# NEW JERSEY HAZMAT EMERGENCY RESPONSE COURSE

## HAZMAT TRAINING COURSE NUMBER: 06047

# CONFINED SPACE AWARENESS

*PRESENTED BY:*

**NEW JERSEY STATE POLICE HOMELAND SECURITY BRANCH**
**SPECIAL OPERTIONS SECTION , TECHNICAL RESPONSE BUREAU**
**HAZARDOUS MATERIALS RESPONSE UNIT**

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## PREFACE

Confined space recognition and entry training has been a necessity and a source of confusion for workers and the emergency response community with separate regulations for public and private sector workers. In the past year, the confusion between the two regulations (NJAC 12:100-9, and OSHA 29 CFR 1910.146) was resolved when the New Jersey PEOSHA program adopted OSHA regulations for worker safety and emergency response. Now public and private sector workers and responders are working from the same regulations and speaking a common language.

We hope that this course will begin to answer the questions associated with safe confined space work and compliance with federal and state laws.

The Hazardous Material Response Unit would appreciate hearing comments and suggestions relevant to this training from the emergency response community; the phone number for Hazardous Material Response Unit is 732-721-4040, by FAX 732-721-4672 or by E-MAIL at NJHAZMAT@YAHOO.COM.

October 2004

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# CONFINED SPACE AWARENESS

**COURSE GOAL:**

**Participants in this course will be able to identify a confined space and recognize its potential hazards.**

## MODULE 1

## OBJECTIVES

Participants will be able to:

1. Identify the legal standard that requires confined space training.
2. Identify at least two guidance documents that will help them plan confined space work.

### New Jersey State Hazardous Materials Training Program Outline:

The N.J. State Hazardous Materials Training Program is a system of training modules designed to aid participants in achieving whatever level of training is appropriate to their job duties. Established levels start with First Responder Awareness and progress up to On Scene Incident Commander. Annual Refresher training or documented demonstration of competence is required by OSHA and PEOSHA. Periodic updates and revisions may change the training criteria. These changes will be incorporated into the recertification process so that all participants in the program will have the appropriate training at each level.

## GENERAL CONSIDERATIONS

You are taking this course because there are confined spaces at your job site or in your jurisdiction. You will be working in proximity to these spaces or participating in confined space operations as part of your normal job duties. This course will train you to recognize a **Confined Space**, be aware of the potential hazards of that space and introduce the equipment and procedures you will need to maintain a safe work environment.

As with any situation involving a hazardous work site or hazardous materials, the more planning you do prior to an incident, the better. It is critical to realize that your safety comes first. There is no point in entering a confined space to perform a job assignment if you may become the next victim to require rescue.

It is important for you to know that your confined space training and procedures must be detailed in your employer's Standard Operating Procedures (SOP). Every employer in New Jersey, whether public (paid and volunteer) or private, is required to have a comprehensive SOP for confined space entry and rescue per OSHA 29 CFR 1910.146. You should be familiar with all of the procedures outlined in your SOPs.

Your employer's plan should be an accurate representation of your method of operation. If it isn't; **do something about it!** Get in contact with your safety coordinator and sit down and discuss it. Offer to assist in developing or rewriting the SOPs.

## REGULATORY STANDARDS:

### OSHA'S FINAL RULE JAN. 14, 1993 (effective, APRIL 15, 1993) 29 CFR PART 1910.146

(PERMIT REQUIRED CONFINED SPACES)

Adopted by PEOSHA - NJ

The OSHA regulation applies to confined space activities carried out by employers in general industry. This regulation contains requirements for practices and procedures to protect employees from those hazards of entry into and work within permit required confined spaces in **General Industry** which can be identified by an employer exercising reasonable care. 29 CFR 1910.146 does not apply to agriculture, construction, electric generation or transmission industries, grain handling facilities, purely maritime industry activities or the onshore operations of maritime industry where confined spaces in those industries are regulated by a more specific entry standard.

In addition, there are other standards in OSHA that have been adopted by reference by PEOSHA that affect confined space work in specific industries.

## GUIDANCE DOCUMENTS:

"Guidance Documents" are opinion papers or position papers that represent the consensus opinion of industrial councils or professional groups. Often the standards proposed by a guidance document will exceed the standards required by OSHA or PEOSHA laws. These documents are not the law but they cannot be ignored as they represent a consensus opinion of qualifying professionals. Some of the groups that have addressed confined space work are:

### THE AMERICAN NATIONAL STANDARDS INSTITUTE

(ANSI: SAFETY FOR CONFINED SPACES - Z117.1)

ANSI standards are intended as guidance documents to aid employers and employees in creating and maintaining a safe work environment. As a guidance document, this standard is not law but it represents a consensus of the community concerned with confined space entry and operations. Z117.1 presents a consensus opinion of safety professionals of the minimum safety requirements to be followed while entering, exiting and working in confined spaces that are not already covered in other, more specific, consensus standards.

**THE NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH**
**(NIOSH: PUBLICATION NO. 80-106)**
**DEPARTMENT OF HEALTH EDUCATION AND WELFARE**

WORKING IN CONFINED SPACES and
**(NIOSH: PUBLICATION NO. 87-113)**
**DEPARTMENT OF HEALTH AND HUMAN SERVICES**

A GUIDE TO SAFETY IN CONFINED SPACES

The National Institute for Occupational Safety and Health evaluates available research and recommends standards for safe work practices and occupational exposure to toxic substances. These recommendations are then considered by the Secretary of Labor in promulgating regulatory standards and may be used by employers as guidance documents to create and maintain safe work environments.

**THE NATIONAL SAFETY COUNCIL**
CONFINED SPACES

The National Safety Council publishes and makes available worker safety booklets and provides safety training mandated by OSHA. The Council's materials are based on OSHA regulations and may be used as part of an employer's compliance program.

# MODULE 2

# CONFINED SPACE IDENTIFICATION AND RECOGNITION OF HAZARDS

## Outline

Unit Objectives

Confined Space Recognition

Confined Space Hazards

Chemical and toxicological terms

Common gases and vapors

# MODULE 2

# OBJECTIVES

Participants will be able to:

1. Identify a confined space.
2. List at least four physical hazards associated with confined spaces.
3. Demonstrate an awareness of the chemical hazards likely to be encountered in a confined space and their impact on worker safety.
4. Define the terms vapor density, lower explosive limit, PEL and IDLH and describe

## WHAT IS A CONFINED SPACE?

Examples of confined spaces include but are not limited to:

pits, pumping stations, pipelines, boilers, cupolas, degreasers, furnaces, septic tanks, reaction and pressures vessels, sewage digesters, sewers, silos, storage tanks, ship holds, utility vaults, vats, trenches and excavations.

The standards and guidance documents generally agree on the characteristics that define a confined space though the wording and priority given to these characteristics may vary.

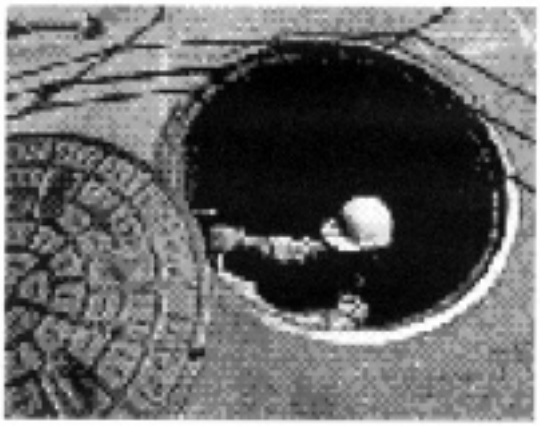
“Entry” into a confined space is any action on your part will expose your respiratory system to the hazards of that space. Basically this refers to any action that results in any part of your face crossing the plane of the opening into the confined space. But remember—even by standing near the opening of a confined space may expose you to vapors and gases that are venting from or being forced out of the space.

The **Occupational Safety and Health Act** (OSHA 29 CFR 1910.146) defines confined spaces (both “non-permit” and “permit required”) as enclosed spaces which:

1) Are large enough and so configured that an employee can bodily enter and perform assigned work
2) Have limited or restricted routes of entry or exit
3) Are not designed for continuous employee occupancy

Additionally, a “Permit required confined space” (29 CFR 1910.146(b)):

4) Has, or has the potential for, one or more of the following (four) characteristics:
   a) A hazardous atmosphere
   b) An engulfment hazard
   c) An internal configuration that could trap or asphyxiate an entrant (such as inwardly converging walls, a downward sloping floor that tapers to a smaller cross-section
   d Any other recognized serious safety or health hazard



**National Institute for Occupational Safety and Health** (NIOSH) recommends that a confined work space be defined as:

1) a work space normally enclosed by design, like storage tanks and equipment shafts, or 2) a work space that is enclosed by its configuration in design or construction, like pipe runs and ventilation ducts.

**The National Safety Council** uses the OSHA definition but adds that a confined space is any open surface tank or pit deeper than four feet.

## CONFINED SPACE HAZARDS

Confined spaces pose many hazards to workers and rescuers. Some of these hazards are unique to confined spaces; other are dangers that may be encountered at any industrial work site or hazardous material incident. The hazards you are likely to encounter in a confined space entry include:

1) Limited access that hinders entry and exit or emergency rescue (typically 18-27" manways)
2) Existing or potential hazardous atmospheres; either inherent in the space or introduced by the work being performed or adjacent work
3) Poisoning from toxic gases and vapors
4) Asphyxiation caused by displacement of oxygen
5) Energy sources controlled at some point outside the space (steam, electricity, etc.)
6) Explosion from the ignition of explosive or flammable materials
7) Mechanical equipment controlled from an outside location
8) Small internal dimensions that put workers into close proximity to hazards
9) Lack of communication between workers inside the space and those outside
10) Possibility of tools or material falling into the space from other workers or supernumeraries
11) Unstable walls (as in a pit or trench)

12) Asphyxiation caused by engulfment
13) Heat from combustion or oxidation inside the space or energy from an outside source
14) Biologics
15) Insecure or structurally unsound footings (rusty ladder rungs, slippery stirrups, even grease on a shoe)
16) Poor lighting/visibility (rescuers shall use intrinsically safe lighting)

17) Miscellaneous unexpected hazards (rodents, spiders, snakes, stinging insects)

Most of the chemical related hazards arise from six factors:

1) Residues of previously stored products
2) Unexpected leaks or spills into or from containers within the confined space
3) Unexpected introduction of materials through uncontrolled pipes, inlets or other openings
4) Unexpected chemical reactions within the space
5) By-products of operations within the space
6) Poor venting of "inerting" gas

The hazards that you will encounter in a given confined space will be enumerated in the entry permit and rescue plan for that space ***if the plan has been properly done***. Do not use a plan if you doubt its accuracy and safety.

## CHEMICAL SAFETY AND TOXICOLOGY

Whenever extraneous substances are present in the environment, you run a risk of exposure to those substances. That exposure can come by four basic routes; inhalation, ingestion, absorption, or injection.

**Inhalation** (breathing) exposes lung tissue to the contaminant. A self-contained breathing apparatus will protect you but before you consider respiratory protection, you should decide if its really necessary to go into the area at all.

**Ingestion** (swallowing) exposes the digestive tract to contaminants. Most people are smart enough that they won't grab a handful of hazardous material to see if it tastes toxic but they still may grab for a glass of water before thoroughly decontaminating their hands. In this manner, they may transfer contaminants from their hands to a glass and from the glass to their mouth.

**Absorption** through skin contact may cause contact dermatitis (rashes or other skin problems) or materials can pass through the skin into the blood stream and cause systemic effects.

**Injection** can come from any sharp object within the confined space. Be aware of sharp objects, exposed metal edges, and "mystery bags" of waste.

Your exposure to toxic substances is regulated according to recommendations from

various industrial health organizations based on toxicity data.

The Permissible Exposure Limit (**PEL**) is the average concentration of a substance (determined by OSHA) in which the average worker can work 8 hrs/day, 40 hrs/wk, over a working lifetime. The PEL is a Time Weighted Average (**TWA**). That is, Dose received averaged over Time of exposure.

The Threshold Limit Value (**TLV**), determined by the ACGIH, is the recommended average air concentration of a substance in which the average worker can work for an eight-hour work day without ill effects.

The Recommended Exposure Limit (**REL**) is the average concentration of a substance (determined by NIOSH) in which the average worker can work 8 hrs/day, 40 hrs/wk, over a working lifetime.

PELs, RELs, and TLVs are all Time Weighted Averages (**TWA**). That is, Dose received divided by Time of exposure. The TWA is commonly calculated for an eight-hour work day and a forty-hour work week. OSHA determined PELs are the law, RELs and TLVs are for your "guidance."

An Immediately Dangerous to Life or Health concentration **(IDLH)** is the concentration of a material which will, immediately, produce irreversible health effects (even death).

The Short Term Exposure Limit (**STEL**) is the level of a material that the average worker can be exposed to for short periods of time (15-minutes) four times daily (allowing a one-hour recovery time between exposures) with no permanent ill effects.

The Short Term Lethal Concentration (**STLC**) is the concentration of a material that will kill the average workers in 10 minutes of exposure.

Ceiling (**TLV-C**) is the concentration of a material above which workers may never be exposed.

Your exposure to a substance can be:

**Acute or Chronic**—Your exposure to hazardous materials can take the form of a single, accidental exposure (acute) or repeated, work related exposures over a longtime (chronic).

The possible effects on you can be:

**Immediate or Delayed**—Immediate effects happen upon exposure to a hazardous substance. Delayed effects take days, weeks, or even years to develop.

**Local or Systemic**—Local effects occur at the site of exposure (if you spill lye on your hand, your hand will be burned); systemic effects occur at an organ of the body that was not directly exposed (if you inhale large amounts of benzene over time, your

lungs have been directly exposed but your kidneys and bladder will have an increased risk of cancer).

Explosion or fire hazards are described by the explosive or flammable range and flash point of a substance:

**Explosive Range (ER) or Flammable Range (FR)**—is the range of concentrations of a substance that will explode or burn. The ER (FR) of a substance is bounded by its upper explosive (flammable) limit (**UEL or UFL**) and its lower explosive flammable limit (**LEL or LFL**). The LEL (LFL) is the lowest concentration (the "leanest" mixture) of a material in the air that can burn. The UEL (UFL) is the highest concentration (the "richest" mixture) of a material in the air that can burn. Concentrations of a material below LEL (LFL) or above UEL (UFL) will not burn—**however**—you must determine why the material is in the air in the first place and how the concentration might change over time before you consider entry.

Concentrations above the UEL (UFL) will probably be lowered when hatches or doors are opened and outside air is allowed to circulate in the space. Concentrations below the LEL (LFL) may rise into the ER (FR) as more of the material is released into the air in the confined space by leaks, evaporation or work procedures.

The **Flash Point** of a substance (FP) is the lowest temperature at which the vapor given off by that substance forms an ignitable mixture with air.

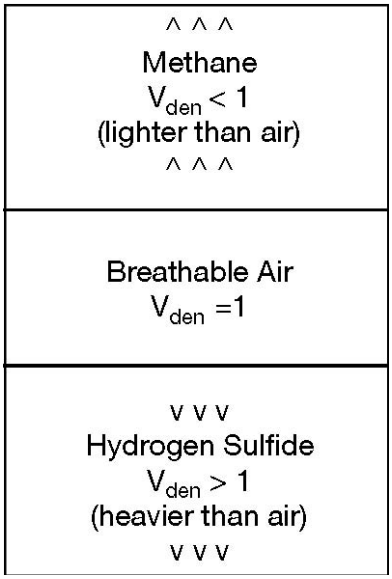
Most of the deaths that occur in confined spaces are caused by atmospheric exposure to hazardous materials. Many workers just don't take the time to properly conduct tests before entry. Explosive gas concentrations will be measured with a combustible gas indicator (CGI). The meter on a CGI will give you a reading in percent of lower explosive limit (LEL) of the calibration gas. A reading of more than 10% is considered the "action level" by PEOSHA; that is, evacuate the area or do not enter until the area can be vented.

The atmosphere must also be checked for the presence of toxic materials. If the likely contaminants are known, the air can be tested with the appropriate meter or colorimetric tube. If you use colorimetric tubes, you will be using them only to confirm or deny the presence of a material; not to determine its concentration. Colorimetric tubes are no longer approved by NIOSH; they have a limited shelf life and a 25% margin of error.

If you are dealing with unknowns, you would use a more general reading instrument (like an OVA) or suspend operations until the material can be identified. In any event, if concentrations of vapors or fumes are above the permitted exposure limits (PEL) for the contaminant; you must wear the appropriate respiratory protection to enter the confined space.

When you are looking for gases or vapors in a confined space you must consider where they are likely to collect. "Vapor Density" is a comparison of the density of a gas or vapor to breathable air ($V_{den}$ = Density X/Density Air). A $V_{den}$ of greater than one indicates that the product is "heavier than air" and will, mostly likely, be found at the bottom of a confined space. A $V_{den}$ of less than one indicates that the product is "lighter than air" and will, most likely, be found at the top of a confined space.

## POTENTIAL SEPARATION OF GASES BY VAPOR DENSITY ($V_{den}$) IN A CONFINED SPACE




## SOME GASES, VAPORS AND FUMES OF CONCERN IN CONFINED SPACE ENTRY:

**OXYGEN** ($O_2$): Normal conditions of the atmosphere are (approximately) 20.9% oxygen, 78% Nitrogen, 0.9% inert gases, and 0.04% Carbon dioxide with no extraneous substances that will adversely affect the health of workers. Breathing air has an average concentration of 20.9% oxygen. If you detect oxygen levels inside the confined space that are at all different from normal levels (20.9%), you must ask "WHY?". is oxygen being displaced by another substance? Is oxygen being used by a chemical or biological process inside the space? Is there a leaking oxygen line from a welder's torch? WHAT IS CAUSING THE CONDITION? A concentration of more than 23.5% $O_2$ is considered (by PEOSHA AND OSHA) an oxygen enriched atmosphere where many materials become dangerously flammable. A concentration of less than 19.5% is considered oxygen deficient and the appropriate type of supplied air respirator must be worn under these conditions. The vapor density of oxygen is approximately 1.1 so it may collect at the bottom of a confined space if large quantities are being released by some chemical or physical process.

| **OXYGEN** ($O_2$): | |
|---|---|
| CONCENTRATION IN AIR: | COMMENTS: |
| 23.5% or more | Oxygen enriched; flammability range of gases increases |
| 20.9% | Normal atmospheric conditions |
| 19.5% or less | Oxygen deficient conditions |
| 16% | Noticeable physical impairment |
| 14% | Faulty judgment, rapid fatigue |
| 10% | Nausea and vomiting followed by death |
| 5% | Death occurs quickly |

**NITROGEN**: Often used as an "inerting" gas for confined space work (especially on board ships). Though it constitutes approximately 78% of normal breathing air and is not considered toxic, Nitrogen can be a simple asphyxiant. Nitrogen is often introduced into confined spaces from pressurized cylinders to displace flammable gases and vapors and oxygen. Because oxygen is displaced, even when more flammable material collects in the space, the chance of a fire is greatly reduced. Remember that any "inerting" process displaces oxygen and creates an oxygen deficient work environment.

**HYDROGEN SULFIDE** ($H_2S$): Hydrogen sulfide is a colorless gas with the odor of rotten eggs and is widely used in industry. It is commonly produced by the decomposition of sulfur bearing organic material. The gas is an irritant and an asphyxiant as well as being dangerously flammable in high concentrations. Very low concentrations cause irritation to the eyes. Slightly higher concentrations cause irritation of the upper respiratory tract. Collapse, coma and death from respiratory failure may come within a few seconds of one or two inspirations. In low concentrations, the symptoms of exposure may be nausea, stomach distress, belching, coughing, headache, irritation of the eyes and blistering of the lips. The sense of smell is quickly fatigued by $H_2S$, and may fail to give warning of its presence. The gas has a vapor density of about 1.2 so it will collect in depressions and the bottom of confined spaces.

| HYDROGEN SULFIDE $H_2S$ | |
|---|---|
| **CONCENTRATION IN AIR** | **COMMENTS** |
| 44% | UEL |
| 4% | LEL |
| 0.2% | Rapid Unconsciousness and death 2000 ppm |
| 0.07% | Unconsciousness and respiratory failure 700 ppm |
| 0.03% | IDLH (OSHA) 300 ppm |
| 0.01% | Coughing and eye irritation 100 ppm |
| 0.002% | Ceiling 20 ppm |
| 0.0005% | Odor detected 5 ppm |

If $H_2S$ is the only airborne hazard in the confined space, a lethal concentration (2000 ppm) will only displace enough air to lower the oxygen concentration from 20.9% to 20.86%.

**METHANE** ($CH_4$): Methane is formed by the decomposition of organic materials, it is also known as “marsh gas.” Natural gas may contain as much as 90% methane. Methane gas is colorless, odorless and tasteless; it will explode when the gas/air mixture is 5-15% methane. Because it is a product of decomposition, methane is likely to be found in spaces associated with sewer wastewater and treatment systems. Its vapor density is about 0.5 so methane will be trapped in the upper levels of manholes, valves and other sewer or sewage related spaces. Methane is considered a simple asphyxiant, that is, it can displace oxygen if it is present in high concentrations.

| METHANE $CH_4$ | |
|---|---|
| **CONCENTRATION IN AIR** | **COMMENTS** |
| 15% | UEL |
| | EXPLOSIVE RANGE |
| 5% | LEL |

At its LEL, methane will lower the available oxygen from 20.9% to about 19.86%.

**CARBON MONOXIDE** (CO): Carbon monoxide is a colorless, odorless tasteless gas produced during the combustion of any carbon-based material. In particular, be aware that it is a by-product of internal combustion engines (i.e., cars, generators, and ventilators). Carbon monoxide induces drowsiness and sleep; other symptoms of exposure include: headache, dizziness, weakness, vomiting, inability to concentrate, collapse, unconsciousness and death. Carbon monoxide is a chemical asphyxiant that will combine with the hemoglobin in blood and make the blood incapable of transporting oxygen through the body. Its vapor density is about 0.97, nearly the same as air, so it can accumulate in areas with poor ventilation.

| CARBON MONOXIDE (CO) | |
|---|---|
| **CONCENTRATION IN AIR** | **COMMENTS** |
| 75% | UEL |
| | Flammable Range |
| 12% | LFL |
| 0.15% | IDLH Level (OSHA) 1500 ppm |
| 0.02% | Ceiling Limit (NIOSH) 200 ppm |
| 0.005% | PEL (OSHA) 50 ppm |
| 0.0035% | REL (NIOSH) 35 ppm |

At its IDLH concentration, carbon monoxide will lower the available oxygen in a confined space from 20.9% to about 20.87%.

**CARBON DIOXIDE** ($CO_2$): Carbon dioxide is a colorless, odorless noncombustible gas produced during the combustion of any carbon-based material. It has a faint acid taste. Carbon dioxide has a vapor density of about 1.5 and so, will collect in any depressions or at the bottom of a confined space. People cannot breathe air containing more than 10% $CO_2$ without losing consciousness. Carbon dioxide is sometimes used as an “inerting” gas in confined space work. It is introduced into the space in the form of “dry ice” to displace flammable gases and vapors and to reduce oxygen concentration by displacement thereby reducing the chances of an explosion or fire.

| CARBON DIOXIDE ($CO_2$) | |
|---|---|
| **CONCENTRATION IN AIR** | **COMMENTS** |
| 10% | Unconscious |
| 5% | IDLH (OSHA) |
| 3% | 10 min Ceiling (NIOSH) |
| 0.5% | PEL (OSHA) |

At its IDLH concentration, carbon dioxide will lower the available oxygen concentration from 20.9% to about 19.8%.

**NITROGEN DIOXIDE** and Nitrogen tetroxide ($NO_2$ and $N_2O_4$): A dark brown fuming liquid or vapor. Nitrogen dioxide is a product of diesel engines, blasting and high temperature welding. The product will not burn but is an oxidizer and can support the combustion of other materials. Vapor density is approximately 1.6, so the vapor will collect at the bottom of a confined space. If inhaled, it dissolves moisture in the lungs forming nitrous and nitric acids. Symptoms include coughing, frothy sputum, labored breathing, chest pain, pulmonary edema, cyanosis, eye irritation and rapid heart beat. Irritation of the upper respiratory tract may disappear upon reaching fresh air and inflammation of the lungs may pass unnoticed but the resulting pulmonary edema may cause severe problems (even death) hours or days later.

| NITROGEN DIOXIDE (and Nitrogen tetroxide) $NO_2$ (and $N_2O_4$) | |
|---|---|
| **CONCENTRATION IN AIR** | **COMMENTS** |
| 0.005% | IDLH (OSHA) 50 PPM |
| 0.0005% | Ceiling 5 ppm |

At its IDLH concentration, nitrogen dioxide will lower the available oxygen from 20.9% to about 20.89%.

**NOTE: This is not a complete list of toxic hazards associated with confined spaces nor is it intended to replace other sources of information on hazardous materials.**

# MODULE 3

# CONFINED SPACE PROGRAMS AND

# DUTIES OF PERSONNEL

## Outline

Unit Objectives

Confined space program

Entry permits

Training

Roles of personnel:

- ☐ Entrants
- ☐ Supervisors
- ☐ Attendants
- ☐ Rescuers

# MODULE 3

## OBJECTIVES

Participants will be able to:

1. Identify the training required for attendants, entrants and supervisors for confined space work.

2. Describe the requirements of a confined space program.

3. Describe the purpose of a confined space permit.

4. Describe the duties of attendants and supervisors for confined space work.

## CONFINED SPACE PROGRAMS

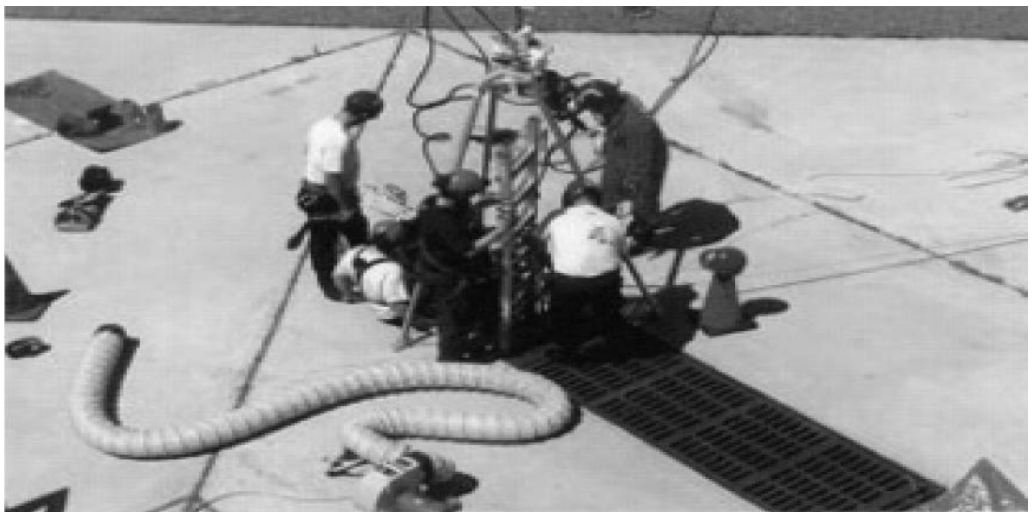
You must have a written confined space program. OSHA presents outlines for an employer's program (OSHA 29 CFR 1910.146) with the following (13) required elements:

1) **The employer or the individual responsible for sending workers (paid or volunteer) into a confined space must be a "qualified person."** A qualified person must be designated in writing by an employer and is capable by education and/or training of anticipating, recognizing and evaluating personnel exposure to unsafe conditions in confined spaces and specifying necessary control measures or protective actions to ensure worker safety.

2) **There must be written procedures for the employer's confined space program.** That is, there must be a written SOP available to all employees and safety inspectors and that SOP must be understood and used by all employees.

3) **Each confined space in the employer's jurisdiction must be identified for employees by signs, placards, training program or other means to prevent unauthorized entry.** As a point of safety, all employees must be able to recognize a confined space and know about the hazards (including fatalities) associated with unauthorized entry.

4) **Provide employees (paid or volunteer) with the specific training necessary to safely enter and exit a confined space to perform their duties.** All employees must be trained to recognize the danger of unauthorized or improper confined space entry. Employees whose work involves confined space entry must be trained in the employer's SOPs for confined space work and know that they will never enter a space without following those procedures. Employees will be aware of the duties of an attendant, entrant, supervisor or rescuer for confined space work and be trained to perform in one or more of those capacities.



5) **Provide the proper protective clothing for each confined space entry.** Employees must receive training in the proper use of the PPE that they will use in the course of their duties.

6) **Assure on-site availability of safety and rescue equipment or services, such as lifting or retrieval devices for use in an emergency.** Again, employees must be trained to use the equipment that is required for safe operations.

7) **Provide and require the use of retrieval lines for confined spaces with IDLH atmosphere conditions or engulfment hazards to make rescue possible without entering the space. If retrieval lines are an entanglement hazard, the employer shall provide an equivalent method for rescue.** You shouldn't send anyone into a confined space unless it is absolutely necessary. By using adequate retrieval lines, a worker in trouble can often be removed from a confined space without exposing rescuers to the hazards of that space.

8) **Provide and maintain proper monitoring devices to evaluate the hazards posed by the atmosphere in a confined space.** Atmospheric hazards are one of the major sources of confined space injury. Monitoring devices must be on hand that will detect and quantify the hazards that are found in an employer's confined spaces. The devices must be properly maintained and calibrated according to their manufacturer's instructions. All monitoring device maintenance and calibration must be specified in the employer's SOPs and documented in a maintenance log.

9) **Monitor and evaluate the hazards of confined space air at the time of entry and while an entrant is in the space. SOPs shall describe actions to be taken if the severity of the hazard increases while the entrant(s) are in the space.** Anyone who enters a space where atmospheric hazards may exist must be trained in the use of the air monitoring equipment that they will need to detect those hazards.

10) **Provide an attendant for each entry permit** (unless the space is specifically exempted). That is, if a permit must be filled out for the entry, an attendant will be present to ensure the safety of the entrant(s).

11) **Provide and maintain all equipment necessary to make a safe entry.** This includes PPE, monitoring equipment, fall prevention, lifting apparatus, etc. and documented maintenance records for all equipment.

12) **Train employees to perform atmospheric monitoring in a confined space and properly use and calibrate the necessary equipment.** The training program ensures that no employee will use an item of equipment that they cannot operate in a competent manner.

13) **Establish an entry permit system** The permit system establishes a procedure to document all confined space entries and includes written SOPs for entry and rescue from each confined space.

## ENTRY PERMIT SYSTEM

The entry permit system must be available for reference and training in written form and include certain elements:

1) **Written** SOPs that specify the procedure on issuing entry permits.

2) SOPs (**written**) must identify all confined spaces in the jurisdiction that employees may have cause to enter.

3) Actual and potential hazards of each confined space must be described in the (**written**) SOPs so the appropriate means to execute a safe entry can be established.

4) The permit system (**written**) SOPs must describe the appropriate monitoring to be used in each confined space.

5) The system will describe and provide a (**written**) routine for calibration of testing and monitoring equipment.

6) The system will describe (**in writing**) appropriate vehicle and pedestrian guards to protect entry personnel and attendants from local traffic hazards and protects non-entering employees from hazards arising from the confined space.

7) The system provides for pre-planned emergency evacuation or rescue.

8) The persons are identified by job title who must sign each entry permit before it is considered valid and the duties of each are described.

9) The system must provide for the training of any people who participate in the entry permit system in **any** capacity.

10) The system must provide, by appropriate testing, that the control measures used are effective.

We cannot emphasize too strongly that **all SOPs must be available in written form**. Safety issues aside, when a State or Federal safety inspector shows up at your site and your SOPs are not available in written form, the inspector must assume that they do not exist and will levy fines against you accordingly

## ENTRY PERMIT

The original of the permit must be kept on file in the office of the employer who issued the permit.

A copy of the permit will be posted at the entrance to the confined space.

## THE PERMIT SHALL:

1) Describe the hazards known or reasonably expected to be in that confined space.

2) Specify the minimum acceptable conditions for entry and work in the space.

3) Make provisions to certify that the specified pre-entry requirements are met.

4) Specify by name or job title the person authorizing or in charge of the entry.

5) Name the attendant.

6) Assure that a rescue team is available.

7) Be signed by the operation's supervisor and all attendants and entrants.

**ADDITIONALLY, the permit or an attached checklist shall:**

1) Specify procedures and certify that isolation, cleaning, purging, inerting or ventilation have been performed prior to entry to control hazards.
2) Describe any other hazards that might reasonably be expected to be generated by the activities performed by the entrants and specify any work procedures to be followed.
3) Specify PPE (including respiratory devices).
4) Specify atmospheric testing to be done and designate the person who will do it.

**HOT WORK PERMIT:**

"Hot work" is any operation that is capable of providing an ignition source for flammable materials through a heat source, static discharge or other ignition source. Examples of hot work are riveting, sand blasting, welding, cutting and burning. Hot work must be authorized in writing as part of an entry permit or by a separate (attached) hot work permit.

**RESCUE PROCEDURES:**

Specify rescue equipment required for the space. Rescue equipment shall be available at the point of entry. At least one member of each rescue team will have current certification in basic first-aid and CPR.

## ROLES OF PERSONNEL:

### THE ATTENDANT:

An attendant for a confined space operation shall remain outside of the space at all times and assure the safety of workers inside the space.

Specifically, the attendant shall:

1) Remain outside the confined space at all times for the duration of the entry.

2) Maintain continuous communication with each of the entrants inside the space.

3) Have the authority to order entrants to exit the confined space at the first indication of a not-permitted or unsafe condition.

4) Be able to summon emergency assistance without leaving the proximity of the space.

5) Warn unauthorized persons not to enter the confined space.

### THE SUPERVISOR:

The supervisor of an entry is the person in charge of that entry and may be the attendant if they will be present throughout the entry period.

The person in charge of an entry will be trained to recognize the symptoms and effects of exposure to the substances expected to be present in a confined space and carry out the following duties:

1) Assure the pre-entry portions of the permit are completed before any employee enters a confined space.

2) Verify:

   a) necessary pre-entry conditions exist

   b) if an in-plant rescue team is to be used, that they are available

   c) the means of summoning emergency assistance are operable.

3) Terminate the entry upon becoming aware of any not-permitted condition.

**THE ENTRANT:**

An “entrant” for a confined space operation is any worker authorized by their employer and qualified by training to safely go into a space to carry out a specific task and return. The training they receive includes hazard recognition and the use of specialized PPE and safety equipment.
All authorized confined space workers and rescuers will receive training (including annual retraining) covering the following issues before they are allowed to enter any confined space:

1) The nature of the hazards in confined spaces and the appropriate testing to determine if a space is safe for entry.

2) Use of PPE and special equipment that is required for entry or rescue operations.

3) Self-rescue (exit) from a confined space whenever the order to evacuate is given by the attendant, when an automatic evacuation alarm sounds or when they recognize the warning signs of exposure to hazardous substances that are known or suspected to be in the space.

4) Toxic effects and symptoms of exposure to hazardous substances that they can expect to encounter in the spaces where they will be working.

5) Modifications of normal work practices required in the confined space where they will be working.

6) Use and calibration of atmospheric testing equipment (and any other testing equipment) they will be using in confined spaces.

**THE RESCUER:**

When a rescue becomes necessary, you know that some situation has arisen that was not anticipated in the entry SOP or some piece of equipment has failed. The rescuer

should, generally, assume that an IDLH situation exists in the atmosphere of the space and proceed accordingly. There are three things for the rescuer to bear in mind:

1) SAFETY

2) SAFETY

3) SAFETY

**First**, you must be concerned for the safety of your rescue personnel (see training for "entrants").

**Second**, you must be concerned for the safety of other site personnel who may enter the space in a mis-guided attempt to effect a fast rescue.

**Third**, you must be concerned for the safety of victims who are in the confined space.

On-site (industrial plant teams) and off-site (emergency responder) rescue teams must train at least once a year in the type of spaces where they will be expected to effect rescues. The written entry plans and rescue plans for each space must be made available to rescue teams BEFORE an emergency situation occurs. Rescue teams must have at least one member who is currently certified in basic first aid and CPR. They must have the equipment available to them to conduct a safe entry and rescue; this will usually include equipment specified in the confined space entry permit PLUS specialized equipment for operating with IDLH atmospheric conditions and equipment for removing unconscious or injured workers from the space. While rescue efforts do not require entry permits (except for training exercises), a checklist is helpful to ensure team safety.

# MODULE 4

# LOCKOUT, TAGOUT AND ISOLATION

Outline

Unit Objectives

Purpose of lockout/tagout

SOPs

Isolation

# MODULE 4

# OBJECTIVES

Participants will be able to:

1. Describe the purpose of a lockout/tagout program.

2. Describe the reason why each worker in the lockout/tagout program shall have their own lock.

3. Describe why lockout devices are used with tagout devices.

## LOCKOUT/TAGOUT (ENERGY ISOLATION)

The purpose of the regulations are to prevent accidents due to accidental machinery and/or equipment start-up and the unexpected release of stored energy or material when maintenance or service is performed on any piece of machinery or equipment. “Stored energy” includes (but is not limited to) such sources as electrical power, compressed air, hydraulic power, steam or the movement of liquids through pipes.

Lockout/tagout requirements (OSHA 29 CFR 1910.147) apply to all work environments that pose the possibility of mechanical hazards, electrical hazards or engulfment hazards for workers.

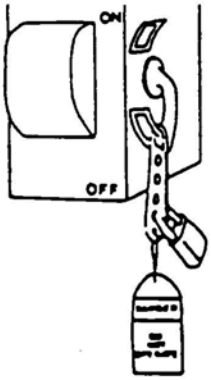

Lockout/tagout regulations require that employers establish a **written program of SOPs**. The written program shall address the following:

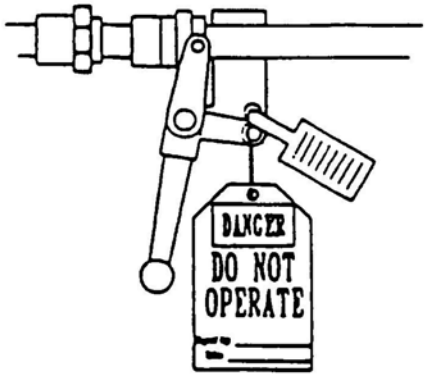
1. The steps (in proper sequence) for shutting down and securing all machines and equipment. The program should detail the energy sources for each piece of equipment and how each should be locked/tagged. All sources of hazardous energy should be listed and the means of either releasing or blocking the energy should be detailed.
2. The procedure for applying lockout/tagout devices, their location of placement and the name(s) of those authorized to apply the devices shall be noted.
3. The test to verify that all energy sources are safely isolated or turned off after shutdown and lockout.
4. The steps (in proper sequence) for restarting the equipment after maintenance has been completed.
5. Employees authorized to lockout/tagout machinery should be identified in the written program.
6. If the maintenance task requires that a number of different people will be performing the maintenance activity, then a “group lockout” shall occur. Each individual shall have their own lock applied at each lockout point. Only the person applying the lock shall have the key to that particular lock. This procedure assures that as the people performing maintenance complete their tasks and remove their locks, the remaining people are still fully protected from hazardous energy releases because their locks are still in place at the lockout point.

# ISOLATION OF WORK AREAS

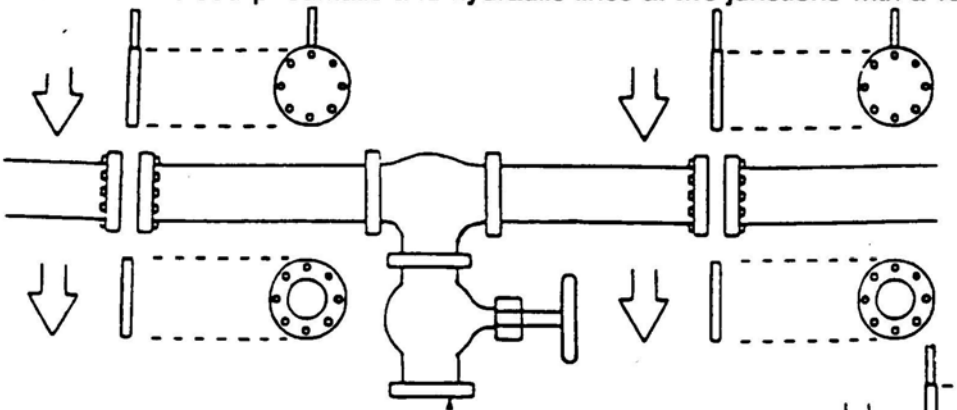
Isolation of a work space is a process where the space is removed from service by:

***lock out/tag out*** electrical sources, preferably at disconnect switches remote from the equipment.

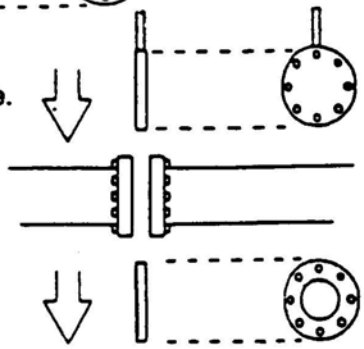


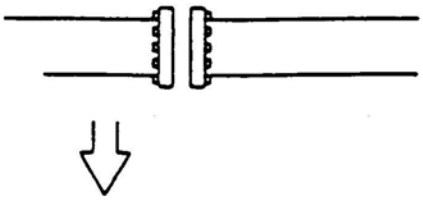

***double block and bleed*** pneumatic and hydraulic lines at two junctions with a valve between them.



***blank (blind)*** pipes, lines or ducts at junctions with a solid plate.



***disconnect (and misalign)*** pipelines, belt and chain drives and mechanical linkages on shaft-driven equipment where possible.



***secure*** mechanical moving parts within work space with latches, chains, chocks, blocks or other devices.

AN AUDIT MUST BE PERFORMED AT LEAST ANNUALLY TO ASSURE THAT THESE REQUIREMENTS ARE BEING MET.

All employees must be trained in their employer's written lockout/tagout procedures and know what a tagout signifies and why a machine or piece of equipment has been locked or tagged. Authorized employees must know and understand the type and magnitude of energy being dealt with before they shutdown and lockout/tagout a piece of equipment. Retraining is required when an employee is re-assigned to a different area or machine.

Each employee authorized to perform maintenance should be fully knowledgeable of all hazardous energy on the specific machinery on which they perform maintenance.

Devices used for lockout/tagout should be used ONLY for that activity. Tags that are used to indicate lockout/tagout should be standardized in color, shape, size, print and format. When attached, the tags must be securely fastened in place. The OSHA standard requires that the tag withstand at least 50 pounds of pull.

REMEMBER: Tags alone do not restrain. Padlocks and other physical restraints should always be used.

**ISOLATION**

In addition to lockout/tagout procedures, confined spaces are often receptacles for dry or liquid products that present engulfment hazards for the entrant. Pneumatic, hydraulic or gravity feed lines or pipes should be disconnected and dislocated or double blocked and bled. Disconnect and dislocate is usually a fairly simple procedure for small diameter pipes but large diameter or inflexibly mounted pipes require block and bleed procedures. "Double block and bleed" (or "double blank and bleed") refers to the insertion of two solid (or "blank") gaskets in pipe flanges up and down gradient of a valved spigot and leaving the spigot open. This practice virtually guarantees that no product will flow down the pipe into the confined space. Any product that does get through the first (up gradient) block will harmlessly run out the spigot rather than run into the confined space exposing the workers there.


PLUG LOCKOUT


DANGER
DO NOT
OPERATE

# APPENDIX A:

# GUIDANCE DOCUMENTS

- ☐ Safety Rules
- ☐ Entry Procedures
- ☐ Entry Checklist
- ☐ Considerations for Pre-Entry Atmospheric Testing Protocols
- ☐ Air testing protocol

# APPENDIX A

## GENERAL SAFETY RULES FOR CONFINED SPACE WORK

In order to assure your safety, there are ten basic rules to remember before entering a confined space:

1) SOPs for entry and rescue have been written and reviewed by qualified persons.

2) The atmosphere of the confined space has been tested with the appropriate instruments.

3) The space is properly ventilated.

4) Personnel involved with the entry have had appropriate training.

5) All machinery and electrical circuits have been locked out and/or tagged out.

6) The appropriate standby/communication people are on hand.

7) The proper tools and equipment (as per SOPs) are being used.

8) An Entry Permit has been filed for the space and the job (except emergency rescue).

9) The atmosphere is being monitored continuously or at appropriate intervals.

10) Records are kept of the entry including equipment and the people making the entry.

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## ROUTINE CONFINED SPACE ENTRY PROCEDURES

1) Obtain entry permit for the space.

2) At least two people (entrant and attendant) are required for safe routine entry.

3) Turn off truck and car engines in the vicinity of the space or remove them to a safe location.

4) Use appropriate warning devices or barricades to keep unauthorized people out of the area.

5) Wear appropriate protective clothing (including respiratory equipment) as specified in the permit.

6) No smoking while involved with confined space work.

7) Use appropriate gas detector (specified in permit).

8) Isolate (lockout/tagout) the confined space.

9) Ventilate the confined space.

10) Have appropriate proper rescue equipment ready at hand.

11) Be familiar with current rescue SOPs for the confined space.

12) Evaluate current physical hazards in the space.

13) Inform base station or supervisor when you are about to make entry.

***A CHECKLIST OF CONSIDERATIONS FOR A ROUTINE ENTRY INTO A CONFINED SPACE (BASED ON NIOSH GUIDELINES):***

**IF YOU ANSWER TO ANY OF THE QUESTIONS ON THIS FIRST PAGE IS "NO," DO NOT ATTEMPT ENTRY UNTIL THE SITUATION IS CORRECTED !**

| YES | NO | |
|---|---|---|
| _____ | _____ | Do you have a clear, achievable task to perform? |
| _____ | _____ | Is it really necessary to enter the space to achieve your designated task? |

**STANDARD OPERATING PROCEDURES**

| | | |
|---|---|---|
| _____ | _____ | Are there any written employer SOPs that address entry into this confined space? |
| _____ | _____ | Are there written employer SOPs that address rescue from this confined space? |
| _____ | _____ | Are copies of the SOPs available and do you understand them ? |

**TRAINING**

| | | |
|---|---|---|
| _____ | _____ | Have you been trained in the proper use of the respiratory protection required for this entry? |
| _____ | _____ | Have you been trained in confined space entry? |

**PERMIT**

*A "permit" is a site generated authorization in writing that states what precautions, equipment, etc. are required to enter a confined space, what work is to be done, and that the space has been tested by a qualified person to determine that it is safe for entry.*

| | | |
|---|---|---|
| _____ | _____ | Has a confined space entry permit been issued? |
| _____ | _____ | Does the permit include a list of emergency telephone numbers? |

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| YES | NO | |
|---|---|---|
| | | **ISOLATION** |
| _____ | _____ | Has the space been isolated from other systems? |
| _____ | _____ | Has electrical equipment been locked out and tagged? |
| _____ | _____ | Have disconnects been used where possible? |
| _____ | _____ | Has mechanical equipment been blocked, chocked and disengaged where necessary? |
| _____ | _____ | Have lines under pressure been blanked and bled? |
| | | **CLEANING** |
| _____ | _____ | Will the space be cleaned prior to entry? |
| _____ | _____ | Has the space been steamed? |
| _____ | _____ | If so, has it been allowed to cool? |
| | | **TESTING** |
| _____ | _____ | Do you know what materials have been present in the space? |
| _____ | _____ | Are the test instruments specified in the SOP available in good working order and are they appropriate to the potential hazards? |
| _____ | _____ | Are the instruments properly calibrated? |
| _____ | _____ | Has the atmosphere been tested? |
| _____ | _____ | Is the Oxygen level within acceptable limits? |
| _____ | _____ | Are toxic, flammable or oxygen-displacing gases/vapors present? |
| | _____ | Hydrogen sulfide |
| | _____ | Carbon monoxide |
| | _____ | Methane |
| | _____ | Carbon dioxide |
| | _____ | other (list)_____ |
| | | **MONITORING** |
| _____ | _____ | Is it necessary to monitor the atmosphere during the work cycle? |
| _____ | _____ | Is it necessary to monitor the atmosphere continuously? |

Is it necessary to monitor the atmosphere periodically?
If yes, at what interval?_____

**VENTILATION**

Will the space be ventilated before entry?

Will continuous ventilation be required during the work cycle?

Is the air intake for the ventilation system located in an area free of combustible dusts and vapors or toxic substances?

If the atmosphere was found unacceptable and then ventilated, was it re-tested prior to entry?

**CLOTHING/EQUIPMENT**

Is special clothing required to protect workers from physical or chemical hazards? (e.g. steel-toed boots, chem suit, hard hat, etc.)

If so, specify:

Is special equipment required? (e.g rescue equipment, tripod and winch, communications, etc.)

If so, specify:

Are special tools required? (e.g. spark proof)

If so, specify:

Are maintenance records up to date and available for all personal protective equipment and special equipment?

**RESPIRATORY PROTECTION**

Is respiratory protection (SAR, SCBA, APR) required?

If so, specify type:

Are MSHA/NIOSH-approved respirators of the type required available at the work site?

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Can workers enter the space with the required respirator on? (Verify before attempting entry) **STANDBY/RESCUE** Are written employer rescue SOPs available to be followed in the event of an emergency? Will there be a standby person on the outside in constant visual or auditory communication with the person(s) on the inside? Has the standby person been trained in appropriate rescue procedures? Will extra safety lines and harness be required to remove a victim? Are you familiar with the emergency rescue procedures for this space? Do you know who to notify in the event of an emergency at this site?

## CONSIDERATIONS FOR PRE-ENTRY ATMOSPHERIC TESTING PROTOCOL:

1) All instruments shall be calibrated in compliance with the manufacturer's instructions.

2) The employer shall train employees (paid and volunteer) to conduct pre-entry atmospheric testing and only those qualified personnel shall perform such testing.

3) The **minimum** acceptable air quality standards prior to confined space entry shall be:

   a) Oxygen concentration not less than 19.5% or more than 23.5% by volume;

   Combustible gas concentration not to exceed 10% of the LEL of any combustible material existing or introduced into the space. (Remember: The CGI is only intended for use in atmospheres with "normal" oxygen concentration. In oxygen deficient or enriched atmospheres, the instrument will give erroneous readings.);

   b) and

   Toxic substances, as determined by SOP, in a concentration not to exceed toxic

   c) guidelines which constitute a threat of death, injury, acute illness, or disablement.

4) Prior to each confined space entry, the atmosphere shall be tested quantitatively for the minimum acceptable levels as stated in (3) above, with an appropriate direct reading device or other acceptable method. The test for oxygen concentration shall be made before tests for other contaminants are performed

5) The space shall be tested continuously to insure acceptable air quality during the confined space operation.

6) When the CGI reading approaches 10% of the LEL in any confined space, steps shall be taken to improve ventilation or reduce contaminants and increase frequency of gas testing to insure improvement of the air quality.

7) When the CGI reading reaches or exceeds 10% of the LEL in any confined space work procedure:

   a) All employees except those necessary to eliminate the hazard shall exit to a safe location; and

   b) All electrical apparatus except that certified as intrinsically safe or explosion-proof shall be disabled or removed until the CGI reading has been reduced to less than 10%of the LEL.

8) Hot work shall not proceed in any confined space when atmospheric level of a combustible gas exceeds 10% of the LEL.

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## SUGGESTED CONFINED SPACE ATMOSPHERIC TESTING PROTOCOL:

1) a) If tests and inspections show acceptable $O_2$ levels and no flammables or toxics, then;
**go to #2**

b) If tests and inspections show $O_2$ depletion or enrichment, or the presence of flammables or toxic materials then;
**go to #7**

2) a) If non-contaminating operations are to be conducted in the space, then;
**go to #3**

b) If contaminated operations are to be conducted in the space, then;
**go to #4**

3) ISSUE PERMIT for entry/work, then; **go to #5**

4) ISSUE PERMIT for entry/work based on requirements of the operations to be conducted, then; **go to #6**

5) RETEST AND UPDATE CERTIFICATE AS NECESSARY

6) Conduct periodic or continuous tests as required by operations, then;
**go to #5**

7) a) If space ventilation **and** cleaning is required, then; **go to #8**

b) If only ventilation is required, then; **go to #9**

8) Ventilate with appropriate equipment, then issue provisional certificate for cleaning—Upon completion of cleaning;
**go to #1**

9) Ventilate with appropriate equipment, then; **go to #1**

# APPENDIX B

# ACCIDENTS

It is estimated that nearly 100 people die in confined spaces each year. Rescues are often unplanned and consist of spontaneous reactions in an emergency. As a result of lack of planning about 60% of confined space deaths occur among rescuers. Protective measures are often neglected because someone says" We've never had a problem before" or "There's no time to think—we have to act fast; someone's in trouble." These attitudes often prove fatal as conditions can change quickly in confined spaces.

**Confined Space––Asphyxiating atmosphere:**

One worker dead
Two rescuers dead

A worker in Oklahoma prepared to enter a molasses tank. The atmosphere had not been tested and no respirators, retrieval lines or harnesses were provided. Following longstanding practice at the company involved, employees removed the tank lid and allowed the tank to "ventilate naturally" for several hours before entering. No air monitoring was performed. The first entrant reported feeling ill as soon as he entered, and collapsed. Two "standby" workers, required by the plant's SOP, entered to rescue him. Each of the rescuers collapsed. All three employees died from oxygen deprivation.

**Confined Space––Toxic atmosphere:**

One worker dead
One rescuer dead
Thirty-eight rescuers injured

In Arizona, a foreman and a worker entered an unventilated sewer to refuel a gasoline-powered pump. The sewer atmosphere was not tested and the employer provided no procedures or equipment for rescue. The worker was overcome by carbon monoxide and died. The foreman escaped from the sewer and called the fire department for help. A "passerby" tried to rescue the worker and was also fatally overcome. Thirty fire fighters and eight other workers were treated for carbon monoxide poisoning from this incident.

**Confined Space––Flammable or explosive atmosphere:**

One worker dead
One rescuer dead
Sixteen rescuers injured

In Arizona, an employee entered a storage tank to remove toluene residue. The tank was cylindrical, 20 feet tall by 10 feet in diameter and had only one opening; an 18-inch hatch in its upper surface. The employer had rented an SCBA and showed the employee how to use it. No air monitoring was performed in the tank and no rescue plan had been developed. The employee was provided with a length of rope for his descent into the tank. The employee could not fit through the tank's hatch while wearing the SCBA so it was decided that the employee would be lowered to the base of the tank with no

respiratory protection and the SCBA would be lowered down to him. The worker collapsed before the SCBA could be lowered to him and the employer called the city fire department for help. The fire fighters who responded to the call were also unable to enter the tank wearing SCBAs and so they decided to cut an opening at the base of the tank to rescue the fallen worker. The toluene vapor in the tank ignited during the course of the rescue killing one fire fighter and injuring 16 others. It was later determined that the first entrant was dead from the effects of high levels of toluene vapors and lack of oxygen before the fire department arrived

## B-2 Appendix B

**Confined Space––Engulfment:**

One worker dead

A group of employees of a Nebraska sawmill entered a 40 foot high storage tank, thought to be nearly full of sawdust. Entry was made through a small opening near the top. One of the workers suddenly disappeared—falling into an air pocket in the sawdust. Rescue operations began immediately, but the worker died of asphyxiation by the time help reached him. Two years earlier, this same employee had narrowly escaped death in a similar incident. OSHA's report on the fatal incident quotes the sawmill's own investigation of the earlier, non-fatal incident, which concluded that bin workers must use a safety rope. The only rope available at the time of the incident was made by knotting together pieces of old sash cord. The employees did not use this rope because they recognized that it was useless for its intended purpose and also "because it was too much trouble."

**Confined Space––Mechanical hazards:**

One worker dead

A workman entered the bag house in the dust collection system of an Ohio basic-oxygen steel-making furnace to check the condition of the bags. He stepped onto the auger conveyer, which was not supposed to be operating at the time, and was caught in the machinery. The employee died before rescuers could remove him from the auger pipe conveyor.

**Confined Space––Untrained rescuers:**

One worker injured
One rescuer dead
Four rescuers seriously injured

At a construction site in New Jersey, workers in a 27 foot deep pit scrambled for safety when indicator badges they were wearing changed color. The color change warned them of the presence of methane and hydrogen sulfide gas. One worker collapsed when he returned to the pit to retrieve a tool that he had dropped. Two workers and three police officers entered the pit to attempt a rescue and also collapsed. Finally, fire fighters and workers cooperated in lowering a cable from a crane and removing the unconscious

worker and rescuers from the pit. Four rescuers and the initial victim were held at the local hospital for treatment. One of the police officers who entered the pit, to attempt rescue, died on the way to the hospital. On the previous day, the officer who died had entered the pit and rescued another worker; apparently without suffering any ill effects.

**Lock out/Tag out:**

No one injured (this time)

At the Idaho National Engineering Lab, a reactor was shut down for routine maintenance. The work plan called for an electrical breaker for the reactor safety rod controls to be locked and tagged "open." The operator performing the task mistakenly locked the breaker in the "closed" position but tagged it "open." The operator performing the verification required in the SOP missed the discrepancy. The next day, the work scope changed and the breaker was to be locked and tagged in the "closed" position. A third operator noted the first day's discrepancy and reported it to the supervisor. That operator was instructed to complete the procedure with the breaker in the "closed" position. The first operator, being informed of the mishap, returned to the breaker to examine it and yanked on the breaker handle to see if it was locked in place. The third operator had tagged the device but not physically logged it. The tag fell off and the switch "opened" when the first operator yanked on it, which cut off power to the controls and dropped the safety rods from the withdrawn position to the fully inserted position.

**THE TOLL FOR THESE SIX CASES:**

**DEAD:**
**FIVE WORKERS**
**THREE RESCUERS**

**INJURED:**
**ONE WORKER**
**SIXTY RESCURERS**

B-4 Appendix B

# APPENDIX C:

# GLOSSARY

## A

**ABSORPTION**—The penetration of one substance into the inner structure of another, as distinguished from adsorption, in which one substance is attracted to and held on the surface of another.

**ADSORPTION**—Adherence of atoms, ions, or molecules of one substance to the surface of another (the adsorbent), as opposed to absorption.

**ANESTHETIC**—A chemical that causes a total or partial loss of sensation. Overexposure to anesthetics can cause impaired judgment, dizziness, drowsiness, headache, unconsciousness and death.

**APR**– –**A**ir **P**urifying **R**espirator. Breathing apparatus used with filter cartridges. For use **only** when the air is monitored and is found to have at least 19.5% oxygen.

**ASPHYXIANT**—A substance that can cause unconsciousness or death by lowering the concentration of oxygen in the air or by out competing oxygen metabolically in the body.

**ATTENDANT**—An individual stationed outside the permit required confined space who has the proper training and monitors the (authorized) entrants inside the space.

**AUTHORIZED ENTRANT**—An employee who is authorized by their employer to enter a permit required confined space.

## B

**BLANKING (BLINDING)**—Absolute closure of a pipe, line or duct by fastening a solid plate across its bore so as to completely cover the bore and is capable of withstanding the maximum upstream pressure.

**BLOW DOWN VA LV E**—A manually operated valve to quickly reduce the pressure in a tank.

**BOILING POINT** (BP)—The temperature at which the vapor pressure of the material being heated equals the atmospheric pressure.

**BREAKTHROUGH**—The action of a chemical physically passing through a material.

**BREAKTHROUGH TIME**—The actual time it takes a chemical to pass from the exterior surface of a material to the interior surface by permeation.

**BULKHEAD**—An upright partition separating compartments.

## C

**CARCINOGEN**—A substance that causes cancer.

**CAUSTIC**—As a noun, it usually refers to caustic soda (sodium hydroxide). As an adjective, it refers to any strongly alkaline (basic) material which has a corrosive or irritating effect on living tissue.

**CEILING (C or TLV-C)**—Exposure level to employees that shall not be exceeded during any part of the work day.

**CHEMICAL INCOMPATIBILITY**– – Chemicals incapable of coexisting harmoniously; gives a harmful reaction.

**CHEMICAL RESISTANCE**—The ability of a fiber, fabric, or material to resist the effects of direct chemical exposure/contact.

**CHRONIC TOXICITY**—A poisonous effect resulting from long-term exposure to low dosages of toxic substances. As a disease, long-lasting or frequently recurring.

**COMBUSTIBLE SUBSTANCE**—A solid, liquid, or gas that will burn.

**CONFINED SPACE**—A space which, by design, has limited openings for entry and exit, unfavorable natural ventilation which could contain or produce dangerous air contaminants, could contain a hazardous atmosphere and which is not intended for continuous employee occupancy. A confined space includes (but is not limited to) a tank, vessel, pit, ventilation duct work, vat, boiler, sewer, or underground utility vault. (NJAC 12:100-9.2)

**CORROSIVE**—Materials that cause irreversible damage to containers or human tissue.

## D

**DECOMPOSITION**—The basic breakdown of a substance into different substances. Energy will be released by this reaction; in the case of highly reactive materials, the release may be sudden, i.e., explosive.

**DECONTAMINATION**—The process of removing hazardous substances to prevent adverse health, safety, or environmental effects.

**DEGRADATION**—(applied to protective clothing) Chemical decomposition brought about by exposure to heat, sunlight, solvents, or oxidation.

**DENSITY**—The weight of a material divided by its volume. Density is usually measured in grams per cubic centimeter (g/cc).

**DERMAL TOXICITY**—The ability of a pesticide or toxic chemical to poison people or animals by contact with the skin.

**DOUBLE BLOCK AND BLEED**– – T h e closure of a line, duct or pipe by locking and tagging a drain or vent which is open to the atmosphere in the line between two locked-closed valves.

## E

**ETIOLOGIC AGENTS or BIOLOGICAL HAZARDS**—Viable microorganisms or their toxins, which may cause human disease.

**EXPLOSIVE LIMITS**—The range of concentration of a gas or vapor (measured in percent by volume in air) that can explode upon ignition in a confined space. The highest and lowest concentration are called, respectively, the Upper Explosive Limit (**UEL**) and the Lower Explosive Limit (**LEL**). At concentrations lower than the LEL, there is not enough product in the air to explode; the mixture is “too lean.” At concentrations above the UEL, there is not enough oxygen to sustain an explosion; the mixture is “too rich.”

**EXPLOSIVE RANGE**—The number (as a percentage) that results from subtracting the LEL of a substance from its UEL.

## F

**FLAMMABLE LIMITS**—The range of concentration of a gas or vapor (measured in percent by volume in air) that can burn upon ignition in a confined space. The highest and lowest concentration are called, respectively, the Upper Flammable Limit (**UFL**) and the Lower Flammable Limit (**LFL**). (See Explosive limits.)

**FLAMMABLE RANGE**—See Explosive range.

**FLAMMABLE SUBSTANCE**– – A solid, liquid, vapor, or gas that will ignite easily and burn rapidly.

**FLASH POINT** (FP)—The lowest temperature at which the vapor given off by a liquid within a test vessel forms an ignitable mixture with air. This is only a flash, not a sustained fire.

**FREEZING POINT**—The freezing point or melting point of a substance is the t e m p e r a t u re at which its crystal are at equilibrium with its liquid state. The terms melting point and freezing point are used interchangeably, depending on whether that temperature is approached by heating or cooling the substance.

**FUMES**—The particulate, smoke-like emanation from the surface of heated metals. Also, the vapor from concentrated acids, evaporating solvents, or as a result of combustion or other decomposition reaction.

## G

**GRADE D AIR**—The minimum grade of breathing air used in supplied air respirators. The standards are established by CGA and adopted by OSHA 1010.134.

**GAUGE PRESSURE**—(psig) The pressure registered on a gauge. It does not include the standard atmospheric pressure of 14.7 psi.

## H

**HAZARDOUS MATERIAL**—Any substance that, when released from its container, is a potential or actual threat to the safety of life or property when it touches or impinges upon them.

**HAZARDOUS MATERIAL INCIDENT**—The unintentional or uncontrolled release (or real potential release) of a hazardous material.

**HAZARDOUS WASTE**—Any substance that may pose an unreasonable risk to health, safety, or property when transported in commerce for the purpose of treatment, storage, or disposal as waste.

**HEAT STRESS**—Refers to a group of illnesses caused by temperature and a number of interacting factors including other environmental conditions (wind, humidity), clothing, work load, and the individual tolerance of the worker.

**HOT WORK PERMIT**—The employer's written authorization to perform operations which could provide a source of ignition.

## I

**IDLH**—**I**mmediately **D**angerous to **L**ife and **H**ealth—Any condition which poses an immediate or delayed threat to life; would result in irreversible or immediate-severe health effects; would result in eye damage; irritation or other conditions which could impair escape from the permit space.

**IMMEDIATE-SEVERE HEALTH EFFECTS**— Any acute clinical sign(s) of a serious, exposure - related re a c t i o n manifested within 72 hours after exposure.

**IGNITION TEMPERATURE** (Ign. Temp.)— The minimum temperature required to initiate sustained self-combustion of a material or compound.

**INERTING**—Rendering the atmosphere of a confined space non-flammable, non-explosive or otherwise chemically non-reactive by such means as displacing or diluting the original atmosphere with a gas that is non-reactive with respect to that space. The procedure results in an IDLH $O_2$ deficient atmosphere.

**IRRITANT**—A chemical that causes a reversible inflammatory effect on living tissue at the site of contact.

## L

**LIQUIFIED GAS**—Gas which, underpressure, is partially a liquid at 21.1º C (70º F).

## M

**MISCIBILITY**—The ability of a liquid or gas to dissolve completely and evenly in another liquid or gas at any concentration.

## N

**NON-IONIZING RADIATION**—A form of radiation which can impart energy to biological molecules and thereby affect living systems.

**NON-LIQUEFIED GAS**—Gas which, under pressure, is entirely in the gaseous state at 21.1º C (70º F).

**NON-PERMIT CONFINED SPACE**– – (OSHA) a confined space that does not contain or (with respect to atmospheric hazards) have the potential to contain any hazard capable of causing death or serious physical harm.

## O

**OVER PRESSURE**—The pressure above atmospheric pressure that is at the leading edge of a shock wave.

**OXIDATION**—The process in which oxygen combines chemically with another substance. It can be slow (rusting) or fast (fire).

**OXYGEN DEFICIENCY**– – Normal air contains approximately 20.9% oxygen; for the purpose of respirator selection, an oxygen deficient atmosphere is defined as air with less than 19.5% oxygen. (NJAC 12:100-9 and OSHA 1910.146).

**OXYGEN ENRICHED ATMOSPHERE**—An atmosphere containing more than 23.5% oxygen by volume (NJAC 12:100-9.2 and OSHA 1910.146).

# P

**PAPR**—**P**owered **A**ir **P**urifying **R**espirator. The same use limitations apply to a PAPR with a "tight fitting mask" as to an APR. A PAPR with a "loose fitting mask" can only be used for certain sand-blasting or welding operations. (NJAC 12:100).

**PEL**– –**P**ermissible **E**xposure **L**imit – – air concentration in the work place which OSHA allows 8 hrs/day, 40 hrs/wk, over a working lifetime.

**PENETRATION**—1) Refers to chemicals physically passing through protective clothing by way of a tear, cut, or improperly sealed closure. 2) Introducing contaminants into the body by way of exposed cuts or injection by sharp materials (broken glass, metal shards, etc.).

**PERMEATION**—Refers to chemicals passing through protective clothing by absorption. **All** protective clothing is permeable to some extent.

**PERMIT REQUIRED CONFINED SPACE**— (OSHA) A confined space with or the potential of one or more of the following:

1) hazardous atmosphere
2) material that might engulf an entrant
3) internal configuration that could entrap or asphyxiate an entrant with inward converging walls or a floor that slopes downward and tapers to a smaller cross section
4) any other serious health hazards

**PERSISTENCE**—Long-term presence of a substance in the environment before chemical breakdown or biodegradation occurs.

**pH**—A measure of a substance's acidic or basic properties, it is the logarithm of the reciprocal of hydrogen ion concentration in gram atoms per liter. Neutral substances have a pH of 7; acids have a pH less than 7; bases have a pH greater than 7.

**POISON**—Any substance that is harmful to living tissue when applied in relatively small doses. (See Toxin.)

**POLAR SOLVENTS**—A solvent whose positive and negative charges are permanently separated. Polar solvents (e.g. water, alcohol, sulfuric acid) are ionic and conduct electricity.

**ppb**—Parts of a substance per billion parts of air or water. It is a measure of concentration by volume.

**ppm**—Parts of a substance per million parts of air or water. It is a measure of concentration by volume.

**PULMONARY EDEMA**—The condition of having fluid in the lungs. The condition may be fatal.

**PYROPHORIC MATERIAL**—Any liquid or solid that will ignite spontaneously at temperatures below 130º Fahrenheit (54.4º Celsius).

## Q

**QUALIFIED PERSON**—A person designated by the employer, in writing, as capable by education or specialized training, or both, of anticipating, recognizing, and evaluating employee exposure to hazardous substances or other unsafe conditions in a confined space and capable of specifying necessary control or protective action both to insure worker safety. (NJAC 12:100-9.1)

## R

**REACTIVE SUBSTANCE**—A solid, liquid, or gas that can cause an explosion under certain conditions or on contact with other specific substances.

**RESIDUE**—The hazardous material that remains in a packaging after its contents have been unloaded to the maximum extent practicable and before the packaging is refilled or cleaned and purged to remove any hazardous vapors.

## S

**SADT**– –**S**elf-**A**ccelerating **D**ecomposition **T**emperature—The molecules of many compounds may be disassociated (decomposed) by the application of heat. Some compounds release heat (are exothermic) during this decomposition which speeds up the reaction. Such compounds are said to have reached their Self-Accelerating Decomposition Temperature. Typically, chemical reactions accelerate by 50% for every 10º F their temperature is raised—chemicals at their SADT require no external source to raise their temperature.

**SAR**—**S**upplied **A**ir **R**espirator—A type of respirator that uses a hose to bring compressed air to the wearer's breathing mask. The air line is often connected to a small air tank on the wearer's harness which acts as an escape air supply and from there to the breathing mask. Some companies refer to this type of device as a SABA (**S**upplied **A**ir **B**reathing **A**pparatus).

**SCBA**– –**S**elf-**C**ontained **B**reathing **A**pparatus—A type of respirator that supplies air from a tank of compressed air that is carried by the wearer on a backpack-type harness. They can be demand or pressure-demand design but only the pressure-demand type may be used for working with hazardous materials.

**SENSITIZER**—A chemical that causes exposed people or animals to develop an allergic reaction after repeated exposure.

**SOLUBILITY**—The ability or tendency of one substance to dissolve evenly in another.

**SOLVENT**—Any substance capable of dissolving another substance (the solute) to form a uniformly dispersed mixture (the solution). Water, referred to as the "universal solvent," is a strongly polar solvent.

**SPECIFIC GRAVITY** (Sp. Gr.)—The ratio of the density of a solid, or liquid, to the density of an equal volume of water.

**STEL**—**S**hort **T**erm **E**xposure **L**imit—The exposure level of a hazardous material that is considered safe for employees to work infor short periods of time (15-minutes), four times a day with one hour in between exposures to recover.

**STLC**—**S**hort **T**erm **L**ethal **C**oncentration— The exposure level of a hazardous material that is considered to be lethal with 10 minutes of exposure time for employees.

**SUBLIMATION**—The direct passage of a substance from the solid to the gaseous state without passing through the intermediate (liquid) state. An example is dry ice (solid carbon dioxide) which vaporizes at room temperature.

**SUMP**—Lowest point of a tank. The emergency valve or outlet valve is usually attached to a tank's sump.

## T

**TARGET ORGAN (TISSUE)**—The organ or tissue of the body that is susceptible to a given toxin.

**TLV**– –**T**hreshold **L**imit **V**alue – – Recommended air concentration in which most persons can work for an 8-hour work day without ill effects. Set by the ACGIH.

**TLV- C**– –**T**hreshold **L**imit **V**alue –**C**eiling – – Exposure level to employees that shall not be exceeded during any part of the work day.

**TLV-STEL**—See STEL.

**TOXICITY**—The state or degree of being poisonous; a harmful effect on biological mechanisms.

**TTL**– –**T**hreshold **T**oxic **L**imit – – The estimated exposure value, below which no ill effects should occur to an individual.

**TWA**– –**T**ime **W**eighted **A**verage – – The calculated average concentration for an 8-hour work day, 10-hour work day or 40-hour work week to which workers may be exposed over their working career without ill effects. Set by the ACGIH.

## V

**VAPOR**—An air dispersion of molecules of a substance that is liquid or solid in its normal state (room temperature).

**VAPOR DENSITY** (VD)—Relative density of a vapor compared to the density of air.

**VAPOR PRESSURE**—A measure of how readily a liquid or solid mixes with air at its surface. A higher vapor pressure indicates a higher concentration of the substance in the air and therefore increases the likelihood of breathing it in.

**VOLATILITY**—The tendency of a solid or liquid to pass into the gaseous state at a given temperature.

## W

**WATER REACTIVE MATERIALS**– – Materials which will violently decompose and/or burn vigorously when they come in contact with water.

**WATER SOLUBILITY**—The degree to which a material, or its vapors, are soluble in water. Materials that are completely soluble in water are said to be **miscible**.

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