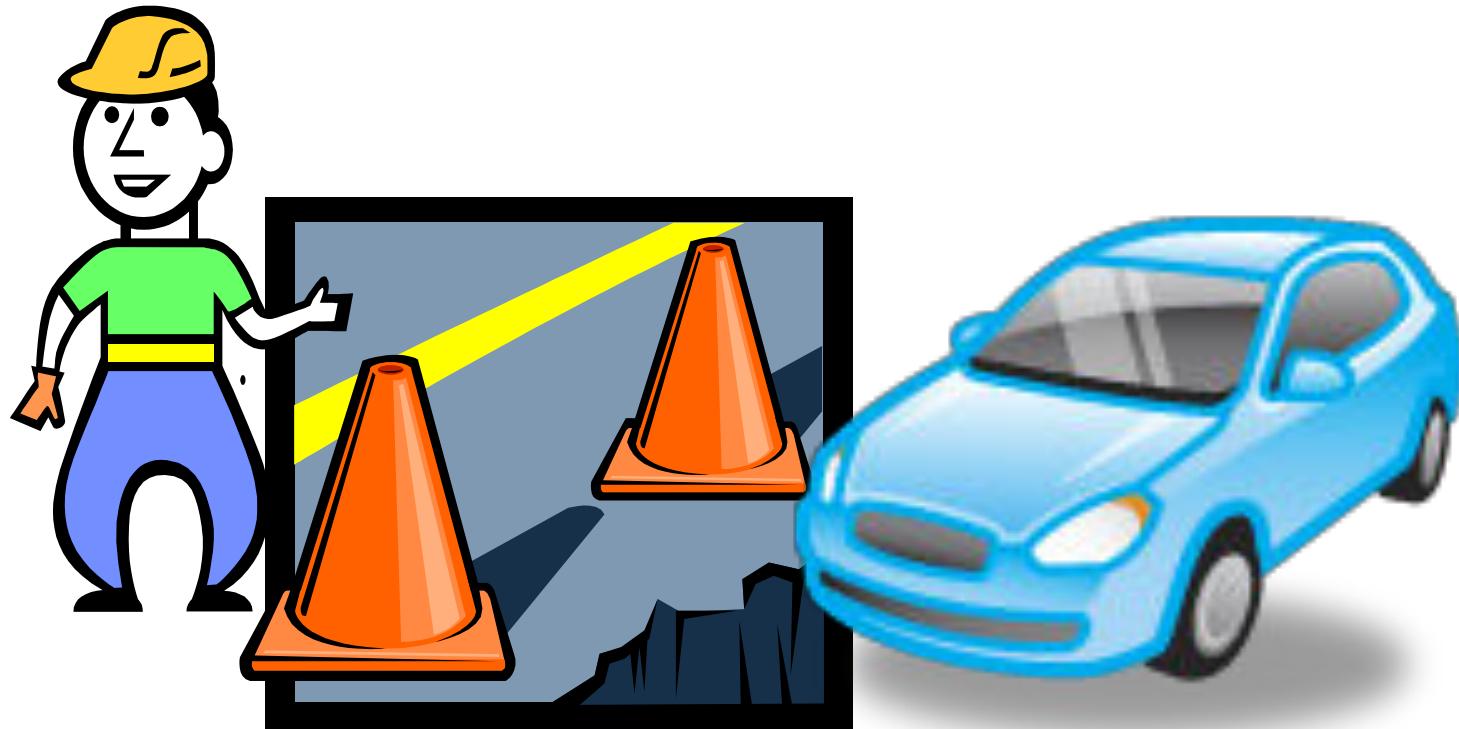
Doing something that could cause you to lose your balance, traction, or grip. This can include not wearing good footwear/gloves, not having a good grip in the first place, or not seeing or thinking about the hazard.

Workers Killed by Motorists

- As noted previously, the primary cause of worker deaths in roadway construction is caused by workers being struck by construction vehicles and equipment.
- The second highest cause is workers being struck by motorists or when a vehicle crashes.

Two Ways Workers Are Killed by Motorist

- Workers Enter the Traffic Space
- Motorists Enter the Work Space



Workers Killed

- Motorists are likely to enter the work space when:
 - Workers are not visible to motorists
 - Motorists are surprised by the work zone and Temporary Traffic Control set up
 - Motorists ignore warnings
 - TTCDs are confusing/not compliant



Killed by Motorists

- Motorists are likely to enter the work space when:
 - Drivers are distracted or impaired (phones, food, drugs, alcohol, drowsy, etc.)
 - Traffic is traveling at high speed through the work zone
 - Equipment / work zone lighting



Risky Worker Behavior

- Workers stray into traffic space
 - Preoccupied by work
 - Become “comfortable” in dangerous environment
 - No convenient access to and from work space
 - rest rooms
 - food and water
 - shade/breaks
 - other local work areas
 - staging of company and personal vehicles
 - Workers cross traffic lanes (especially in high-speed locations)

How Can We Prevent Deaths Caused by Motorists?

- Temporary Traffic Control Devices Must be Set Up Properly
 - Comply with MUTCD or corresponding state document
 - Inspect and maintain TTCDs
 - Ensure only a qualified person makes necessary modifications
- Create Safe Procedures for Deployment and Retrieval of TTCDs
- Ensure sufficient TTCDs for all parts of the project (ramp geometry, exits, closures, etc.)

How Can We Prevent Deaths?

- Workers Should Be Aware of TTCDs in their work location.
- Workers should be trained to notify supervisor immediately if devices are:
 - Not in proper position
 - Damaged or dirty
 - Not being observed or recognized by motorists
- Workers may correct misaligned devices if it is safe for them to do so and they understand where the device is supposed to be situated.

Workers Should be Aware of Basic TTC Rules



ITCP Research Recommendations

1. Ensure that there is a detailed safety plan
2. Daily safety meetings should be conducted
3. Spotters should have direct communication
4. A crew member should be designated to communicate with the rest of the crew when the paving machine is backing up.
5. A crew member should be designated to communicate with the rest of the crew
6. Truck drivers need instructions on how to enter and exit the work zone
7. All others on site should also be made familiar with the ITCP
8. For night work, light standards need to be placed

ITCP Research Recommendations (cont'd)

9. All safety vests should be checked for reflectivity for night operations
10. Establish desirable operating speeds
11. Seat belts should be required for all vehicles
12. Establish a specific lock-out, tag-out program for use when servicing the machinery

Thank You

- Questions????

EXCAVATION & TRENCHING AWARENESS FOR THE CONSTRUCTION INDUSTRY

Disclaimer

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Objectives

- Identify the laws, regulations, and standards as they apply to excavations
- Describe soil classification and the testing used to determine type
- Describe protective systems used in excavations
- Discuss the hazards found in trenches
- Describe the role of the competent person

Facts

- Excavating is recognized as one of the most hazardous construction operations
- Cave-ins can happen without warning
- All of the fatalities and injuries could have been prevented

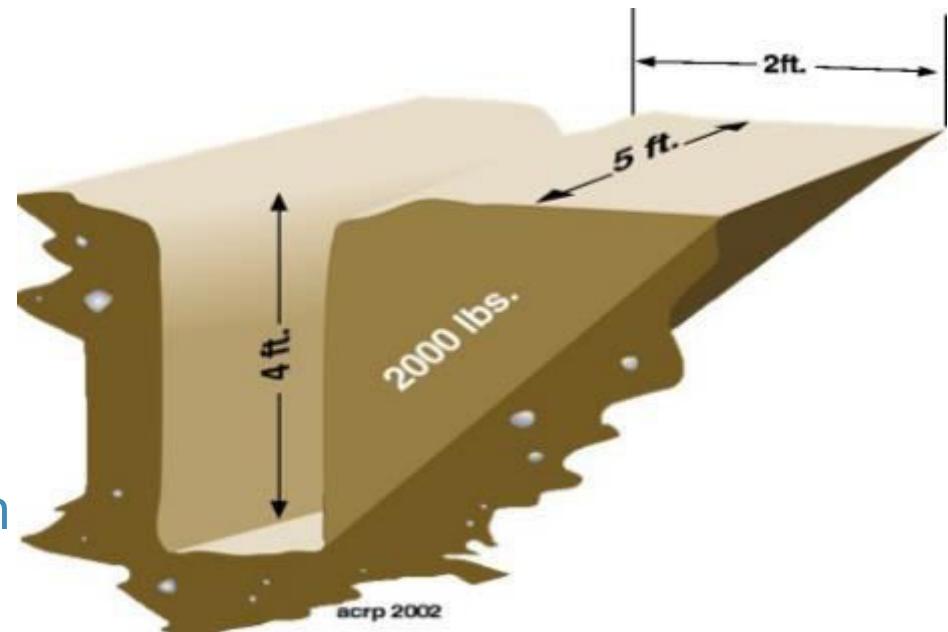


Did you know?

The fatality rate for excavation work is 112% higher than the rate for general construction.

Collapse Forces

- 24 inches of soil on a person's chest weighs 750-1000 lb.
- 18 inches of soil covering a body weighs 1800-3000 lb.
- Shear wall collapse speed is 45 mph
- 1 cubic foot of soil can weigh from 100 to 125 lb.



Collapsing Dirt

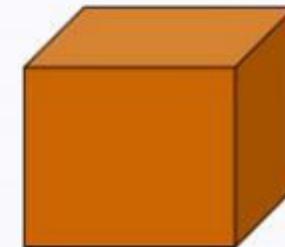
Imagine this coming down on top of you....

Weight of a Volkswagen



2,785 Pounds

Weight of one cubic
yard of soil



2,700 Pounds

The Top Five Trenching Hazards

Cave – ins

Overhead Electric Line Contact

Falls into Excavations

Equipment Falling into Excavations

Explosion / Fire / Electrocution

Legal Aspects

OSHA [29 CFR 1926.650 - 652]

- Excavation standard applies to all open excavations made in the earth's surfaces including trenches, all surface encumbrances that would create a hazard, and protective systems

General Requirements

OSHA1926.651

- (a) Surface encumbrances
- (b) Underground installations
- (c) Access & egress
- (d) Exposure to vehicle traffic
- (e) Exposure to falling loads
- (f) Warning systems for mobile equipment
- (g) Hazardous atmospheres
- (h) Protection from hazards associated with water accumulation
- (i) Stability of adjacent structures
- (j) Protection from loose rock or soil
- (k) Inspections
- (l) Fall protection

General Requirements

Surface Encumbrances

- All surfaces encumbrances that are located so as to create a hazard to employees shall be removed or supported as necessary to safeguard employees

Underground Installations

- Utility companies shall be contacted with in established local response times
 - Advised of proposed work
 - Asked to establish location of utility
 - When request cannot be met, employer may proceed with caution with detection equipment of an acceptable means to locate utility

General Requirement

Underground Installations

- While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees

Access & Egress

- Structural ramps
 - Used by employees shall be designed by a competent person
 - When used for equipment shall be designed competent person qualified in structural design
- Stairway, ladder, ramp or other safe means of egress require no more than 25 ft of lateral travel for employees in excavations that are 4 feet or more in depth
- Ladders must be secured and extend a minimum of 36 inches above the landing

General Requirement

Exposure to vehicle traffic

- Employees exposed to public vehicle traffic shall be provided with and wear warning vests or other suitable garments
 - Marked or made with reflectorized or highly visible material
 - Requiring a designated, trained flag person along with signs, signals, and barricades when necessary

Exposure to falling loads

- No employee shall be permitted underneath loads handled by digging or lifting equipment
- Stand away from vehicle being loaded or unloaded to avoid being struck



General Requirements.

Warning systems for mobile equipment

- When operator does not have clear view of edge of excavation
- Warning system shall be utilized
 - Barricades
 - Hand or mechanical signals
 - Stop logs



General Requirements..

Hazardous Atmospheres

- Testing and controls
 - To prevent harmful levels of atmospheric contaminants
 - Less than 19.5% or more than 23.5% oxygen
 - Atmosphere tested before entry
 - Adequate precautions shall be taken
 - Ventilation
 - Proper respiratory protection
 - Testing done often as necessary



Emergency Rescue Equipment

- Rescue equipment
 - Breathing equipment
 - Safety harness and line or basket stretcher
 - Must be readily available
 - Must be attended
 - Bell-bottom pier holes, deep and confined footing excavation shall wear a harness with a lifeline securely attached to it

General Requirements...

Water Accumulation

- Employees shall not work in excavations where there is accumulated water, or where water is accumulating, unless adequate precautions have been taken, to protect employees.



General Requirements....

Stability of adjacent structures

- Where stability is endangered by excavation operations
- Support systems such as shoring, bracing or underpinning shall be provided
- Sidewalks, pavement and appurtenant structures shall not be undermined unless support systems are used to protect employees



General Requirements.....

- Protection from loose rock and soil
- Hazard from falling or rolling from excavation face
 - Scaling to remove loose materials
 - Installation of protective barricades
 - Other means (retaining devices)
 - 2 feet from edge of excavation



General Requirements....

Inspections

- Daily and before start of work
- As needed throughout the shift
- After snowstorms, windstorms, thaw, earthquake
- Employees shall be removed until precautions have been taken
- When fissures, tension cracks, sloughing undercutting, water seepage, bulging at the bottom
- Change in size, location or placement of the spoil pile
- Indication of movement in adjacent structures



General Requirements

Fall protection

- If walkway provided
 - Where employees permitted to cross, guard rails provided where 6 feet or more above lower levels
 - Fall protection standard

Requirements of Protective Systems

- Employees shall be protected from cave-in by an adequate protective system except;
 - Entirely in stable rock
 - Less than **5 feet** in depth with no indication of cave-in



Protective System Designs using Manufacturers Data

- Deviation will only be allowed after manufacturer issues specific written approval
- Written form at the job site during construction
- Trench Boxes: Make sure all cross members and safety pins are used when necessary



Installation & Removal

- Excavate to no greater than 2 feet below – only if system is rated at full depth and there are no indications of a loss of soil from behind or below the support system
- Employees are not permitted to work below other employees unless adequately protected from falling, rolling, sliding material
- Employees are not allowed in shields when installed, removed or moved vertically

Not a certified trench box. Made by laborers on site

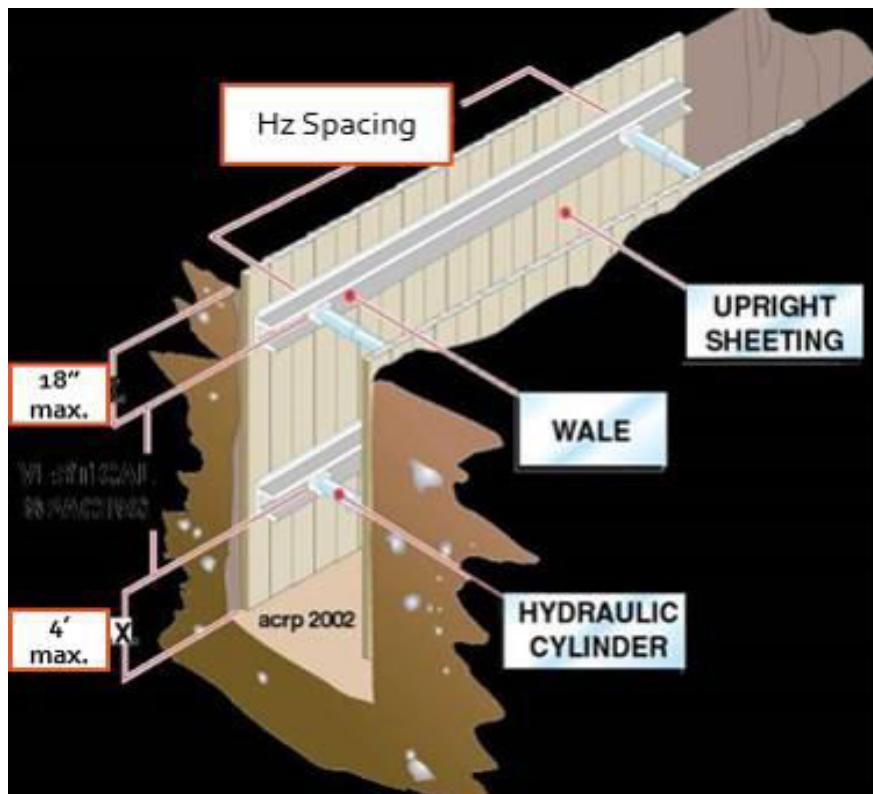


**Good – easy system to use, a lot of work done quickly.
Bad – not tall enough, no ladder**

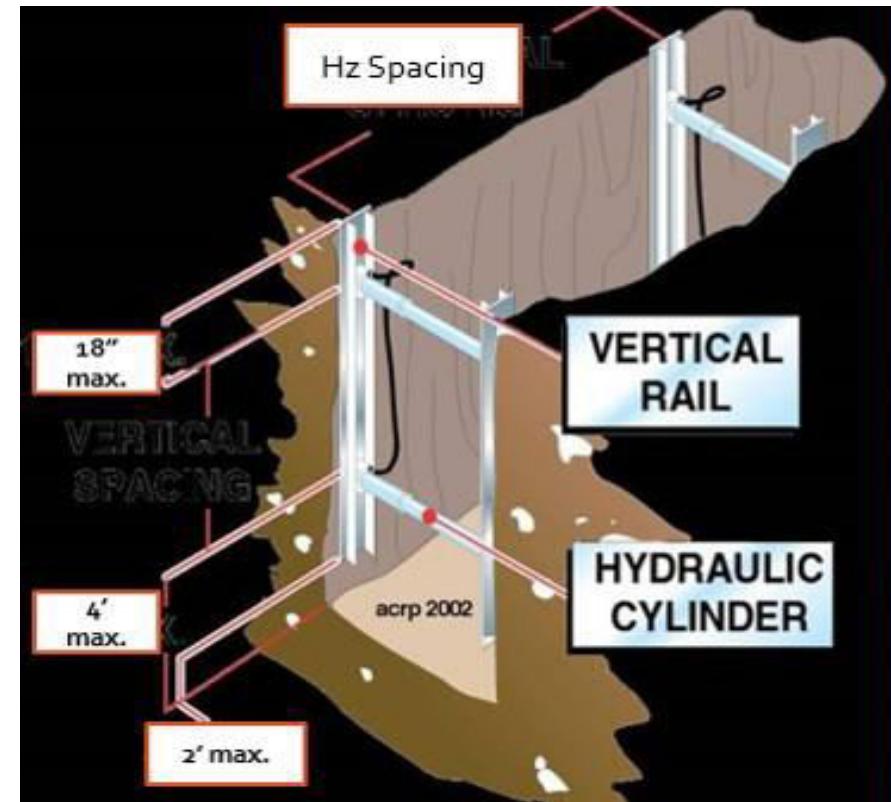


Horizontal and Vertical Shoring Dimensions

Hz. Shoring Dimensions



Vt. Shoring Dimensions



SHIELD USAGE AND SAFETY

Shields are used to protect workers from cave-ins, not to provide support for the trench.

- Manufacturer's Data must be present at work site.
- Top of the shield must extend to the top of the trench.
- If used with sloping, top of shield must extend **18 inches above** vertical trench walls.
- Shields may be stacked, provided the bottom one is rated for the total depth of the trench.
- The trench may be dug **2 feet lower than the shield bottom, but the shield must be rated for that depth.**
- Backfill around the box to prevent lateral movement.

Soil Classifications

Stable rock

- Natural solid mineral material that can be excavated with vertical sides and remain intact while exposed. Examples are granite and sandstone.

Type A

- cohesive soils with an unconfined compressive strength of **1.5 tons per square foot [tsf]**
 - Clay, silty clay, sandy clay
- **No soil is type A if;**
 - Fissured
 - Subject to vibration
 - Previously disturbed
 - Seeping water
 - Part of a sloped or layered system of four horizontal to one vertical

Soil Fissuring



To Much Water?



Weight and Vibration



Soil Classification

Type B

- cohesive soils with an unconfined compressive strength greater than **0.5 tsf but less than 1.5 tsf**
- Silt, silt loam, angular gravel
- soils that are fissured, or subject to vibration

Type - C

- cohesive soils with a unconfined compressive strength of **0.5 tsf or less**
- gravel, sand, loamy sand, submerged soil, soil from which water is freely seeping

Basis of classification

- The classification of deposits shall be made based on the results of at least one visual and one manual analysis conducted by a competent person

Acceptable visual test

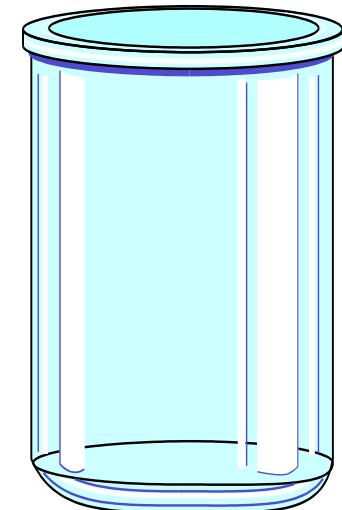
- Determine qualitative information on site in general
- Soil adjacent to excavation
- Soil forming the sides of the open excavation
- Soil taken as samples from excavated material
- Estimate range of particle sizes
- Observe evidence of surface water
- Water seeping from the sides
- Location of the level of the water table
- Sources of vibration that may affect stability
- Evidence of previously disturbed soil

Acceptable manual test

- Plasticity
- Ribbon and thread test
- Dry strength test
- Thumb penetration test
- Other strength test
- Pocket penetrometer
- Hand-operated shearvane

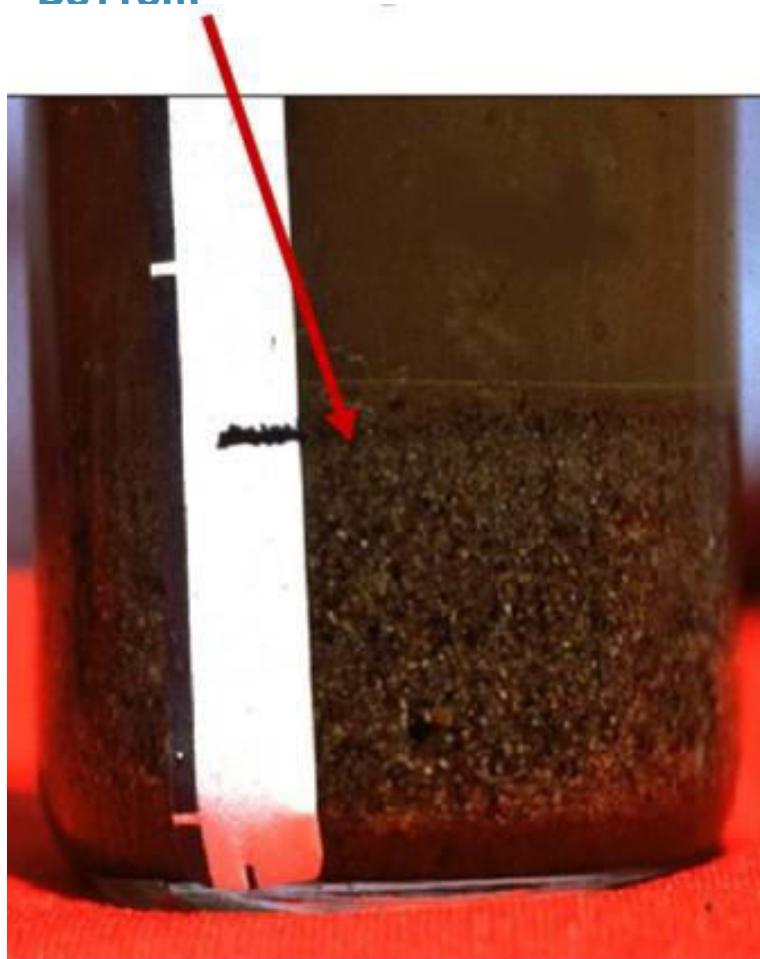
Field Sedimentation Test

- Determines sand content
- Used only on sandy soils
- Flat bottom container - at least 7 inches high (old olive jar)
- 1 1/2 to 2 inches of soil
- Place soil in the glass jar
- 5 inches of water on top of soil

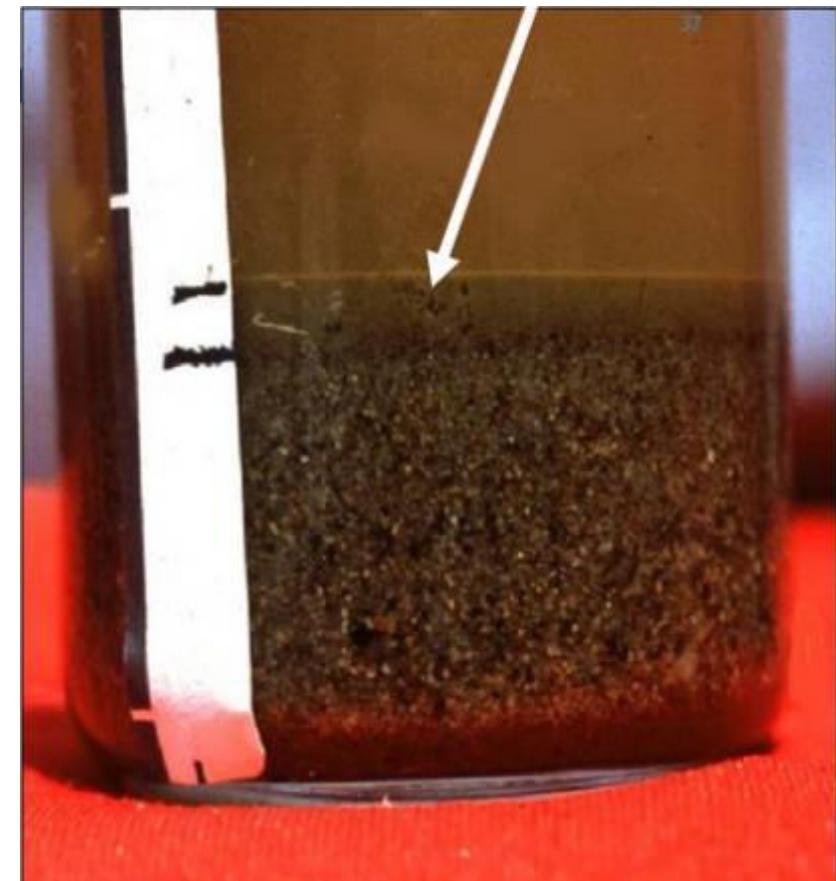


Example

After 30 seconds granular sand type material settles at the bottom



After 3 minutes silt type material settles on top of the sand

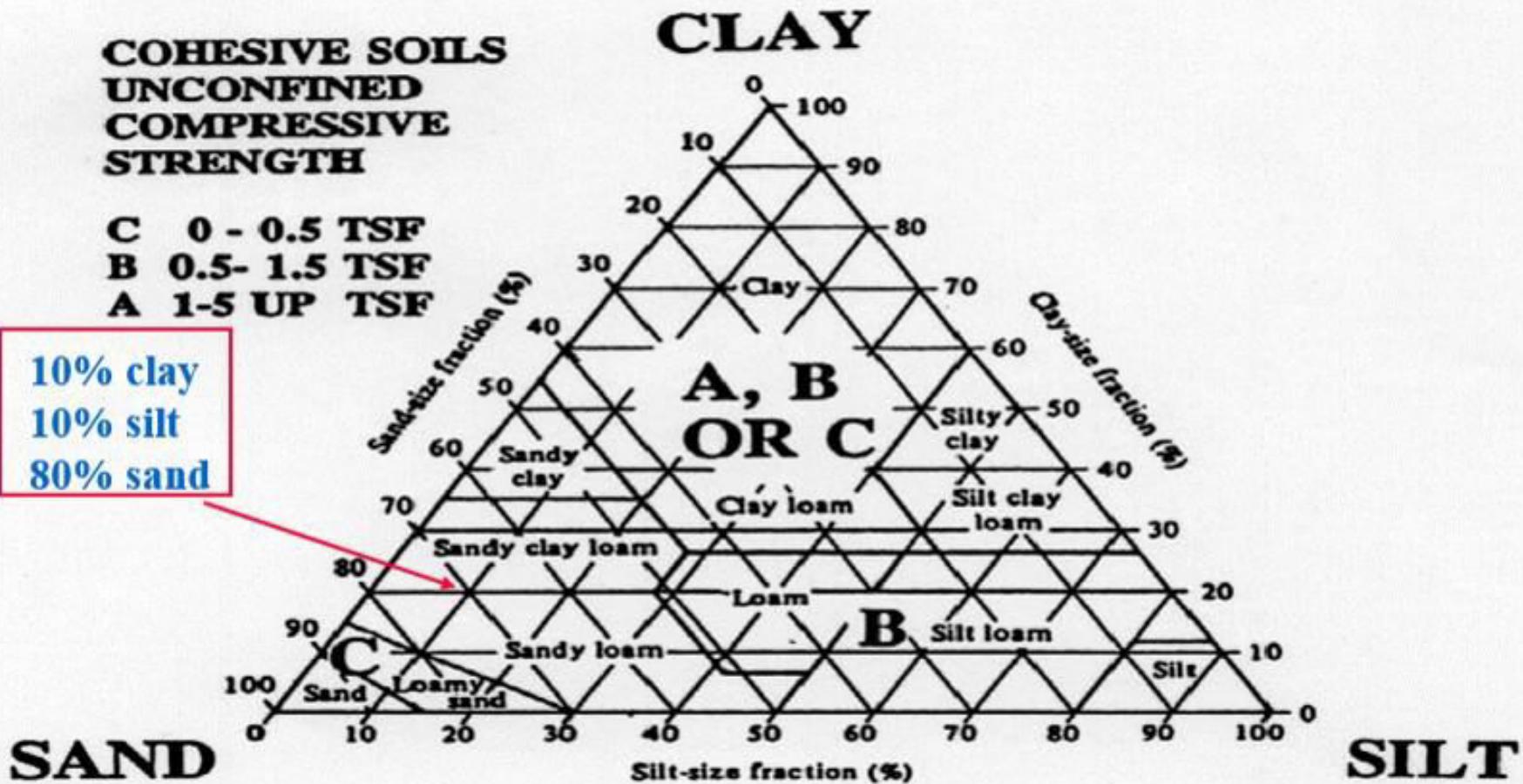


Compressive strength

COHESIVE SOILS UNCONFINED COMPRESSIVE STRENGTH

C 0 - 0.5 TSF
B 0.5- 1.5 TSF
A 1-5 UP TSF

10% clay
10% silt
80% sand



The Ribbon Test

- ▶ Run only on that part of the soil which passes # 40 sieve
- ▶ Mix soil + water to make into plastic mass
- ▶ Roll mass into cylindrical shape 1/2 to 3/4 inch diameter
- ▶ Lay across palm of hand
- ▶ Press between thumb and second joint of index finger



The Ribbon Test (continued)

- ▶ Pass through thumb
- ▶ Squeeze until it takes the shape of a $1/8$ to $1/4$ inch thick strip
- ▶ Allow to hang freely from hand



The Ribbon Test

- ↳ Clay loam will barely ribbon and break easily
- ↳ Clay = relatively long ribbon 6 to 8 inches or more
- ↳ More clay = longer and stronger ribbon
- ↳ Silt has tendency to produce short ribbon with broken appearance



Penciling



If a 2 inch or longer thread can be held without breaking,
the soil is cohesive.

Shearvane/Torvane



Measures Soil's Shear Strength

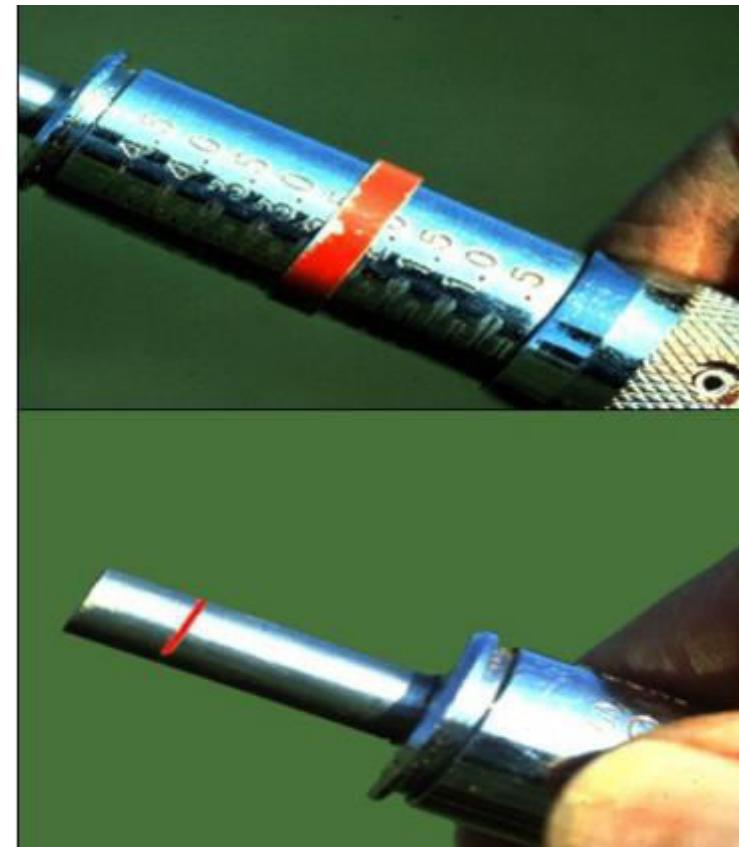
Shearvane/Torvane

- ↳ Select fresh clod or block of undisturbed soil from spoil pile
- ↳ Cut a smooth surface on the clod
- ↳ Insert vanes of device into the soil
- ↳ Retract vanes to show foot imprint
- ↳ Set indicator at zero
- ↳ Hold device firmly against soil and twist in clockwise manner until soil fails in shear



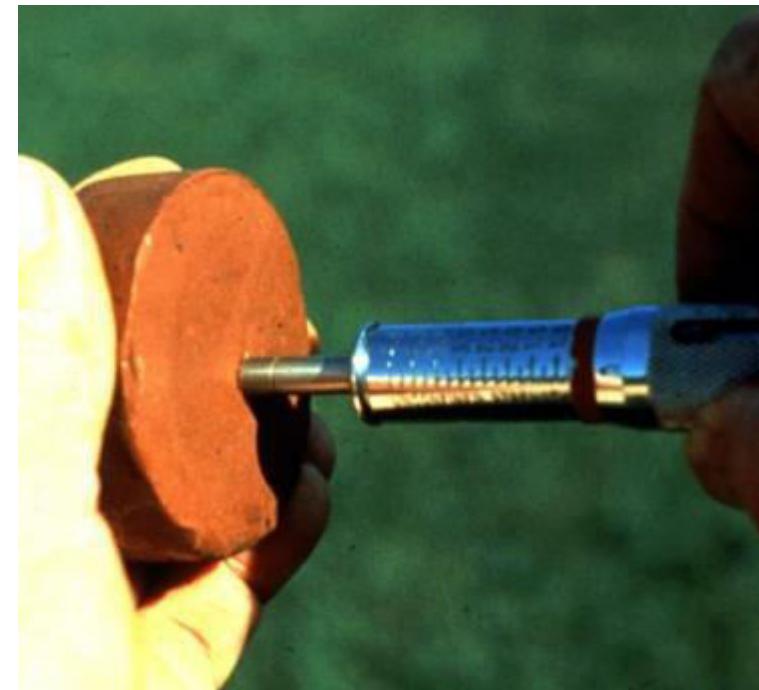
Pocket Penetrometer Test

- Device is designed to work on saturated clay soil
- Measures unconfined compressive strength of soil
- Twice the value of shear strength of same soil
- Note machine ring



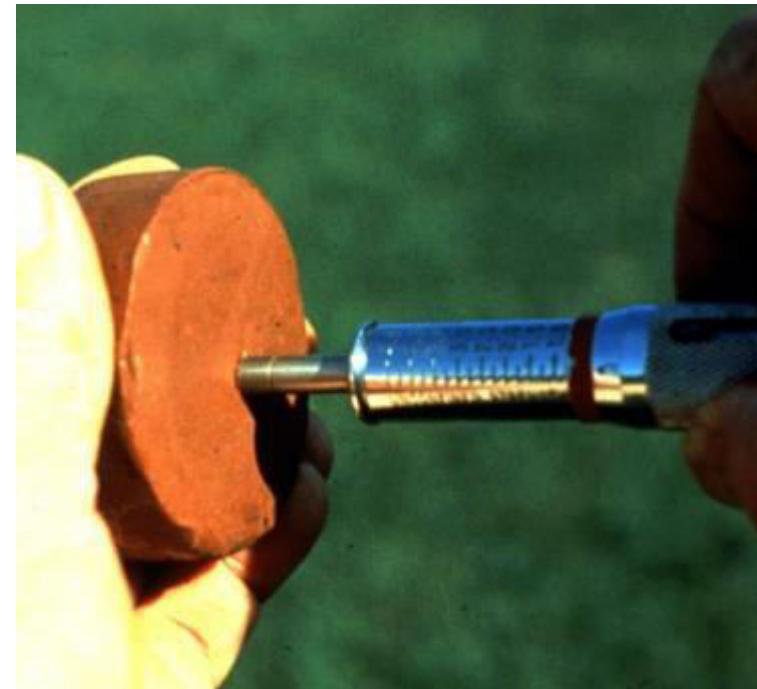
Pocket Penetrometer Test

- To begin test, remove red protective cap, push ring against body so that low side reads “O”
- Slowly insert piston until engraved mark is level with soil



Pocket Penetrometer

- Read strength in tons/sq ft using low side of ring (side closest to the piston end). Record reading and repeat step #1.
- For weak soils, use 1" adaptor foot, multiply by .0625



Thumb Penetration Test



If the thumb makes an indentation in the soil only with great difficulty, the soil is probably Type A.

If the thumb penetrates no further than the length of the thumb nail, it is probably Type B soil.

If the thumb penetrates the full length of the thumb it is Type C soil.

The thumb test is subjective and is therefore the least accurate of the tests.

Soil Strength is Dependent Upon:

- Type of Soil.
- Amount of Moisture in the Soil.
- Whether the Soil Has Been Previously Disturbed.

If Water is Added

- It Brings Additional Weight
 - *Hydrostatic Pressure*
- It Erodes the Trench Wall
 - *Water movement typically moves soil*
- It Can Freeze and Thaw
 - *Resulting in cracks & false cohesion*

REMOVAL OF GROUND WATER IS CRITICAL

SOIL COMPONENTS

- **Clay:**

- Composed of mineral particles less than 0.002 mm in diameter

- **Silt:**

- Individual mineral fragments that range from 0.002 to 0.05 mm in diameter.

- **Sand:**

- Individual rock or mineral fragments that range in diameter from 0.05 to 2.0 mm in diameter.

- **Gravel:**

- Can be either angular or rounded.

COHESIVE SOIL

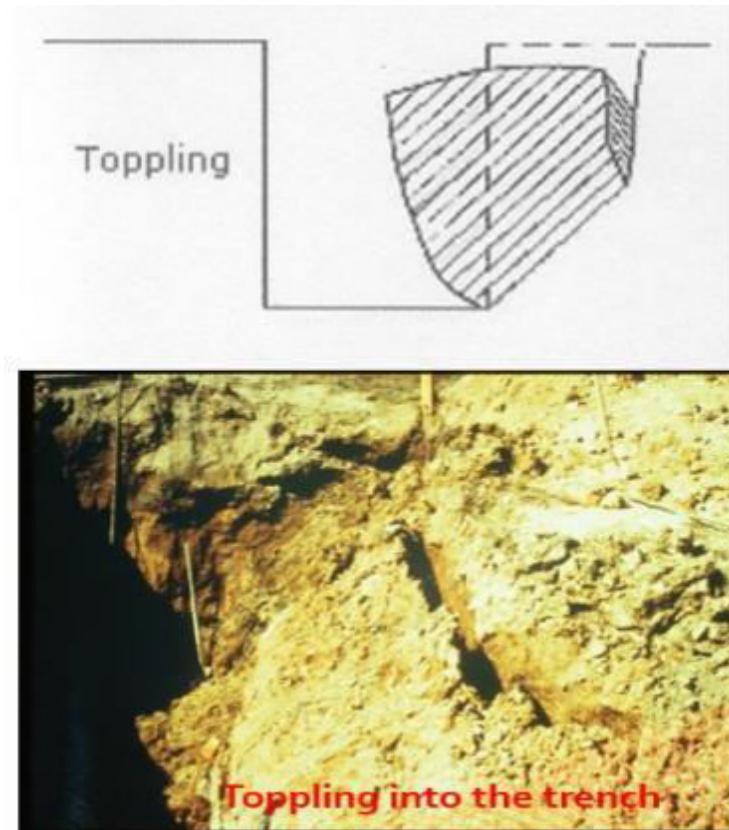
- Soil with a high clay content which has cohesive strength.
- It does not crumble.
- It can be excavated with vertical side slopes.
- It is hard to break up when dry.
- It can be molded.
- It exhibits significant cohesion even when submerged.

GRANULAR SOIL

- Soils that include gravel, sand, silt.
- Very low clay content.
- It has no cohesive strength.
- Some moist granular soils exhibit apparent cohesion.
- It cannot be molded when moist and crumbles easily when dry.

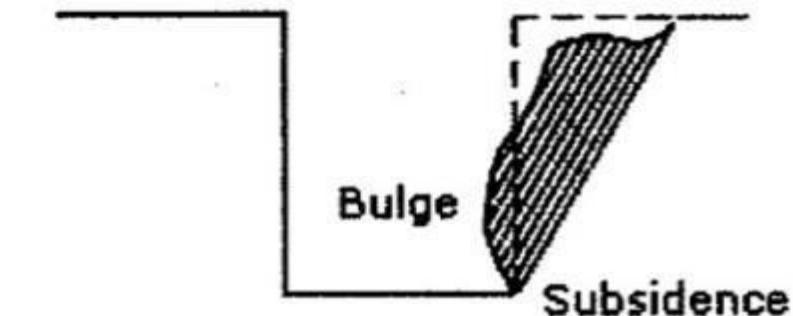
Soil Mechanics

- Toppling occurs when the trench's vertical face shears along the tension crack line and topples into the excavation



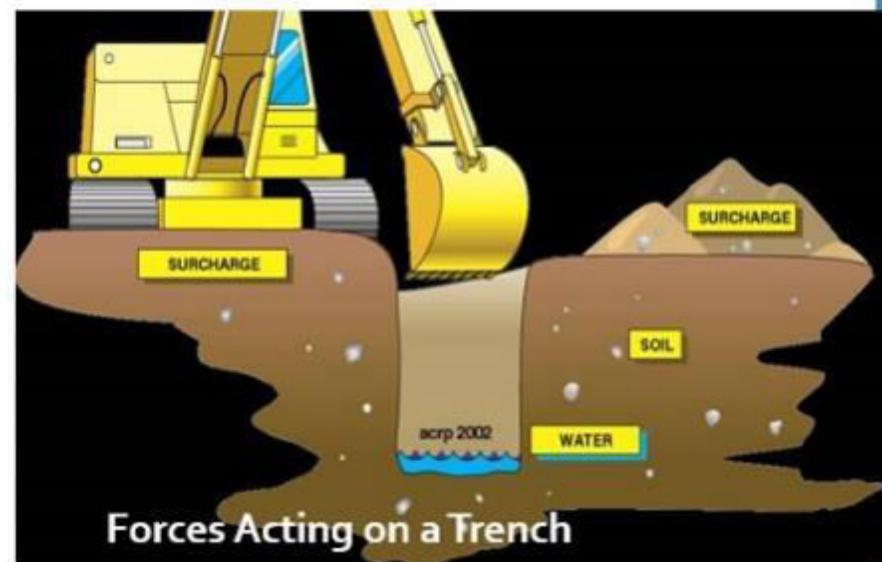
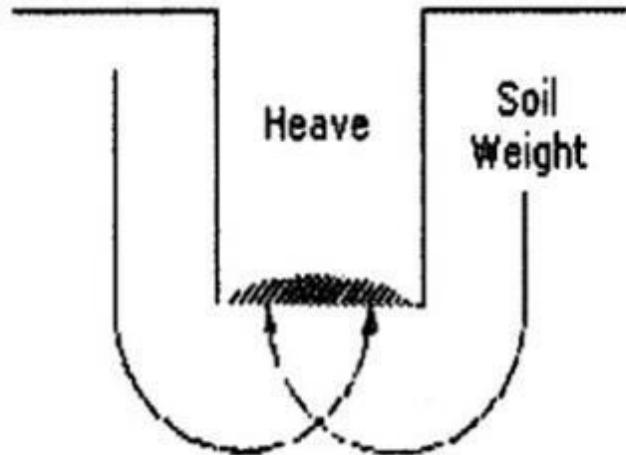
Soil Mechanics.....

- Subsidence and bulging occurs when an unsupported excavation can create an unbalanced stress in the soil which causes subsidence at the surface and bulging of the vertical face
Can the weight of this crane cause bulge or failure?



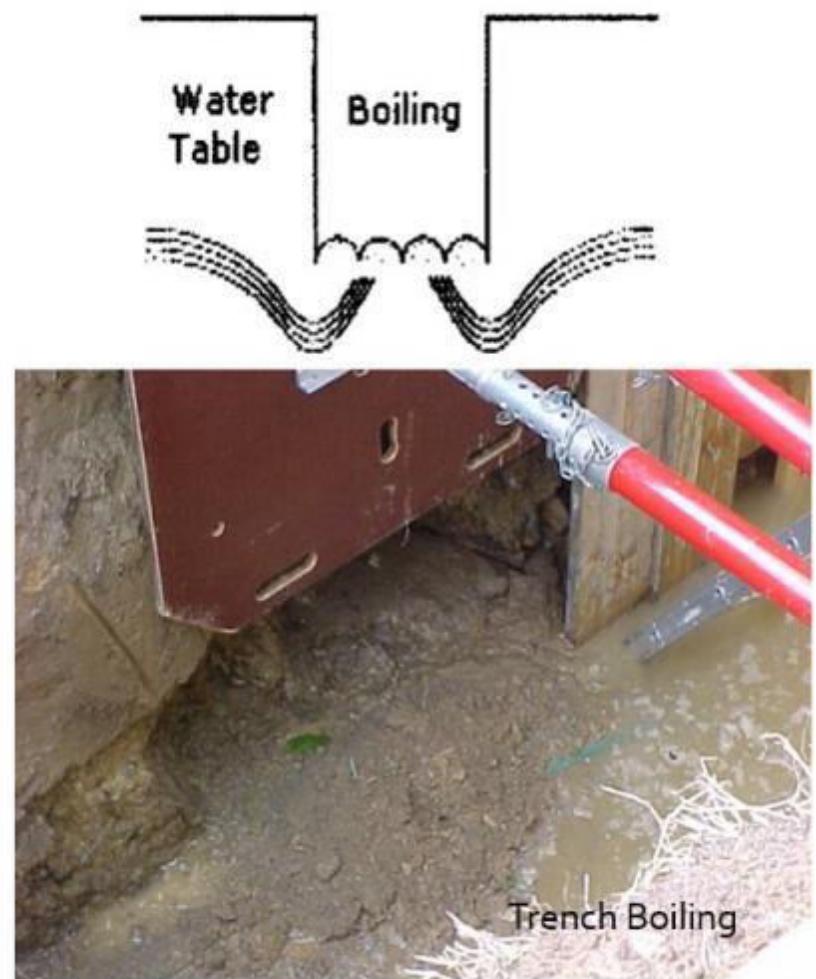
Soil Mechanics.

- Heaving or squeezing is caused by the downward pressure created by the weight of adjoining soil or equipment
- Can occur even when shoring or shielding has been properly installed



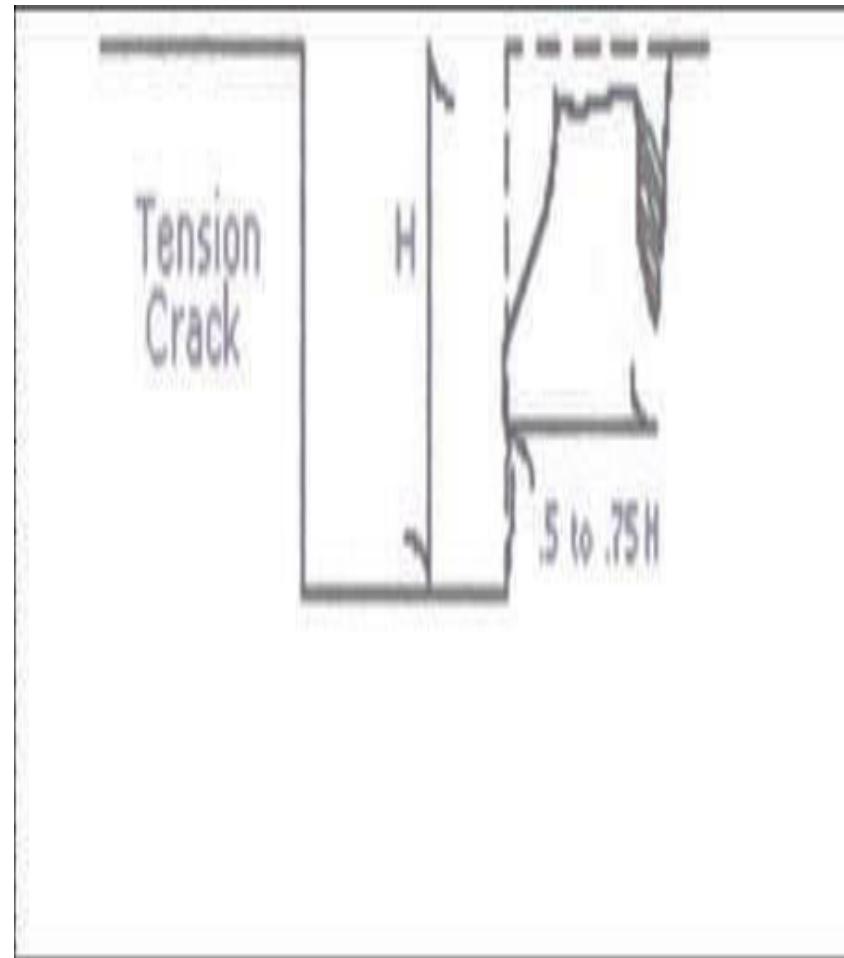
Soil Mechanics..

- Boiling is evidenced by an upward water flow into the bottom of the cut
- High water table is one cause
- Boiling produces a quick condition even when trench boxes are used



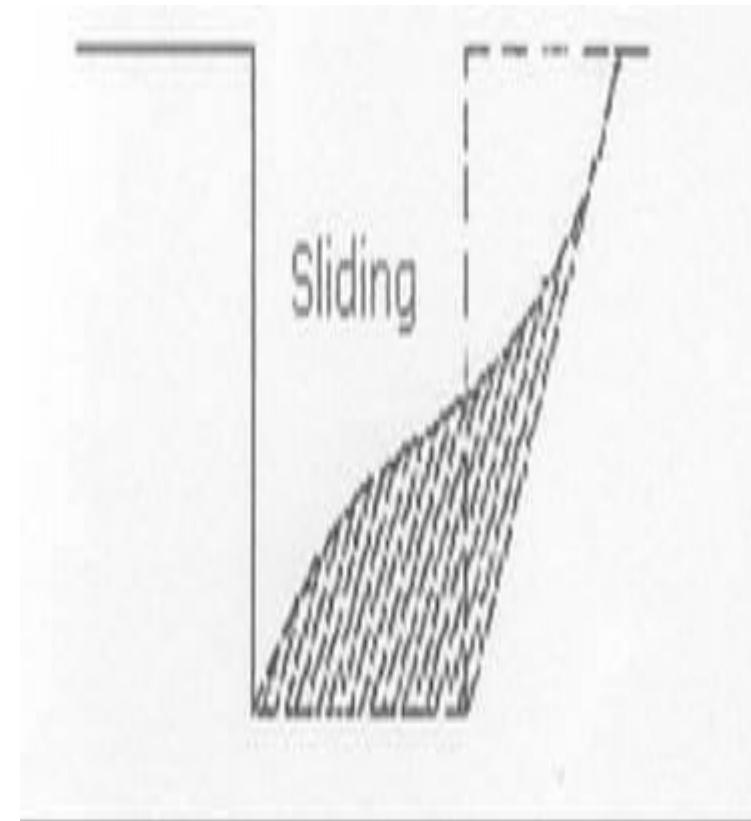
Soil Mechanics...

- Tension cracks usually form at a horizontal distance of 0.5 to .75 times the depth of the trench



Soil Mechanics....

- Sliding or sloughing may occur as a result of tension cracks



Design of Sloping and Benching

- Allowable configurations and slopes
 - Not steeper than **1 1/2 horizontal to 1 vertical**
- Designs using other tabulated data
- Shall be in written form
- Must identify limits of use of the data
- Identify the registered professional engineer who approved



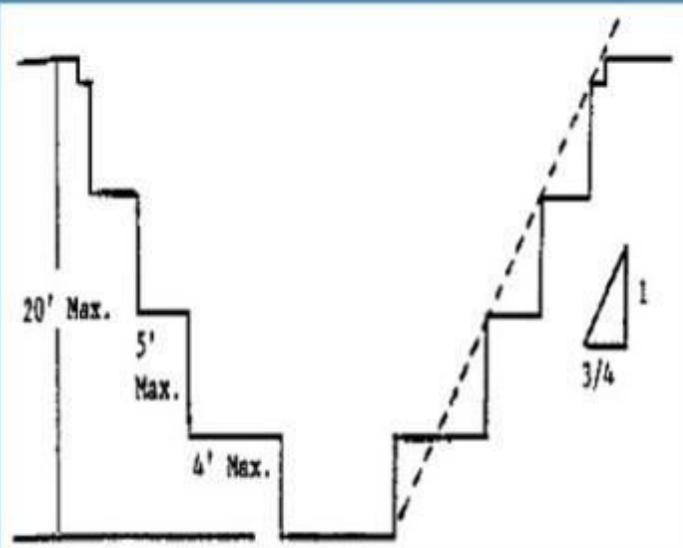
Allowable Slopes

- Soil type Height/depth Slope angle
 - Stable rock Vertical 90 deg
 - Type A $\frac{3}{4}$ to 1 53 deg
 - Type B 1 to 1 45 deg
 - Type C $1\frac{1}{2}$ to 1 34 deg
-
- Type A
 - short term $\frac{1}{2}$ to 1 63 deg
 - max excavation depth 12 ft

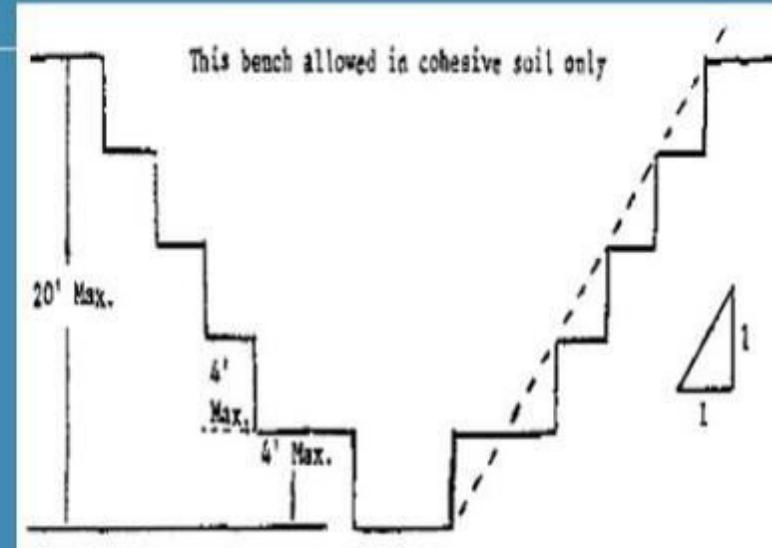
BENCHING

Only to be used on soil types A and B

Type A

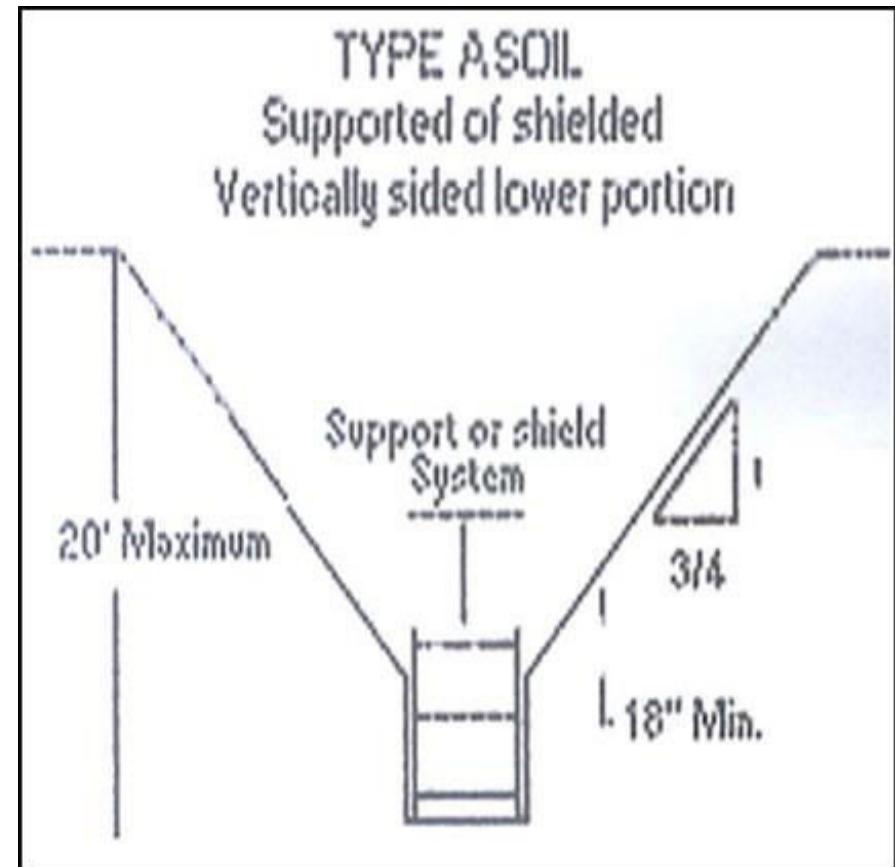


Type B



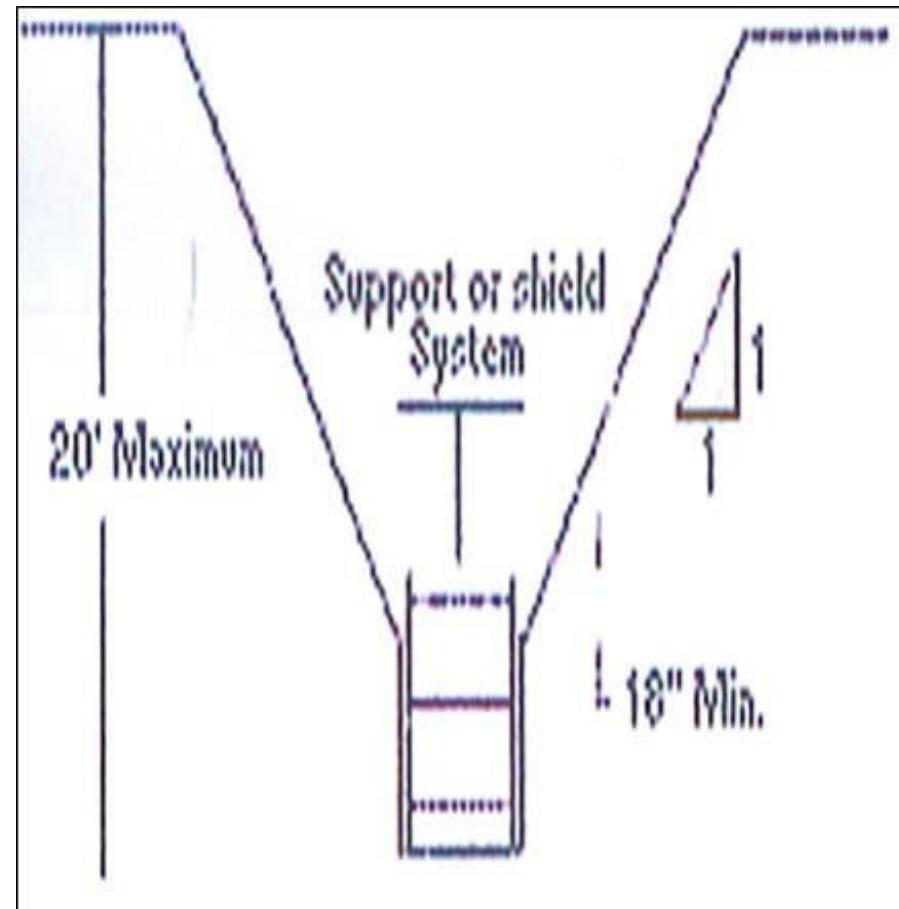
Allowable Slopes.

- Type A soil
- Supported or shielded vertically sided lower portion
- $\frac{3}{4}$ to 1
- 20 feet max depth
- Shield 18 inches above to prevent rollover



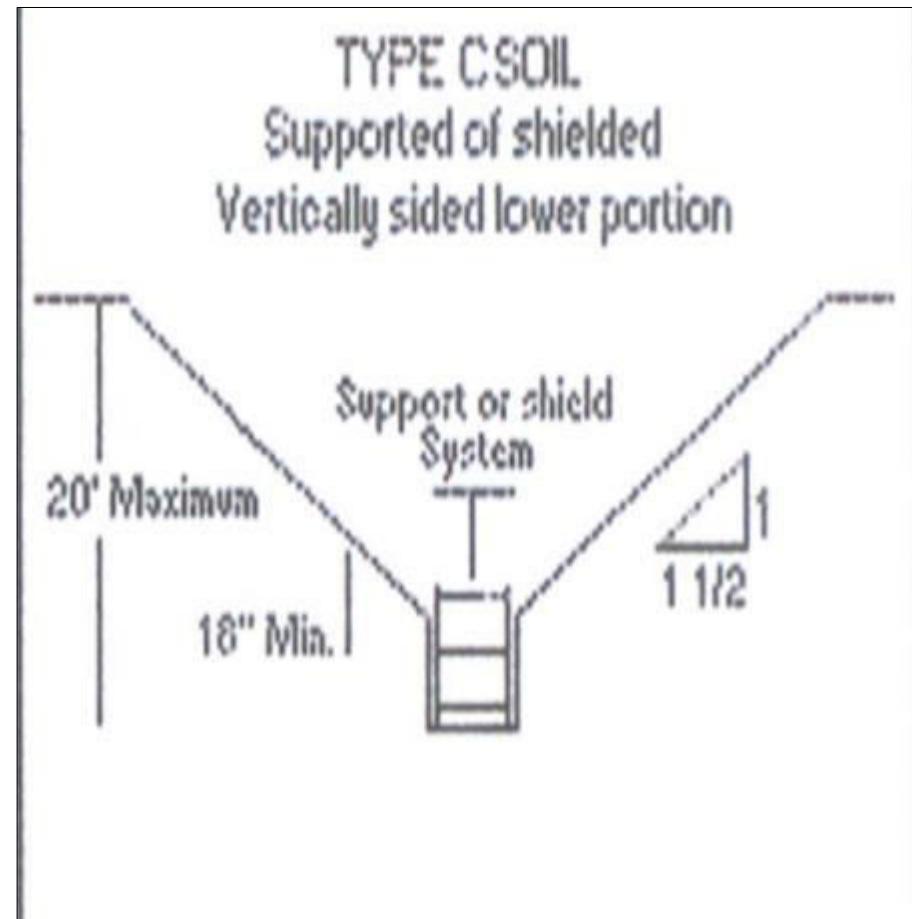
Allowable Slopes..

- Type B soil
- Supported or shielded vertically sided lower portion
- 1 to 1 sloped
- 18 inches minimum at top of shield to prevent rollover



Allowable Slopes

- Type C soil supported or shielded vertically sided lower portion
 - 1 $\frac{1}{2}$ to 1
 - 20 feet max depth
 - 18 inches above to prevent rollover



Other Factors Influencing Cave-Ins

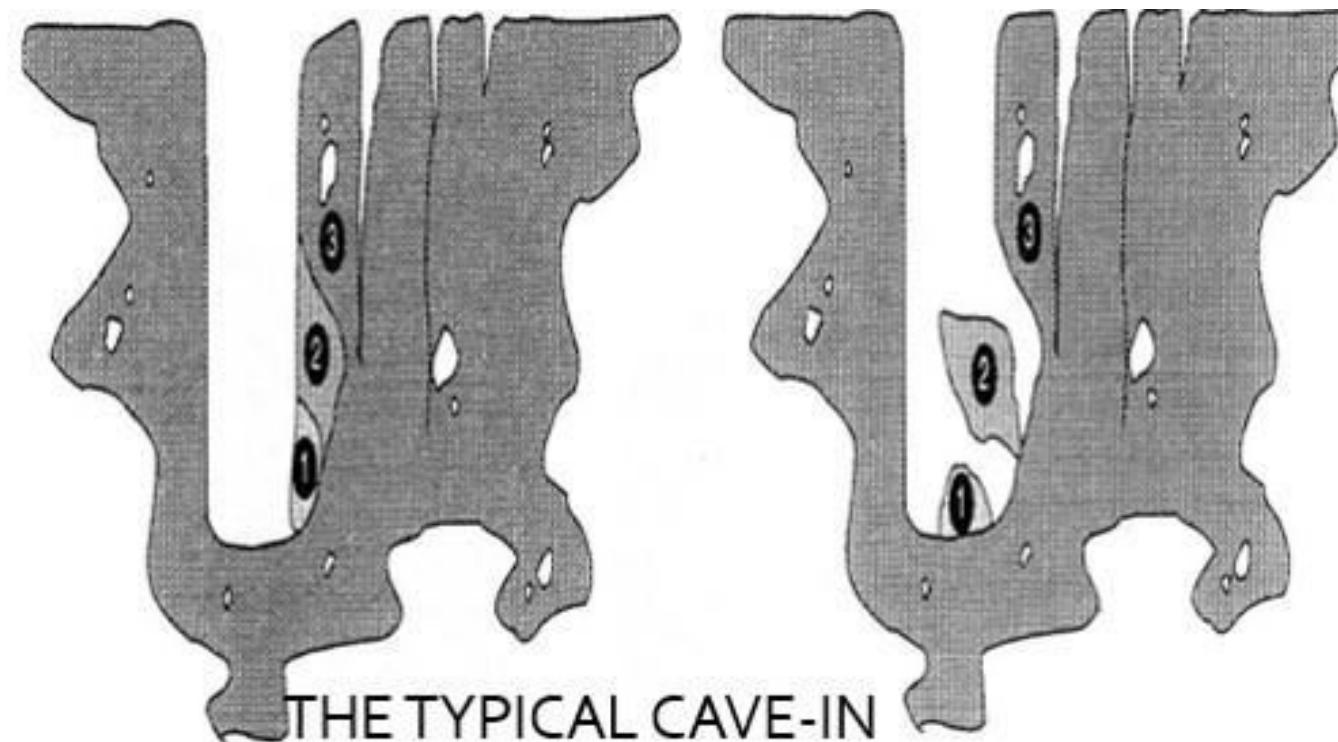
- ✉ Intersecting Trenches
- ✉ Previously Disturbed
- ✉ Vibration
- ✉ Surcharged Load
- ✉ Inclined Layers
- ✉ Drying / Saturation
- ✉ Free standing time

Fallacies And Misconceptions

- Most incidents occur in bad weather
 - False
 - Good weather - crews are more careful in bad weather
- At what depth/width do most incidents occur
 - Between 6-8 ft. deep and less than 6 ft. wide
 - Most utilities found in this area

Fallacies And Misconceptions

- Clay is the least dangerous soil type
 - False
 - Clay looks strong but it is very deceptive - most fatal trench accidents occur in clay soil



Competent Person

- Has specific training in and be knowledgeable about soil analysis, use of protective systems and the requirements of the standard

COMPETENT PERSON MUST BE AWARE OF:

- Falling loads or equipment
- Hazardous atmospheres
- Weather conditions and forecast
- Stability of adjacent structures.
- Surface and overhead encumbrances
- Underground utilities
- Access and egress
- Vehicular traffic
- Continuation of trade activity

KEEP THE JOB SAFE



SO **YOU** CAN GO HOME
SAFE!

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The University of Texas at Arlington



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SPEED **SHORE®**
PIONEERING TRENCH SAFETY

Presents the . . .

Excavation Safety

Competent Person Training Program

Part 1



It's About Dying



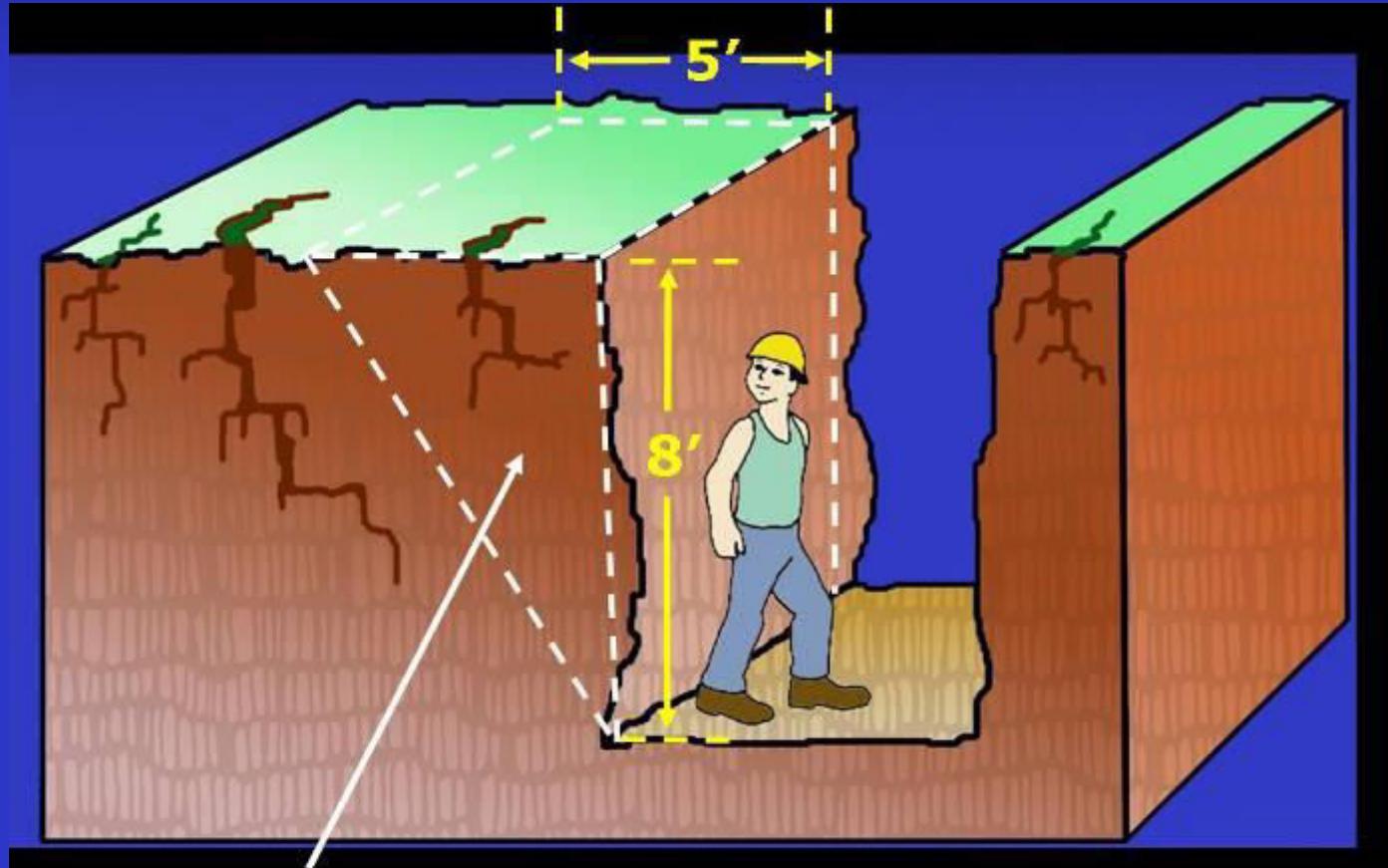
... but it doesn't have to be.



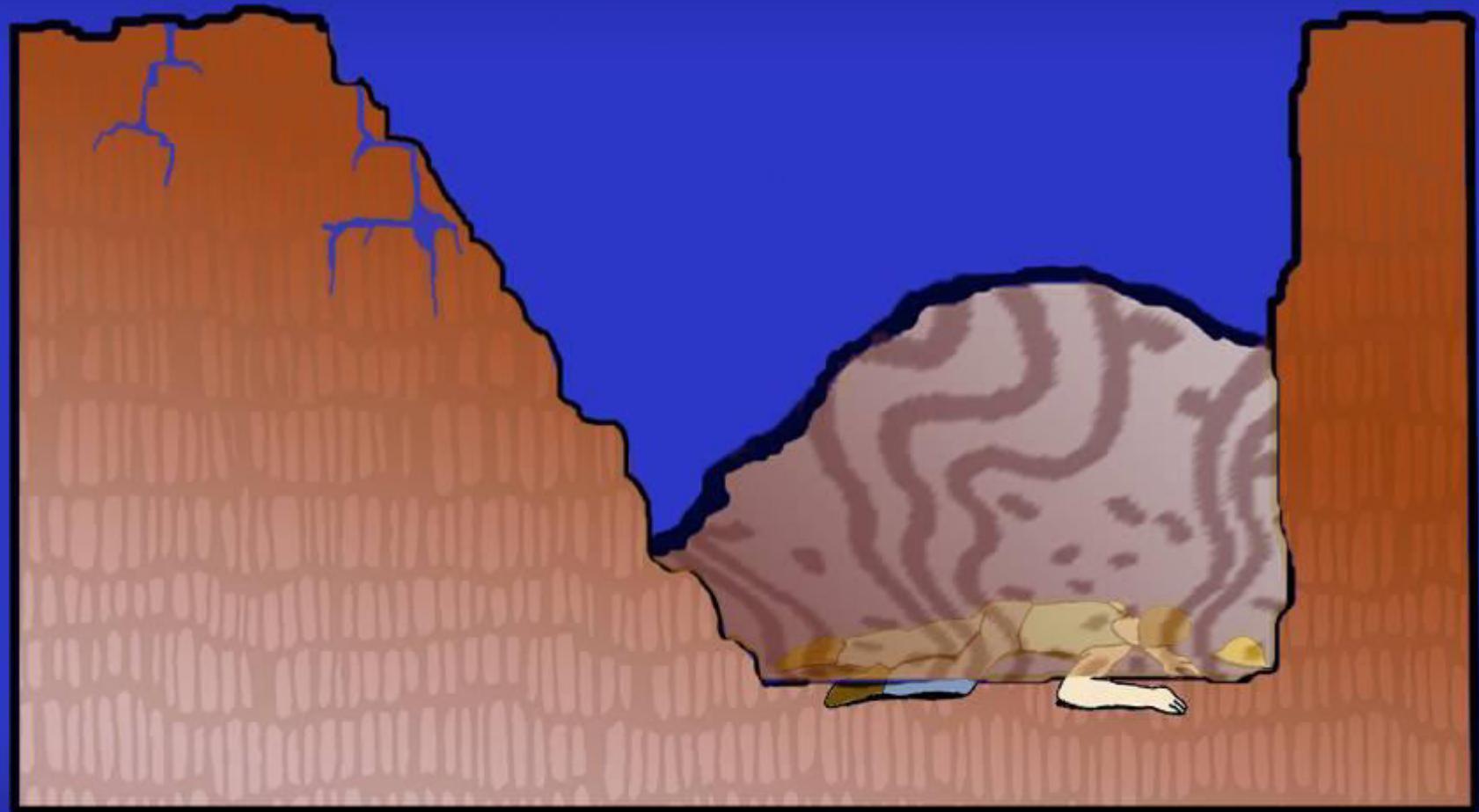
**The fatality rate for
cave-ins is fifteen times
greater than for other
construction accidents.**

(source: preamble to OSHA Standard for Excavations)





Unstable wedge weighs 16,000 lbs.

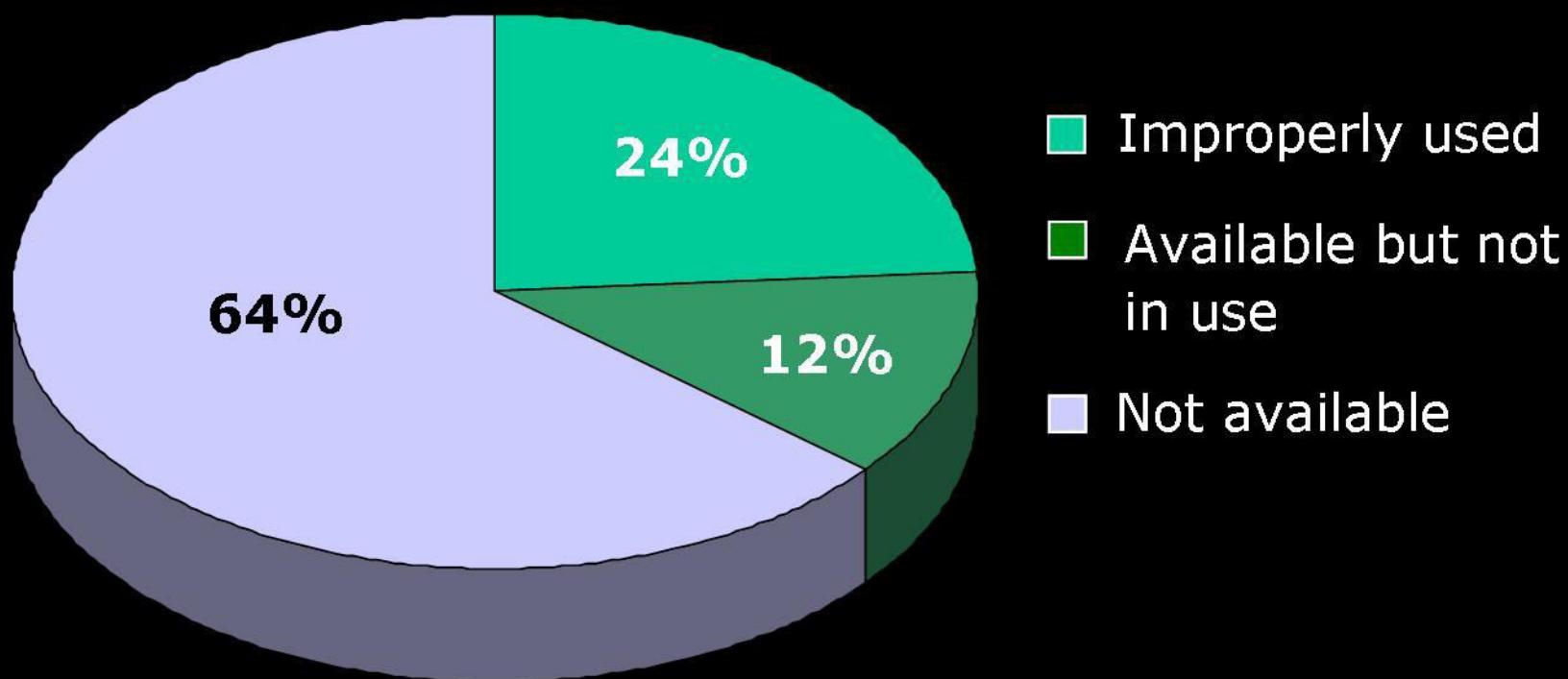


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OSHA Review of Cave-In Fatalities for 2003

Protective Measures in the Fatalities





Susan Harwood Program Grant – The University of Texas at Arlington



OSHA Standard 29 CFR 1926.650-652

Subpart P

OSHA is the Occupational Safety and Health Administration, which is an agency within the Federal Department of Labor. They are charged with promulgating and enforcing workplace safety regulations, which are found in Title 29 of the Code of Federal Regulations, which is the Labor title. Part 1926 contains the regulations for the Construction Industry. Sections 650-652 contain the Excavation regulations, which are also known as Subpart P.



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Scope and Application

This standard applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.



Excavation



Any man made cut cavity, trench, or depression in an earth surface, formed by earth removal.

Trench Excavation

A narrow excavation (*in relation to its length*). In general the depth is greater than the width, but the width of a trench (measured at its bottom) is not greater than 15 feet.



General Requirement for Protection

Each employee in an excavation five feet deep or deeper shall be protected from cave-ins by an adequate protective system, unless the excavation is made entirely in stable rock.



Under 5 Feet

Under 5 feet, the requirement for a protective system is a judgment call for the “Competent Person.”



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 the employees and who has authorization to take prompt corrective measures to eliminate them."

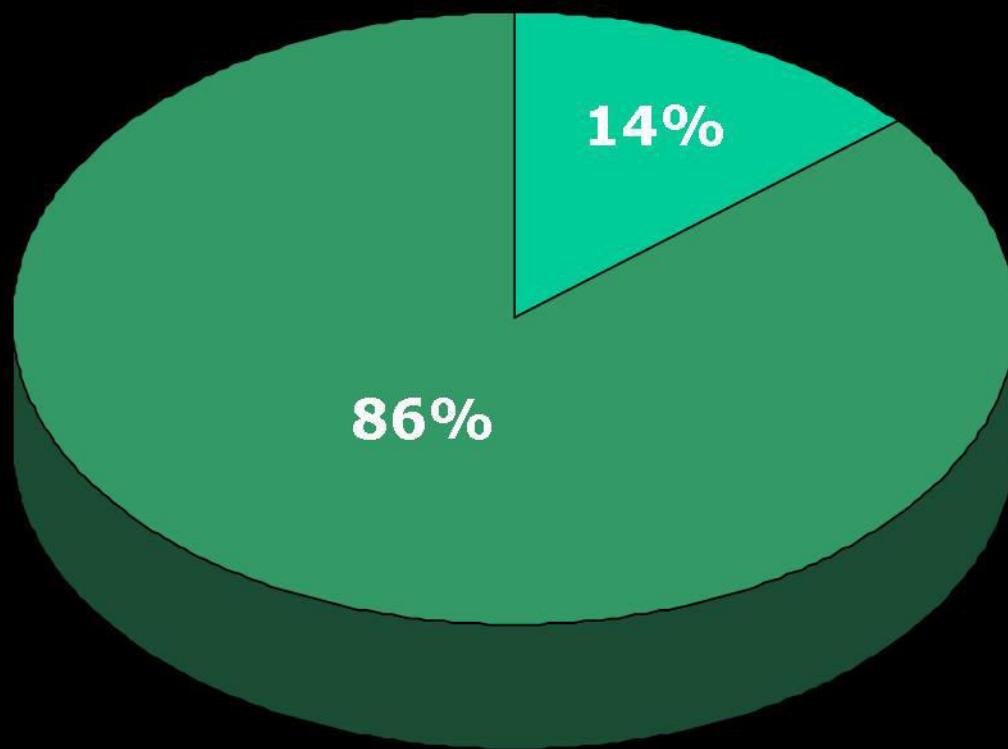


Targeted Competent Persons: Supervisors & Equipment Operators



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OSHA Review of Cave-In Fatalities for 2003



Was the
competent person
onsite at the time
of the fatality?

■ Yes

■ No



Training Requirements for the Competent Person

In the preamble to the Standard, OSHA says that, "...for the purposes of this standard, one must have had specific training in and be knowledgeable about soils analysis, the use of protective systems, and the requirements of the standard. One who does not have such training or knowledge cannot possibly be capable of recognizing existing and predictable hazards in excavation work or taking prompt corrective measures."



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Hazard Recognition Training

In Subpart C, OSHA also requires that all employees be trained in the “recognition and avoidance of hazards,” so they will not unwittingly expose themselves to unsafe conditions.



Specific Responsibilities of the Competent Person

- Conduct tests for soil classification.
- Understand standards and any data provided.
- Determine proper protective system.
- Recognize and reclassify soil after changes in conditions.
- Determine whether damage to excavation safety equipment renders it unusable.



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Specific Responsibilities of the Competent Person *(cont.)*

- Design of structural ramps.
- Location of underground installations/utilities.
- Monitor water removal equipment and operation.
- Perform daily inspections.
- Determine the necessity for a protective system if less than 5 feet deep.



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General Responsibility of the Competent Person

It is the general responsibility of the Competent Person to insure that all aspects of the excavation process are in compliance with the excavation standard and the General Duty Clause of the OSHA Act (5a1.), which requires the employer to provide a safe, healthy workplace, free of known or recognizable hazards.



Options of the Competent Person

1. Use the OSHA Standard for guidance with:

- Sloping
- Shoring with timber or aluminum hydraulic shoring
- Shielding

2. Use a Registered Professional Engineer to provide:

- Tabulated data
- Manufacturers tabulated data
- A site specific design*

*(*must be registered in the state where the work is being done.)*



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Registered Professional Engineers must be used if:

- The excavation is deeper than 20 feet.
- An “alternate system” (such as sheet piling) that the Standard does not provide guidance for is used.
- If the excavator is at “variance” with the Standard (i.e. doing less than the Standard requires).

Note: OSHA expects that the engineer will be registered in a related area such as a civil, mechanical, geotechnical, or architectural engineer.



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It is a Show Me In Writing Standard

Excavation protection solutions must either come from the OSHA Standard or a Registered Professional Engineer.



Right Or Wrong?



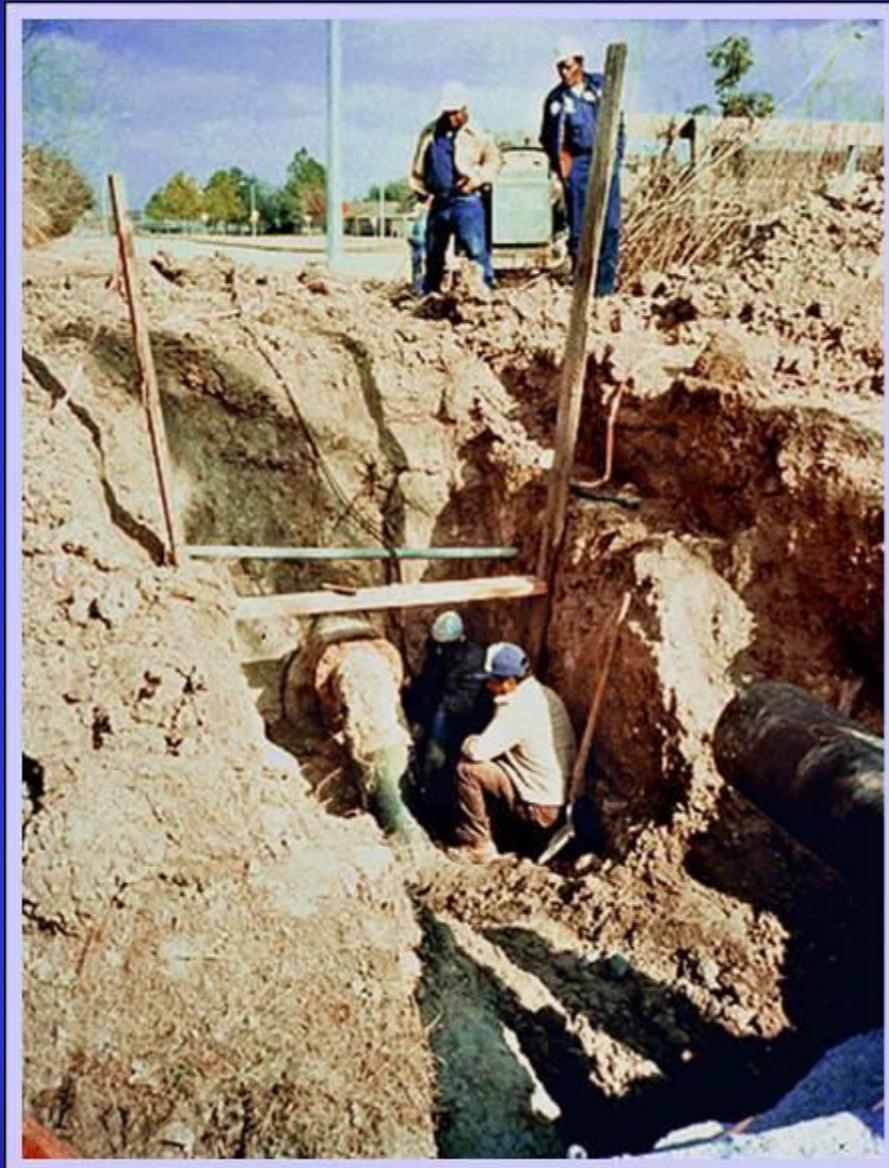


All four
men are at
exposure.



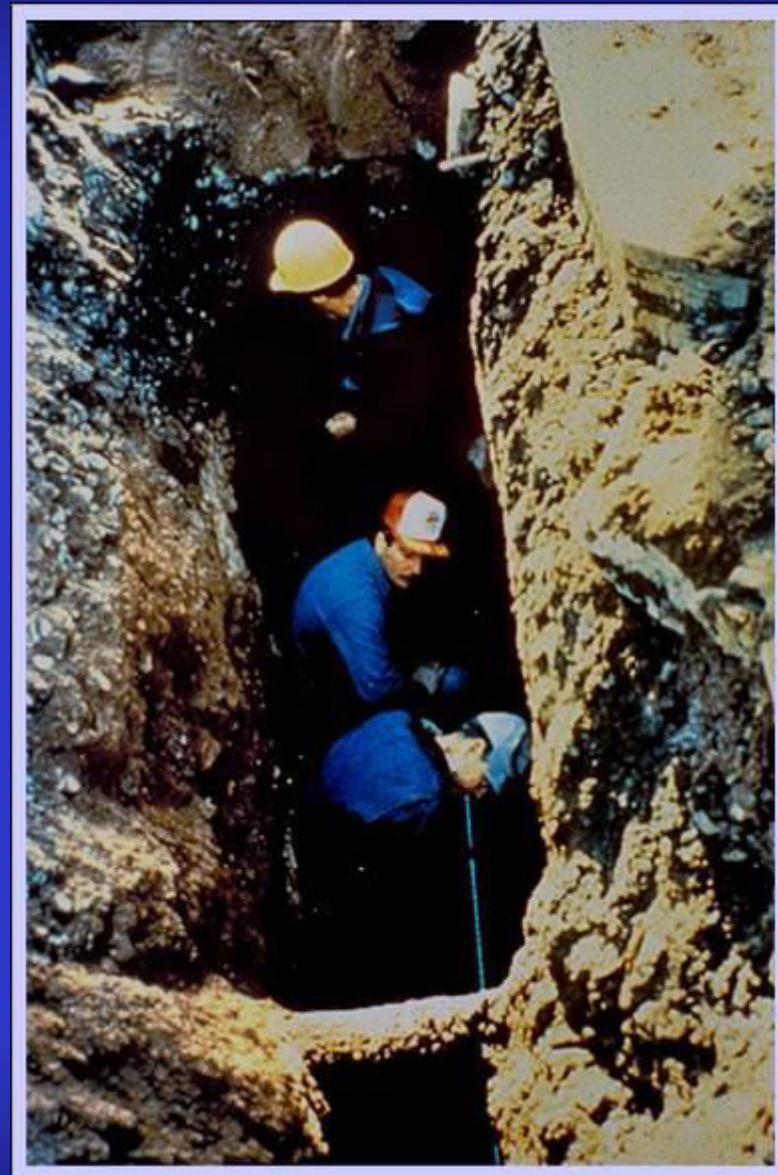
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