

Mastering Confined Space Safety

A Comprehensive Guide for Safety Directors

Presented By BHHC Loss Control

June 2025

Introduction

1130

Number of fatalities in confined spaces from 2011 to 2018

166

Highest annual number of CSE fatalities in 2017

205

Tanks, bins, vats: 205 fatalities, primarily due to engulfment

203

Ditches, channels, trenches: 203 fatalities, mostly from trench collapses

129

Underground mines, caves, tunnels: 129 fatalities, often due to inhalation of harmful substances

Fatality at a Paper Mill

- Two contract workers died of smoke inhalation and multiple blunt-force injuries during maintenance work on the inner walls of a connected pair of pulp bleaching towers at a paper mill.
- Two crews, each working in connected towers. Crew one started a fire which spread to tower two and caused the 94' tall scaffold to ignite and eventually collapse on the two workers
- Whenever workers are assigned duties in a permit required confined space (PRCS), employers must ensure that all hazards are identified, and entry permits are issued before starting work

CAUSES & CONTRIBUTORY CAUSES

- There was **no communication** between contractors to share concurrent work activities, or any planned changes.
- Failure to use available **cold work options**.
- Hot work deficiencies:
 - Failure to recognize the **heat gun as an ignition source**
 - Failure to request a **hot work permit** for its use near flammable vapors.
 - Use of **an ignition source near a flammable liquid**.
 - A **fire extinguisher was not immediately available** during hot work activities.
- Confined space deficiencies:
 - **Failure to identify hazards** within the confined space, such as use of a flammable resin and combustible FRP, or the fire hazard introduced by use of the heat gun.
 - Failure to complete required sections of the **confined space entry permit**, including a designated entry supervisor
 - Rescue personnel **could not respond in a timely manner**.
 - No **continuous forced air ventilation** while work was being performed in the confined space.
 - **Failure to recognize the pair of towers as interconnected** and communicate/coordinate concurrent operations between different crews



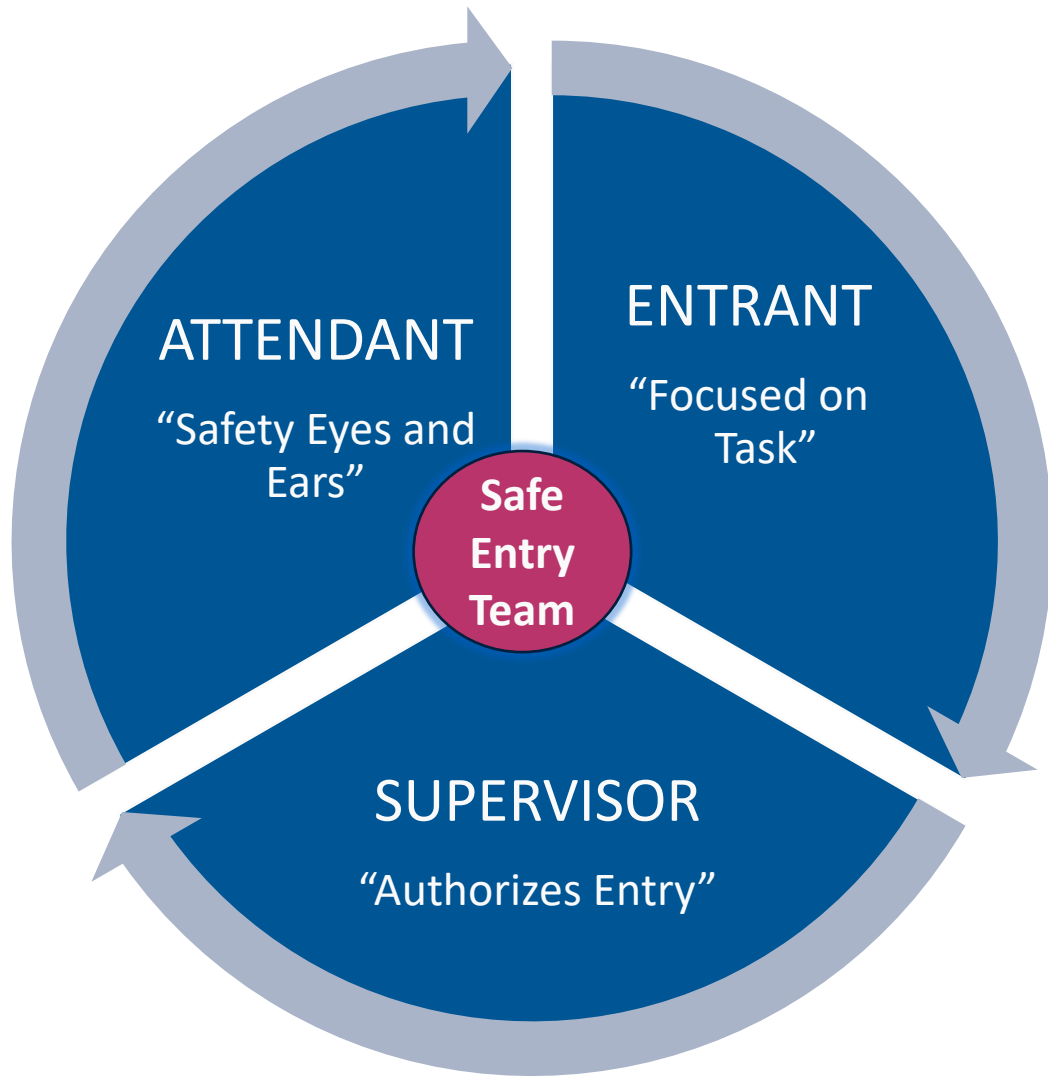
CSE Fatalities

Type of confined space	Fatalities	Most frequent event ^[1]
Tank, bin, vat interiors	205	Engulfment in other collapsing material (86)
Silo, grain bin interiors	107	Engulfment in other collapsing material (72)
Septic tank or water tank interiors	19	Falls to lower level (7)
Hopper interiors	10	Engulfment in other collapsing material (7)
Oil storage tank interiors	7	Inhalation of a harmful substance (4)
Grain elevator interiors	6	Engulfment in other collapsing material (3)
Trash bin or dumpster interiors	3	No publishable data
Ditches, channels, trenches, excavations	203	Trench collapse (166)
Underground mines, caves, tunnels	129	Inhalation of a harmful substance (29)
Sewers, manholes, storm drains	61	Inhalation of a harmful substance (27)
Underground mines, mine tunnels	58	Struck by falling object or equipment (21)
Confined spaces on vehicles	45	Inhalation of a harmful substance (20)
Tanker truck interiors	20	Inhalation of a harmful substance (16)
Manure pits	18	Inhalation of a harmful substance (7)
Crawl spaces	13	Direct exposure to electricity, 220 volts or less (5), Exposure to environmental heat (5)
Wells, cisterns	10	Falls to lower level (6)

[1] Based on the BLS Occupational Injury and Illness Classification System (OIICS) 2.01 implemented for 2011 data forward. More on OIICS can be found at <https://www.bls.gov/iif/definitions/occupational-injuries-and-illnesses-classification-manual.htm>.

July 2025

1. Identify the Confined Spaces at your facilities
2. Determine the Confined Space Hazards for each
3. Permit Required Confined Spaces (PRCS) vs. Non-Permit Required Confined Spaces
4. Confined Space Entry Programs and Controls
5. Confined Space Entry Control Hierarchy



Source – Statistics from OSHA

Focus Confined Space Entry

#1

According to OSHA, confined space incidents remain among the most dangerous workplace hazards, often resulting in multiple fatalities due to atmospheric hazards or rescue attempts



Construction, Manufacturing, Utilities and Wastewater treatment are the industries most affected

60%

The fatality rate in confined spaces is disproportionately high compared to other work environments. In past years, 60% of confined space deaths involved would-be rescuers.

<6%

Immediate unconsciousness; coma in 40 seconds; death likely within minutes

We will focus on Best Practices....

...with a hint of compliance. Why?

- The goal of a CSE effort is to prevent injuries and accidents in confined spaces.
- Regulatory standards are *minimum* requirements. Best in class employers go above and beyond.
- Remember that every workplace is different. Find the risk potential and address it proactively.

From: World Construction Today





Steps to CSE Safety!

- 1 Identify the confined spaces at your facility.
- 2 Identify the specific hazards each may present
- 3 Determine if they are Permit Required
- 4 Create CSE Procedures (program)
- 5 Train and Educate Staff

1 Defining a Confined Space

Tanks

Manholes

Crawl spaces

Boilers

Silos

Utility vaults

Pits

Vats

Characteristics of a confined space:

- **Limited Entry and Exit:** The space has few or narrow openings for people to enter and exit.
- **Not Designed for Continuous Occupancy:** It's not typically meant to be a place where people would regularly work or spend a lot of time.
- **Potential for Hazards:** Confined spaces can pose various hazards, such as hazardous atmospheres, engulfment, or entrapment.

Defining a Confined Space

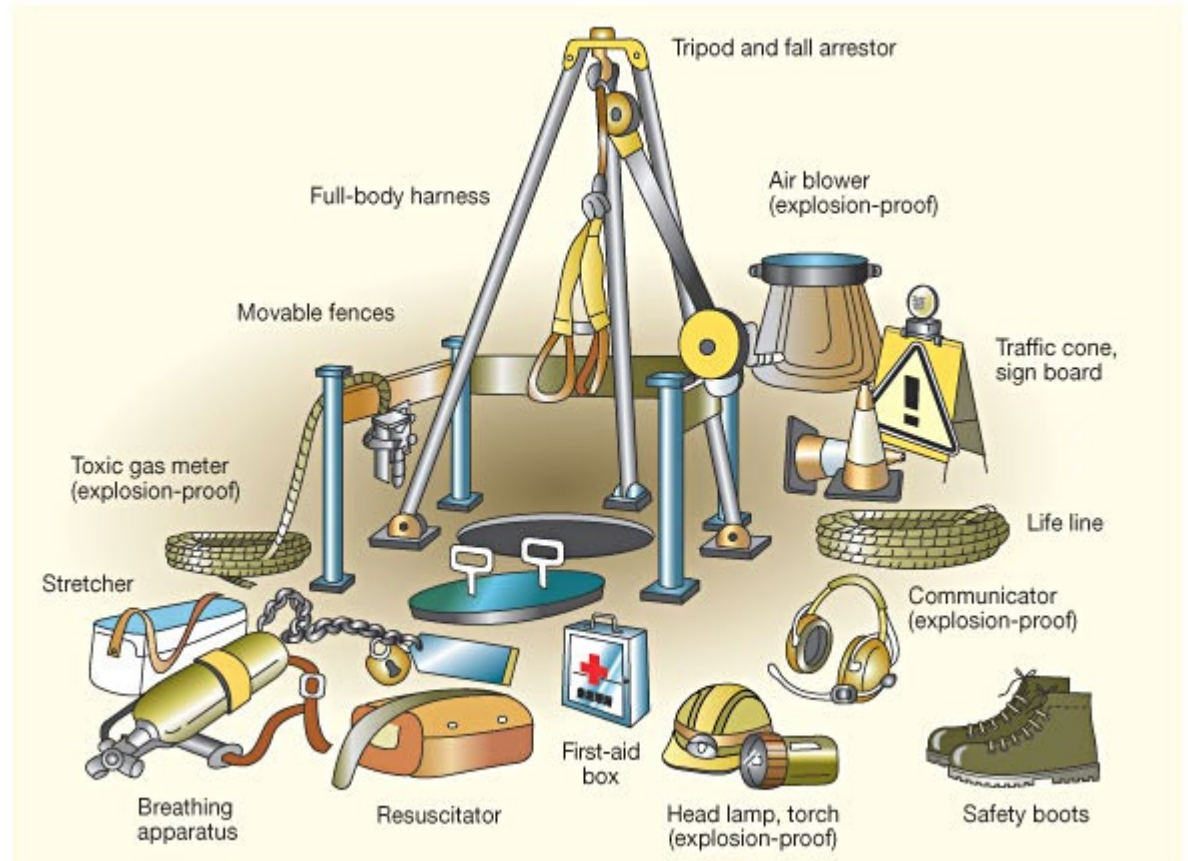
Confined Space List

- Space ID or Name
 - Location (building, floor, coordinates, etc.)
 - Date of Assessment
 - Assessor's Name and Contact Info
- Physical Description
 - Type of space (e.g., tank, vault, silo, pit, tunnel)
 - Dimensions (length, width, height, volume)
 - Access points (number, size, location)
 - Lighting and visibility conditions

2

Confined Space Hazards

- **Hazardous Atmospheres:** The enclosed nature of a confined space can allow for the buildup of toxic, flammable, or oxygen-deficient gases.
- **Engulfment:** Free-flowing materials (like grain or sand) can engulf a worker, making escape difficult or impossible.
- **Entrapment:** Narrow openings and inwardly converging walls can trap workers inside the space.
- **Other Hazards:** Confined spaces can also present risks related to electrical hazards, noise, or other workplace hazards.



Hazardous Atmosphere



Hazardous Atmosphere

- Flammable gas, vapor, or mist more than 10% of its LFL (LEL)
- Airborne dust at a concentration that meets or exceeds its LFL (Rule of thumb: vision at <5')
- Oxygen <19.5% or >23.5%
- Atmospheric concentrations of substances above PEL
- Other atmospheric conditions: IDLH.

Oxygen Levels

- **20.9%** is the normal concentration of Oxygen in the air
- **19.5%** is the minimum acceptable level – Below is **Oxygen Deficient**
- **23.5%** and higher is considered **Oxygen Enriched**, presenting other hazards
 - Causes flammable and combustible materials to burn violently when ignited
 - Hair, clothing, materials, etc.
 - Oil soaked clothing and materials

19.5 %	Minimum acceptable oxygen level.
15 - 19%	Decreased ability to work strenuously. Impaired coordination. Early symptoms.
12-14%	Respiration increases. Poor judgment.
10-12%	Respiration increases. Lips blue.
8-10%	Mental failure. Fainting. Nausea. Unconsciousness. Vomiting.
6-8%	8 minutes – fatal, 6 minutes - 50% fatal 4-5 minutes - possible recovery
4-6%	Coma in 40 seconds. Death.

Source – OSHA

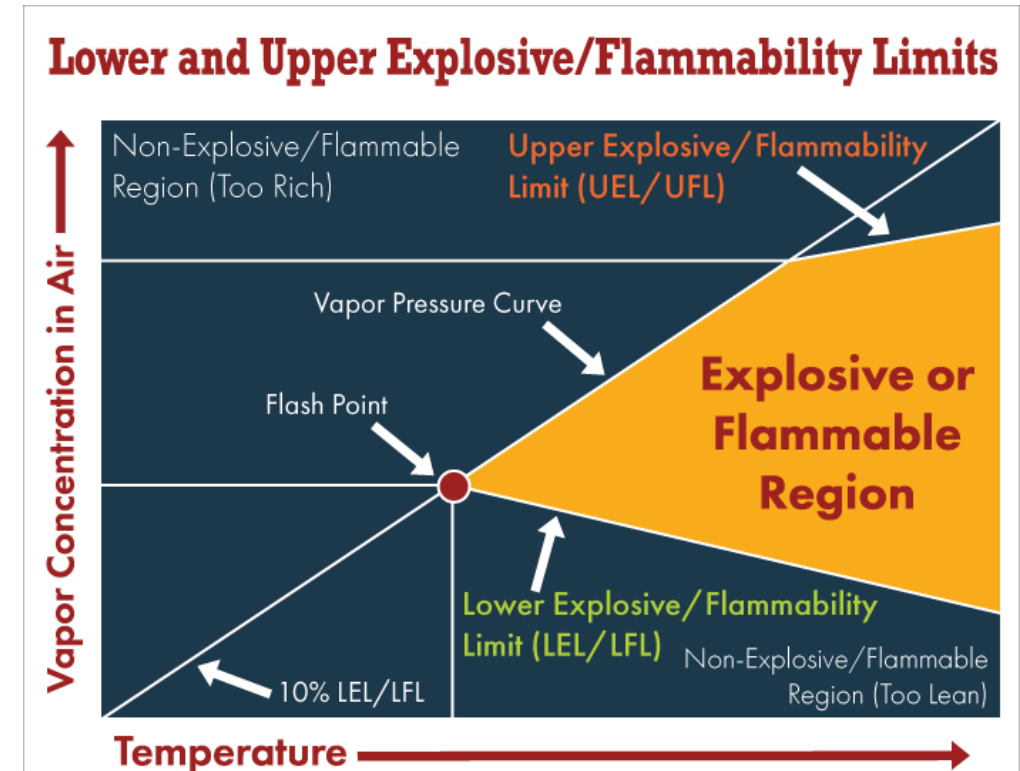
Flammable Atmosphere

- **Critical Factors:**

- Oxygen content in the air
- Presence of a flammable gas, or vapor
- Presence of dust (visibility of 5' or less)
- Proper air/gas mixture can lead to explosion

- **Typical Ignition Sources:**

- Sparking or electric tool
- Welding / cutting operations
- Smoking

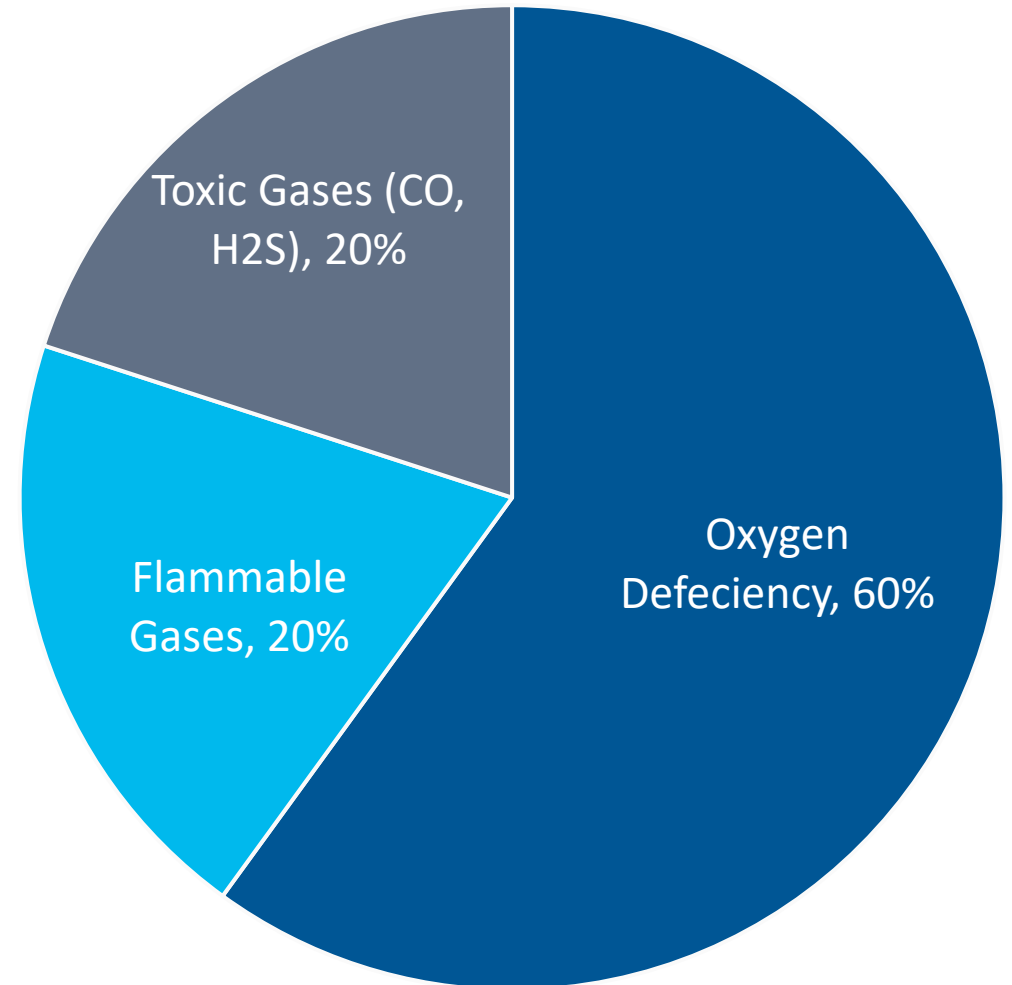


Source – OSHA

Toxic Atmosphere

- **Product stored in a confined space:**
 - Gases released when cleaning
 - Materials absorbed into walls of confined space
 - Decomposition of materials in the confined space
- **Work performed in a confined space:**
 - Welding, cutting, brazing, soldering
 - Painting, scraping, sanding, degreasing
 - Sealing, bonding, melting
- **Areas adjacent to a confined space**

Fatal Atmospheric Conditions





Tri Gas Meter

- Oxygen Level
- LEL
- Toxic Gas
 - Carbon Monoxide
 - Hydrogen Sulfide
 - VOC
- Must be calibrated prior to use
- Alarms usually at 10% of danger level
- Oxygen level <19.5% or greater than 23.5%
- Probe to test without entering

Monitoring the Air

Always test the air at various levels to be sure that the entire space is safe.

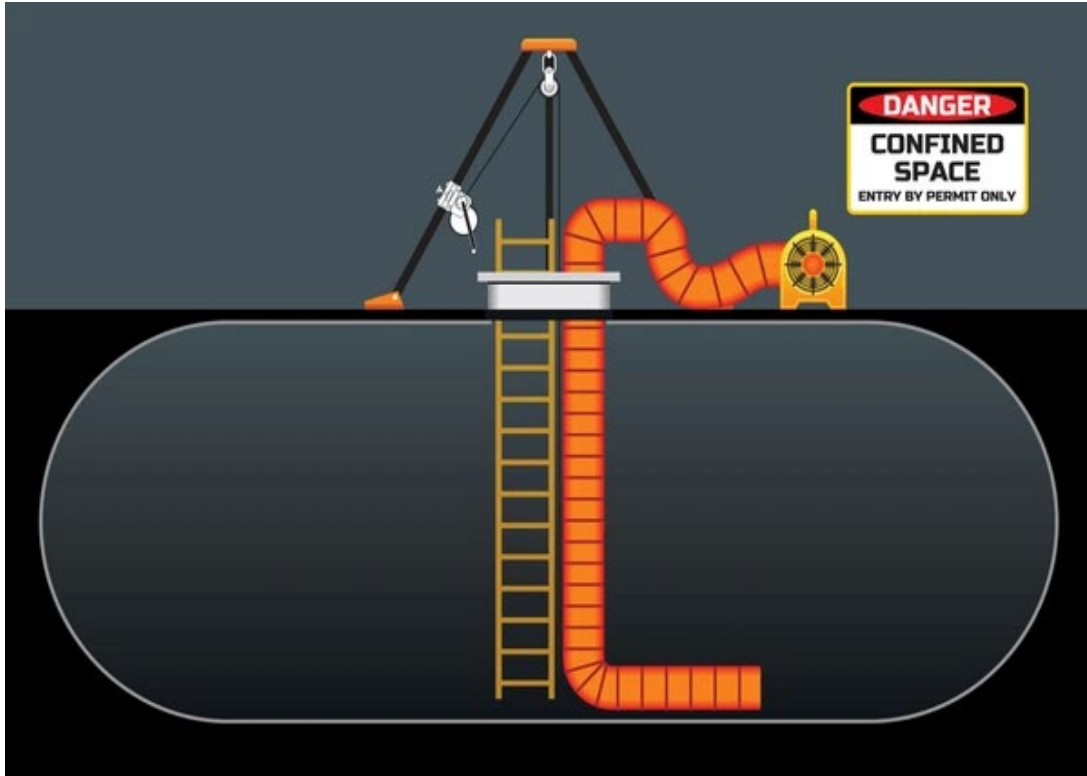
Good air near the opening does NOT mean there is good air at the bottom!



- Prior to entry, the internal atmosphere shall be tested for:
 - Oxygen content
 - Flammable gases & vapors
 - Potential toxic air contaminants

In that order!

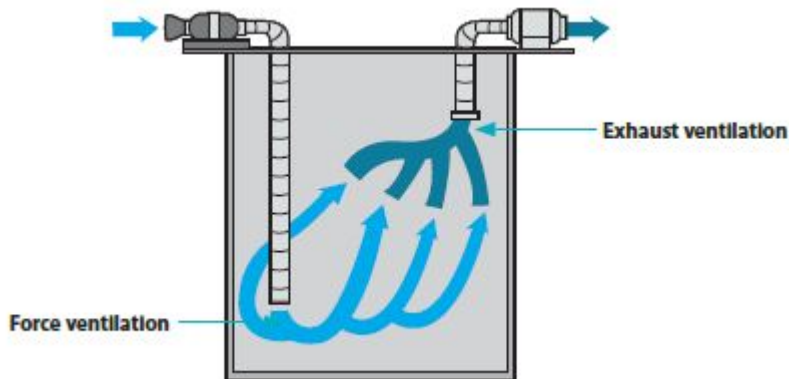
- Entrant/representative must be allowed to observe pre-entry testing



Ventilate the Space

Recommended Air Changes per Hour (ACH)

- **Minimum Standard:** 7 air changes per hour is commonly recommended as a baseline for general confined space ventilation.
- **High-Risk Environments** (e.g., toxic gases, flammable vapors): 20 air changes per hour or more may be necessary, especially when purging contaminants or maintaining safe oxygen levels.
- **Continuous Ventilation:** Ventilation should be continuous during occupancy unless testing confirms that the atmosphere remains safe without it.



Engulfment

- The surrounding & effective capture of a person by a liquid or finely divided (flammable) solid substance that can:
 - Be aspirated to cause death by filling or plugging the respiratory system
 - Exert enough force on the body to cause death by strangulation, constriction, or crushing.
 - Loose, granular materials stored in bins and hoppers - grain, sand, coal, etc.
 - Crusting and bridging below a worker
 - Flooding of confined space
 - Water or sewage flow



Source – OSHA

Entrapment

- Configuration Hazard
 - Has an internal configuration such that an entrant could be trapped or asphyxiated
 - By inwardly converging walls
 - By a floor which slopes downward & tapers to a smaller cross-section



Source -- CalOSHA

Other Hazards – Moving Machinery

“Hazardous Motions are machinery motions and actions that can cause injury to employees.”



- **Rotating Motion:** This includes parts like shafts, couplings, and gears that rotate.
- **In-Running Nip Points:** These occur where two parts rotate in opposite directions and are close together, such as between rollers or gears.
- **Reciprocating Motion:** This involves back-and-forth or up-and-down movements, such as those found in presses or saws.
- **Transversing Motion:** This is a straight, continuous movement, like conveyor belts.

Other Hazards

- **Noise** – Amplified due to acoustics within the space Damages hearing; affect communication
- **Slick / Wet Surfaces** - Slips and falls, Increased chance of electric shock
- **Falling Objects** - Topside openings expose workers inside confined space to falling objects
- **Temperature Extremes** - Extreme heat & cold, Humidity factors, Extremely cold liquids, Work processes inside the confined space can increase temperature extremes

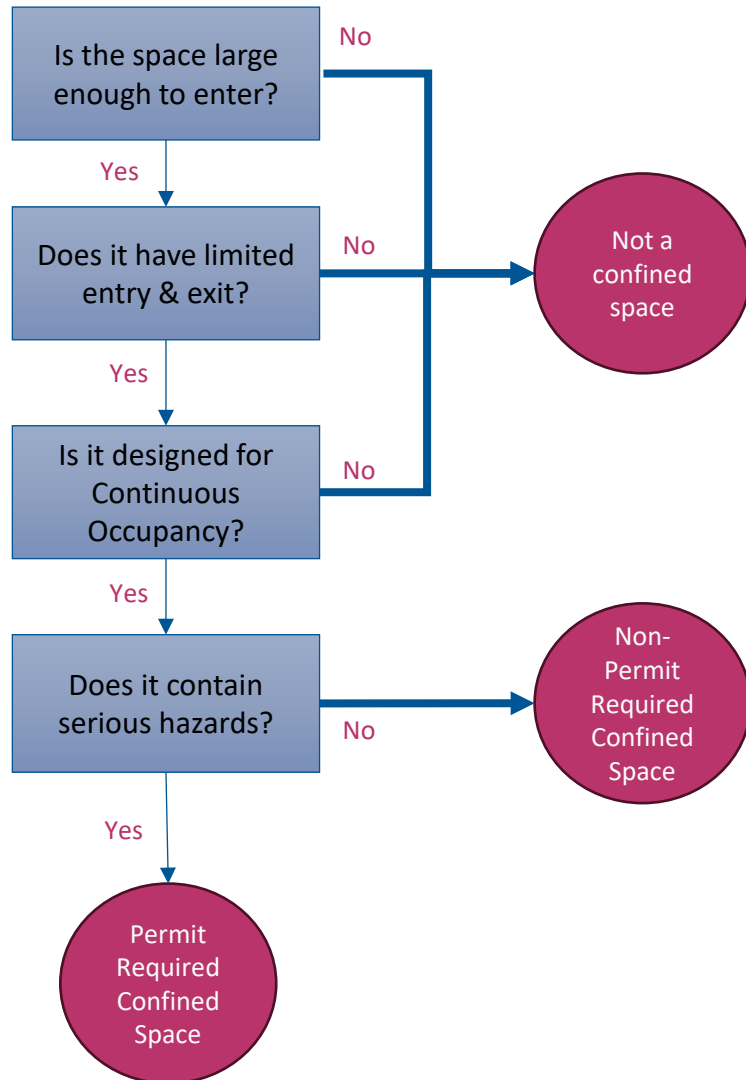
ACGIH Work Rest Requirements American Conference of Government Industrial Hygienists

Work Demands	Acclimatized Worker				Unacclimatized Worker			
	Light	Moderate	Heavy	Very Heavy	Light	Moderate	Heavy	Very Heavy
100% Work	29.5	27.5	26		27.5	25	22.5	
75% Work 25% Rest	30.5	28.5	27.5		29	26.5	24.5	
50% Work 50% Rest	31.5	29.5	28.5	27.5	30	28	26.5	25
25% Work 75% Rest	32.5	31	30	29.5	31	29	28	26.5

Defining a Confined Space

- Space ID or Name
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 - Date of Assessment
 - Assessor's Name and Contact Info
- Physical Description
 - Type of space (e.g., tank, vault, silo, pit, tunnel)
 - Dimensions (length, width, height, volume)
 - Access points (number, size, location)
 - Lighting and visibility conditions
- Hazard Identification
 - Atmospheric hazards (oxygen deficiency, toxic gases, flammable vapors)
 - Engulfment risks (liquids, loose materials)
 - Mechanical or electrical hazards
 - Temperature extremes
 - Noise or vibration
 - Biological hazards

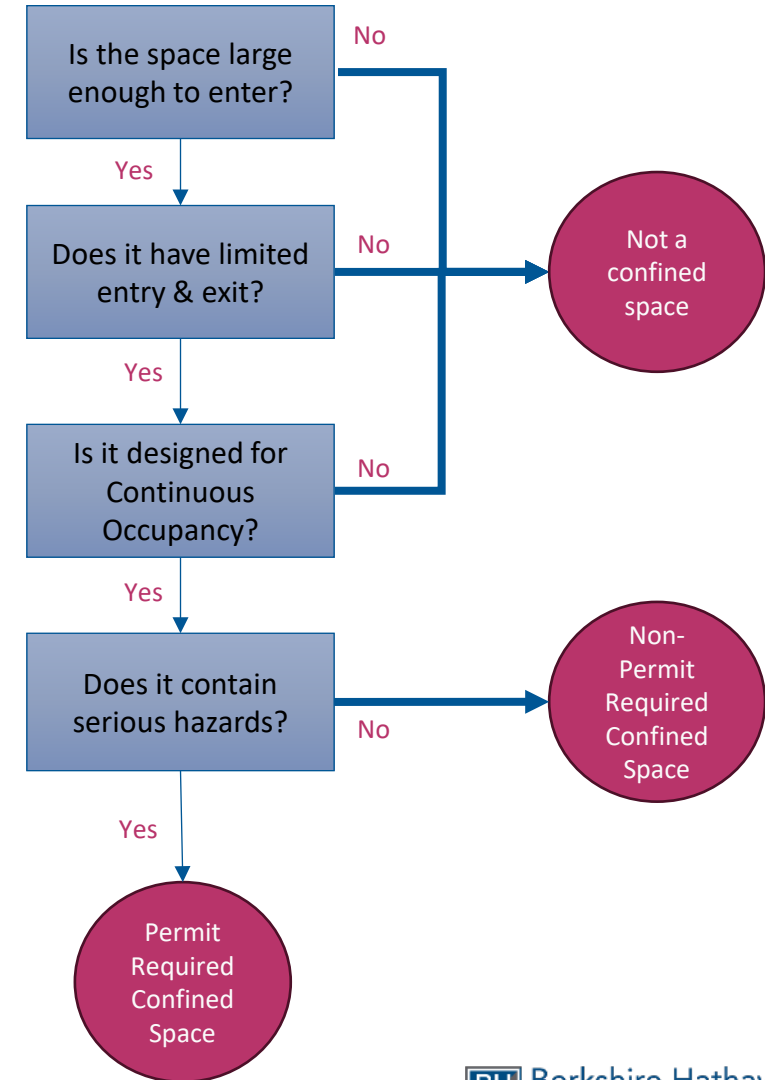
Permit or Non-Permit Required Space



- Non-Permit and Permit required spaces are the same with the exception of a potentially hazardous environment
- Spaces can change from one to the other if the potential for a hazardous atmosphere changes

Reclassification: Non-permit to Permit

- Non-Permit to Permit Required
 - Where changes in use or configuration might increase the hazards
 - When work may generate hazard
- Reclassification: permit to non-permit
 - When atmospheric hazards are not present, or while they remain eliminated
 - Entry to determine this must be made in full compliance



Defining a Confined Space

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 - Atmospheric hazards (oxygen deficiency, toxic gases, flammable vapors)
 - Engulfment risks (liquids, loose materials)
 - Mechanical or electrical hazards
 - Temperature extremes
 - Noise or vibration
 - Biological hazards
- Permit Requirements
 - Is it a permit-required confined space under OSHA 1910.146?
 - Permit form location and responsible personnel

Confined Space Entry Program

Steps Leading to a Written Program:

- Employer shall evaluate workplace
- If workplace contains permit spaces, signs shall be posted to give notice of
 - Existence
 - Location
 - Danger
- Effective measures shall be taken to prevent entry if not allowed
- If entry is allowed, a program must be:
 - Written
 - Implemented
 - Made available to employees/representatives

Written Program:

- Develop & implement means, procedures & practices for safe entry:
 - Specify acceptable entry conditions
 - Let entrant/rep observe monitoring/testing
 - Isolate the permit space
 - Purge, inert, flush or ventilate as necessary
 - Provide barriers
 - Verify acceptable conditions throughout entry

Confined Space Entry Program

Provide & Maintain Equipment:

- Testing & monitoring equipment
- Ventilation equipment
- Communication equipment
- PPE
- Lighting equipment
- Barriers & shields
- Ingress/egress equipment (ladders, etc.)
- Rescue & emergency equipment
- Other needed entry/rescue equipment

Written Program:

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A Written Program

- Entry and Rescue Procedures
- Authorized entrants and attendants
- Entry supervisor
- Communication methods
- Rescue plan and equipment
- Emergency contact info
- Ventilation and Isolation
 - Ventilation method (natural or mechanical)
 - Ventilation Specifics
- Lockout/tagout procedures - Isolation of energy sources (electrical, hydraulic, pneumatic)
- PPE Requirements
 - Respirators
 - Harnesses and retrieval systems
 - Protective clothing
- Gas detectors

Confined Space Entry Program Needs

- Additional Needs

- Evaluate permit space to ensure acceptable conditions
- Provide at least one attendant
- Provide means & procedures for emergency response to two spaces if monitored by one attendant
- Designate program personnel & duties and provide training
- Develop & implement procedures for rescue and emergency services
- Develop & implement a system for entry permits
 - preparation
 - issuance
 - use
 - cancellation

- Additional Needs

- Develop & implement procedures to coordinate multi-employer entry operations
- Develop procedures for concluding entry operations
- Review entry operations when protective measures appear insufficient
- Review program at least annually, using retained cancelled permits



OSHA Program Wizard: Permit-Required Confined Spaces

A company may need a confined space entry program to ensure the safety and well-being of workers who need to enter or work in confined spaces. Confined spaces are defined as areas that have limited access points, are not designed for continuous occupancy, and may pose potential hazards such as inadequate oxygen levels, toxic gases, or physical obstructions. Companies need a confined space entry program to implement proper identification, evaluation, and control measures for such spaces. The program helps:

- Access hazards
- Implement safe entry procedures.
- Provide appropriate training to employees.
- Ensuring rescue plans are in place.
- Ensure ongoing safety compliance.

The Occupational Safety and Health Administration (OSHA) has set standards to protect workers who enter confined spaces. OSHA's Confined Spaces in Construction standard, 29 CFR 1926.1200, lays down requirements for safe entry, exit, and work procedures in confined spaces in construction sites. It emphasizes the importance of:

- Hazard identification
- Atmosphere testing
- Ventilation
- Communication protocols
- Personal protective equipment (PPE)
- Rescue procedures.

The standard also mandates the use of permits for entry into confined spaces and requires employers to develop a written confined space entry program. It outlines responsibilities for employers, supervisors, and workers and sets minimum requirements for adequate training and documentation.

Use

This document is a program wizard to help develop or enhance a safety and health program. It provides a guide to help build an organization-specific program with standard practices and procedures that most employers must implement. The Wizard is not all-inclusive. Be certain to evaluate other standards, related regulations, and your commitment to workplace safety. Obtain input from your workforce when developing this program. A plan is only as good as the commitment behind it.

Instructions

To develop your customized plan, follow steps 1 through 3 in order, by clicking the buttons and following the instructions prompted by the program.

Step 1	Customize
Step 2	Review & Approve
Step 3	Print

Confined Space Entry Wizard

Macro Driven:

- Answer questions and complete the program draft for your operation

Cut and Paste

- If macro does not work for you, you can simply go through and replace placeholders

Permits

- **Permit Required Entry**

- Entry permit completed by employer authorizes entry
- Documents completion of entry measures required by 1910.146(d)(3)
- Supervisor's signature authorizes entry
- Posted permit provides assurance to entrants/ reps of completed pre-entry prep's
- Duration of permit may not exceed time needed to complete assigned task

- **Permit Required Entry**

- Entry supervisor terminates entry & cancels permit when:
 - The entry operation covered by the permit has been completed; or
 - A condition that is not allowed under the entry permit arises in or near the permit space.
- Cancelled permits are retained for at least 1 year
 - Problems must be noted & evaluated

Entry Permits

- Space to be entered, purpose, date & duration
- Names of attendants and supervisor
- Hazards of space
- Measures to isolate space & control hazards
- Acceptable entry conditions
- Test results, initial and periodic
- Rescue and emergency services
- Communication procedures
- Equipment
- Other information
- Other permits, such as hot work

CONFINED SPACE ENTRY PERMIT
ALL COPIES OF PERMIT WILL REMAIN AT JOB SITE UNTIL JOB IS COMPLETED.

LOCATION/DESCRIPTION OF CONFINED SPACE _____ DATE _____
PURPOSE OF ENTRY _____ TIME _____
DEPARTMENT _____ PERSON IN CHARGE OF WORK _____ EXPIRATION _____

COMMUNICATIONS:

SUPERVISOR(S) In Charge of Crews	Type of Crew	Phone

SPECIAL REQUIREMENTS:

	YES	NO		YES	NO
Lockout De-energize			Escape Harness Required		
Lines Broken - Capped or Blanked			Tripod Emergency Escape Unit		
Purge - Flush and Vent			Lifelines		
Ventilation			Fire Extinguishers		
Secure Area			Lighting		
Breathing Apparatus			Protective Clothing		
Resuscitator - Inhalator			Respirator		

TEST(S) TO BE TAKEN

(VALID FOR ONE 8 HOUR TURN ONLY)	P.E.L.*	YES	NO	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date	Date
				M	M	M	M	M	M	M	M	M	M	M
% of Oxygen	-19.5% +21%													
% of L.E.L.*	Any % over 10%													
Carbon Monoxide	50 ppm													
Aromatic Hydrocarbon	10 ppm													
Hydrocyanic Acid	10 ppm													
Hydrogen Sulfide	10 ppm													
Sulfur Dioxide	5 ppm													
Ammonia	25 ppm													

NAME OF GAS TESTER _____

NOTE: Continuous/periodic tests shall be established before beginning the job.
Any questions pertaining to test requirements should be directed to _____

TESTING INSTRUMENTS USED	NAME	TYPE	IDENTIFICATION NO.

AUTHORIZED ENTRANTS: _____ AUTHORIZED ATTENDANTS: _____

PERMIT AUTHORIZATION:
I certify that all actions and conditions necessary for safe entry have been performed.

NAME (Print) _____ SIGNATURE _____
DATE _____ TIME _____

*P.E.L. Permissible Entry Level
*L.E.L. Lower Explosion Level

FIRE CALL _____ AMBULANCE CALL _____ RESCUE CALL _____

Duties of Authorized Entrants

- Know hazards and symptoms
- Use equipment properly
- Communicate with attendant
- Alert attendants of symptoms or prohibited condition
- Exit as quickly as possible after:
 - Attendant or supervisor give order to evacuate
 - Recognizing sign or symptom of exposure
 - Detecting prohibited condition
 - Evacuation alarm is activated

Duties of Attendant

- Know hazards, symptoms & behavioral effects
- Count, monitor, communicate with & protect personnel
- Stay posted outside space until released
- Summon rescue/emergency services
- Warn unauthorized persons to stay away or exit; inform others if present in space
- Non-entry rescue
- No other interfering duties

Duties of Entry Supervisor

- Know hazards, symptoms & behavioral effects
- Verify permit conditions
- Authorize & terminate entries
- Verify rescue availability
- Remove unauthorized persons
- Ensure compliance with terms of entry permits

Rescue and Emergency Services

Employer shall:

- Evaluate a prospective rescuer's timely response according to hazards
- Evaluate prospective rescue service's ability for pertinent types of rescue
- Select a rescue service based on those criteria
- Inform rescue service of potential hazards
- Provide rescue service with access to permit spaces to develop appropriate plans and practice rescue operations

Rescue service employer shall:

- Provide PPE at no cost to employees.
- Train affected employees to perform assigned rescue duties
- Train in First Aid/CPR
- Practice making permit required rescue at least every 12 months

Retrieval systems for non-entry rescue

- Authorized entrant shall use a chest or full body harness with retrieval line
- Other end of line connected to make quick rescue possible

Alternate Procedures

Alternate Procedures

- Compliance may be simplified (paragraphs (d)-(f) and (h)-(k) exempted) if:
- Can demonstrate that the only hazard is atmospheric
- Can demonstrate that continuous forced air ventilation can control the hazard
- Supportive monitoring & inspection data is developed



ALLEGRO Confined Space Fan: 115 V AC, 8 in Duct Dia, 1/3 hp Horsepower, 778 cfm Max Flow in Free Air

Item 8XAC7 Mfr. Model 9534-15

Alternative Procedures

Simplified Procedures:

- It must be safe to remove the entrance cover
- Open entrance covers must be promptly guarded with Railing or temporary cover/barrier
- Prior to entry, the internal atmosphere shall be tested for:
 - Oxygen content
 - Flammable gases & vapors
 - Potential toxic air contaminants
- Entrant/representative must be allowed to observe pre-entry testing

If hazardous atmosphere is detected during entry:

- *Employees out immediately*
- *Hazard evaluated*
- *Protective measures implemented*

Documenting Alternative Procedures

Documentation:

- Certification requirements:
 - Written
 - Space safe to enter (verified)
 - Pre-entry measures taken (verified)
 - Date
 - Location of the space
 - Signature of certifier
 - Available to entrant/representative



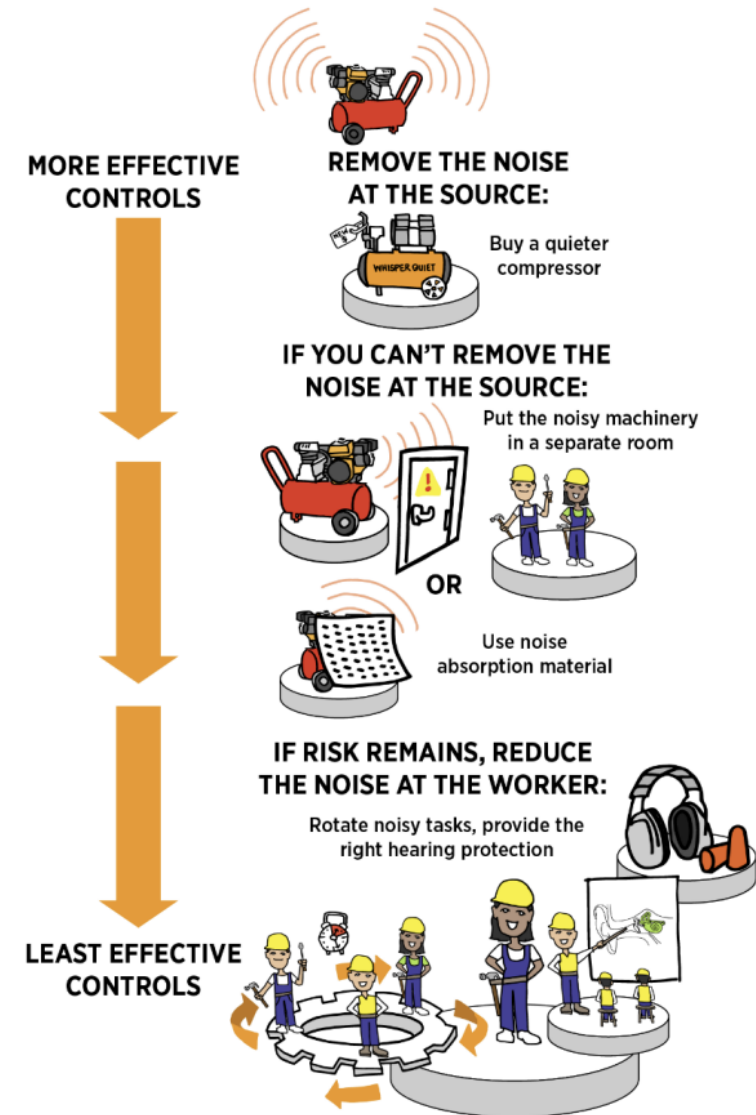
Confined Space Entry Control Hierarchy

Control Hierarchy

Effective Controls Make a Difference

- Training rarely makes a significant impact unless training about a change in status quo
- PPE is very dependent on employee adherence
- Engineering controls are much more positive to control loss
- Substitution and Elimination of the hazard are the most effective controls

EXAMPLE HAZARD: A Noisy Compressor



From:
OSHA IDENTIFYING HAZARD CONTROL
OPTIONS: The Hierarchy of Control

Implementing Controls

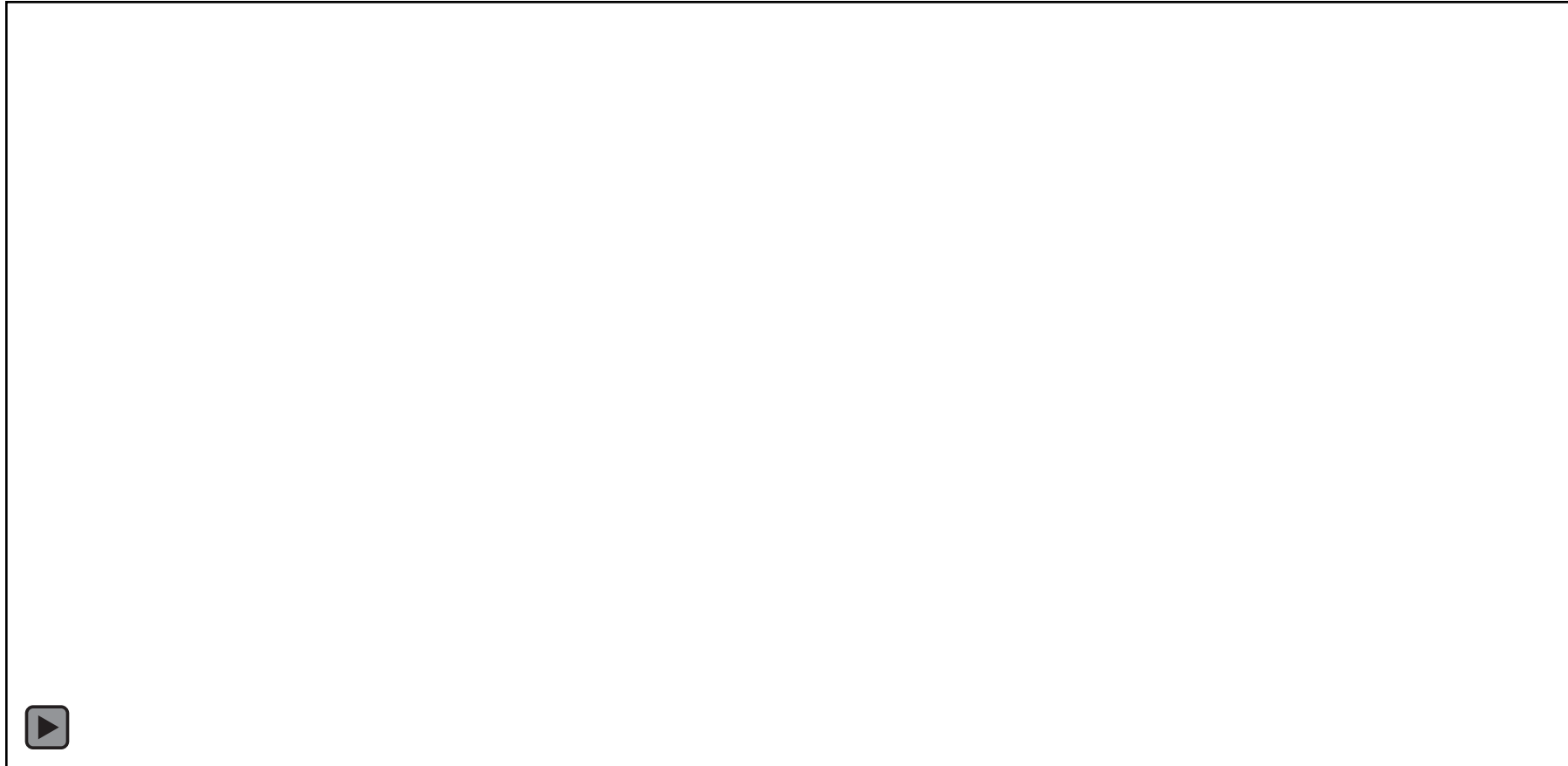
All employees must be involved in implementing controls!

- **Involve Workers:** Engage employees in the process as they often have valuable insights into potential hazards and practical solutions
- **Use the Hierarchy of Controls:** Prioritize control measures by eliminating hazards first, then using engineering controls, administrative controls, and personal protective equipment (PPE) as needed
- **Develop an Entry Plan:** Create a detailed plan that outlines the selected control measures and the steps for their implementation
- **Provide Training and Communication:** Ensure all employees are trained on new safety procedures and understand the importance of the controls
- **Regularly Review and Update Controls:** Continuously evaluate the effectiveness of the controls and make necessary adjustments based on feedback and new information
- **Document Everything:** Keep thorough records of all safety measures

Implementing Controls

- ***Employee Training***
 - Job Instruction Training ideally JHA Based
 - Role Specific Training
 - Attendant
 - Entrant
 - Entry Supervisor
 - Hazard Recognition
 - Rescue and Emergency Response
 - Communication
 - Permit System

Questions?



Please email questions to losscontrol@bhhc.com



Berkshire Hathaway
HOMESTATE COMPANIES

Workers Compensation Division TM

PC23
LAKE TAHOE

