Confined Space Awareness

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Learning Objectives

- Recognize a confined space
- Understand atmospheric and physical hazards
- Review atmospheric monitoring
- Learn about common root causes leading to fatalities

THE MOST IMPORTANT MESSAGE:
YOU NEVER ENTER a CONFINED SPACE

Confined Space: Entrant/Attendant/Supervisor Training

- Assessment and evaluation of hazards and risks
- Safe entry techniques
- Atmospheric monitoring

THIS IS NOT YOU!!!
Confined Space:
Rescue Training

- Special skills and specialized retrieval equipment
- Communication and incident command
- Monitoring, assessment, ventilation
- CPR/First Aid

THIS IS NOT YOU!!!

LEARNING OBJECTIVES
Confined Space Awareness Training

- Recognize a confined space
- Understand the hazards
- Secure and call for resources or call 911
- Learn to stay out

THIS IS YOU!!!

Confined Space Awareness

A confined space is a space you should NEVER enter unless you have received the proper training!
Should You Enter a Confined Space If There is a Victim to be Rescued?

Yes  No

Confined Space Awareness

Do not enter a confined space even if there are victims to be rescued!

Why is it Important?

- Confined spaces are found in more than 200,000 establishments in over 30 different industries
- Over 4.8 million permit required confined spaces
- Over 2 M workers enter confined spaces every year
- Workers enter for maintenance, repair, cleaning, inspection, new construction, retrieval of objects, sampling, rescue
**Why is it Important?**

You may encounter in your work:

- Environmental health
- Food protection
- Water supply
- Wastewater treatment
- Remediation projects
- Oil and gas extraction
- Disease outbreaks
- Hospitals
- Emergency response

If you are not trained as an entrant, you should not enter.
**WHY IS IT IMPORTANT?**

**WORKERS (ENTRANTS) DIE!**

- Incidents usually fatal
- 75% victims have no training
- 60% are would-be rescuers
- 20% incidents involve multiple fatalities

Did you know...

- 92 fatalities per year on average in US

**WHY IS IT IMPORTANT?**

**CAUSES of DEATH**

- 65% hazardous atmosphere
- 13% engulfment
- 7% struck by falling objects
- 6% heat stress/exposure

**DEFINITIONS**

- Complex standard
- Definitions vary from country to country
- Some countries define only based on atmospheric conditions or hazards
- Lake Manoun/Lake Nyos in Cameroon, Africa
DEFINITIONS

Confined Space
OSHA 29CFR1910.146

ALL THREE CONDITIONS MUST BE PRESENT:

- Is large enough and so configured that an employee can bodily enter and perform assigned work, and
- Has limited or restricted means for entry or exit, and
- Is not designed for continuous employee occupancy

DEFINITIONS

Is large enough and so configured that an employee can bodily enter and perform assigned work

- If there is enough room for a person to enter, it could be a confined space
- If you can’t fit your body into the space, you may not become trapped

DEFINITIONS

Has limited or restricted means for entry or exit

- Entrance and exit may be from top, bottom, or side
- Size or location makes escape and rescue difficult
- What do you think are some examples?

Did you know…
Spaces can be all sizes and shapes: below-ground vault or above-ground building with a door opening.
DEFINITIONS

Is not designed for continuous employee occupancy

✓ Broadens the scope
✓ Designed to store products, enclose materials and processes, transport products or substances
✓ Not designed to hold humans
✓ Frequently poor ventilation and lighting

DEFINITIONS

IF YOU HAVE TO WIGGLE, CRAWL or CLIMB to ENTER, IT IS LIKELY TO BE A CONFINED SPACE

DEFINITIONS

ENTRY

✓ The act by which a person intentionally passes through an opening into a permit required confined space.
✓ If any part of the body including extremities passes through the opening it is considered entry.
Permit Required Confined Spaces

- Meet all 3 requirements to be a confined space
- AND
- Contains or has the potential to contain hazardous air conditions
- Contains a material with the potential to engulf someone who enters the space
- Has an internal configuration that might cause an entrant to be trapped or suffocated
- Contains any other recognized serious safety or health hazards.
- So dangerous it requires a written procedure and written permit

Types of Confined Spaces

Non-Permit Confined Spaces

- Are Confined Spaces
- Do not contain or have the potential to contain atmospheric hazards capable of causing death or serious physical harm
- Have natural or permanent mechanical ventilation
- Most confined spaces are permit-required

Definitions

Permit

Written safety checklist that must be completed by authorized and qualified workers BEFORE a permit-required confined space is entered. This permit ensures that all hazards are controlled in the confined space before entry. Permits are kept outside of the space...need a new one for each entry, each shift.

Did you know?

Conditions change, hazards are introduced, and a non-permit confined space could quickly require a permit entry.
EXAMPLES OF CONFINED SPACES

Examples of confined spaces:
- Tanks
- Manholes & Sewers
- Boilers
- Grain storage bins
EXAMPLES OF CONFINED SPACES

- Sewers/septic tanks
- Tunnels/shafts
- Manholes
- Boilers/furnaces
- Tanker cars/railcars
- Cisterns
- Pits, pipelines, pumping stations
- Silos
- Storage bins

EXAMPLES OF CONFINED SPACES

- Storm drains
- Utility vaults
- Trenches
- Elevator pits
- Large trash dumpsters
- Dock plate levelling devices
- Aircraft wing fuel tanks
- Hold of a ship/barge
- Brewery/winery vessels

EXAMPLES OF CONFINED SPACES

- Pump wet wells
- Well pits
- Degreasers
- Grain elevators
- Mixers
- Water tower
- Drained swimming pools
- Open-topped water tanks
- Bottom-access enclosures
- Wind turbine nacelles
EXAMPLES OF CONFINED SPACES

IT IS ALWAYS BEST TO TREAT UNKNOWN AREAS AND THEIR INTERIOR ENVIRONMENTS AS CONFINED SPACES AND TAKE ALL NECESSARY SAFETY PRECAUTIONS

DO NOT ENTER

HAZARDS

Cloaca Maxima – hazards were known thousands of years ago in sewer system of ancient Rome

Hazard assessments:
• What is stored inside the space?
• What processes may be taking place inside the space?
• What is the structure of the space and adjacent areas?

All hazards are magnified when present in a confined space. Hazards may be imperceptible and conditions can change rapidly!

SOURCES OF HAZARDS

• Chemical reactions
• Oxidation/reduction reactions
• Decomposition of organic matter
• Cleaning reagents
• Welding, spray painting, grinding, sand blasting
• Inerting with non-flammable gases
SOURCES OF HAZARDS

- Previously stored products/chemicals
- Unexplained leaks/spills
- Manufacturing Process
- Rusting of Metals
- Charging Batteries
- Muck
ATMOSPHERIC HAZARDS

• Too little oxygen (<19.5%)
• Too much oxygen (>23.5%)
• Flammable atmospheres – gases, vapors, dusts >10% of LEL (LFL)
• Airborne dust above LEL (LFL)
• Toxic chemicals
• ANY ATMOSPHERE that is IDLH

Did you know...
IDLH means Immediately Dangerous to Life and Health

ATMOSPHERIC HAZARDS

Air monitoring MUST be performed to determine if a hazardous atmosphere exists.
✓ Portable multi-gas detectors with alarm
✓ Use before entry
✓ Monitor atmosphere continuously while workers are in space (OSHA)

ATMOSPHERIC HAZARDS

ATMOSPHERIC MONITORING

• Equipment only as good as its calibration- calibrate each time
• User must be knowledgeable of proper instrument operation
• User must be trained, accountable and vigilant
• Equipment must have sensitivity and specificity to ID any hazards
• Sensors selected should reflect the known and potential hazards
ATMOSPHERIC HAZARDS

ATMOSPHERIC MONITORING

- Assume least favorable conditions exist
- Get representative sample at various levels
- Test distance of approximately 4 ft. in direction of travel and to each side for atmospheres that may be stratified,
- Must test for oxygen content, flammable or explosive atmosphere, and toxic gases or vapors in that order
- Allow enough time for sensors to fully stabilize their readings
Oxygen Deficiency

- Oxygen level below 19.5%
- Can be caused by:
  - Oxygen consumed by individuals
  - Decomposition of organic matter
  - Displacement of oxygen by another gas/vapor
  - Oxidation of metals - rusting
  - Combustion

**Did you know...**

Oxygen deficiency can debilitate sensors

Effects of oxygen deficiency

<table>
<thead>
<tr>
<th>% Oxygen</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>19.5% - 16%</td>
<td>Fatigue, mildly impaired</td>
</tr>
<tr>
<td>14% - 12%</td>
<td>Increased breathing rate and pulse, impaired coordination, perception, or judgement</td>
</tr>
<tr>
<td>12% - 10%</td>
<td>Further increase, blue lips, mental confusion</td>
</tr>
<tr>
<td>10% - 8%</td>
<td>Fainting, nausea, vomiting, confusion</td>
</tr>
<tr>
<td>8% - 6%</td>
<td>Collapse, death within 8 minutes</td>
</tr>
<tr>
<td>6% - 0%</td>
<td>Coma within 40 seconds, death</td>
</tr>
</tbody>
</table>
**ATMOSPHERIC HAZARDS**

**Oxygen Enrichment**
- Oxygen levels greater than 23.5%
- Can be caused by:
  - leaking oxygen cylinders or lines
- Should never be used to ventilate a space
- Extreme fire hazard

**Flammable/Combustible Hazards**
- Flammable gases, vapors or mists
- Combustible dusts
- Concentrations high enough to ignite or explode from a spark or flame if level in air is >10% of the LFL (LEL)
- Methane, solvents, combustible dusts
- Leaks in pipelines
- Spray painting or coating
- Welding or cutting
- Need explosion-proof equipment and spark-proof tools
- NO SMOKING!!!!!!

**FIRE TRIANGLE**

For a fire or an explosion to occur, the three components must be present simultaneously. In all cases, the critical point is defined as the range between the lower explosive limit (LEL or LFL) and the upper explosive limit (UEL or UFL).

If the gas-air mixture is below the LEL for a gas, ignition cannot occur – too "lean" to burn.

Ignition will also not occur if gas-air mixture is above UEL – too "rich" to burn.
**ATMOSPHERIC HAZARDS**

**Combustible/Explosive Dust**
- Food products - grain, flour, starches
- Spices - pepper, tea, cinnamon
- Metal powders - aluminum, magnesium, zinc
- Wood products - wood dust, cellulose
- Other - plastic, hard rubber

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**ATMOSPHERIC HAZARDS**

**Methane**
- Colorless, odorless, flammable gas
- Asphyxiant
- Displaces air in confined spaces
- Result of natural decaying process of organic materials (wastewater)
- Dizziness, difficulty breathing, bluish color of the skin and loss of consciousness
- Lighter than air

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**ATMOSPHERIC HAZARDS**

**Atmospheric Testing**
- Detecting in the workplace, sample air for respirable dust.
- Warnings: Prolonged exposure to harmful dust and fumes can lead to serious health issues.
- Observation: Any observed dust or fumes should be addressed promptly.
- Note: Always follow proper safety protocols when handling dust and fumes in the workplace.
ATMOSPHERIC HAZARDS

Toxic Hazards
- Gases, vapors or fumes – poisonous above the PEL
- H₂S, CO, CO₂, SO₂, welding fumes
- Irritants and corrosives
- Asphyxiating
- Product can emit vapors: wood pellets

ATMOSPHERIC HAZARDS

Carbon Monoxide
- Very toxic, colorless, odorless, combustible gas
- By-product of incomplete combustion
  - Gasoline powered internal combustion engines
  - Arc Welding
  - Improperly vented furnaces, boilers, hot water tanks
  - Propane powered engines (forklifts)
- Combines with RBC and replaces oxygen to cause asphyxiation
- PEL for CO 35ppm

ATMOSPHERIC HAZARDS

Effect of Various CO Levels

<table>
<thead>
<tr>
<th>CO Level (ppm)</th>
<th>Reaction</th>
<th>Duration</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>Threshold exposure level</td>
<td>4 to 8 hours</td>
<td>Mild headache, nausea</td>
</tr>
<tr>
<td>400</td>
<td>Moderate</td>
<td>1 to 2 hours</td>
<td>Drowsy, headache, nausea</td>
</tr>
<tr>
<td>800</td>
<td>Significant</td>
<td>1 to 2 hours</td>
<td>Drowsy, headache, nausea, disorientation</td>
</tr>
<tr>
<td>1600</td>
<td>Severe</td>
<td>1 to 2 hours</td>
<td>Drowsy, headache, nausea, disorientation, disorientation</td>
</tr>
<tr>
<td>3200</td>
<td>Very Severe</td>
<td>1 to 2 hours</td>
<td>Drowsy, headache, nausea, disorientation, disorientation, disorientation, disorientation</td>
</tr>
<tr>
<td>6400</td>
<td>Critical</td>
<td>1 to 2 hours</td>
<td>Drowsy, headache, nausea, disorientation, disorientation, disorientation, disorientation, disorientation</td>
</tr>
</tbody>
</table>

PEL for CO: 35 ppm

(From: Fire Prevention)
Hydrogen Sulfide

- Flammable, colorless gas
- By-product of microbial activity
- Found where petroleum products are processed
- Released during the decay of sulphur-containing organic matter – sewers, disturbing sludge
- Rotten-egg odor - below 30 ppm
- Rapid olfactory fatigue: lose sense of smell
- Heavier than air
DON'T RELY ON YOUR NOSE!

- Not all chemicals or contaminants have an odor (carbon monoxide)
- Some chemicals or contaminants can only be detected when such large quantities are present that your health is already being adversely impacted (burning of chlorinated solvents)
- Your nose can become sensitized to strong odors and you may no longer smell them (ammonia, hydrogen sulfide and chlorine)

ATMOSPHERIC HAZARDS

Did you know...

IT IS IMPOSSIBLE TO TELL BY SMELL OR SOME OTHER SENSE WHETHER THE AIR IS SAFE
PHYSICAL HAZARDS

- Liquids or solids that can engulf
- Conditions that can trap or suffocate an entrant
- Mechanical or electrical hazards
- Drowning hazards
- Temperature extremes
- Noise
- Poor visibility, lack of lighting

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PHYSICAL HAZARDS

- Falling objects
- Falling, tripping hazards
- Slick, wet surfaces
- Critters: snakes, rodents, insects etc.
- Toxic chemical storage
- Asbestos on steam pipes
- Biological hazards
- Any other hazards that would make escape or rescue difficult
PHYSICAL HAZARDS

Mechanical Hazards

- Compressing devices
- Drive shafts
- Gears
- Grinding equipment
- Conveyors
- Mixers
- Rotors
- Pumps, impellers
- Cutters
Electrical Hazards

- Electricity presents extra hazard
- Secure power to electrical equipment and sources of electrical energy; must be locked out and tagged out properly
- In wet environments, ground fault circuit interrupters used
Engulfment Hazard

- Liquid or solid substance that traps the entrant; can't escape moving material
- Asphyxiation due to inhalation, plugging of the respiratory system, or surrounding of the entrant causing compression or crushing of the torso
- Examples — grain, sand, sawdust
- Excavations also present hazard — cave-ins

Engulfment Hazard

- When engulfed by solids, your lungs have to generate 800# of force in order to breathe - impossible
**PHYSICAL HAZARDS**

**Entrapment**
- Internal configuration can trap or asphyxiate entrant
- Examples: gravel hoppers, sawdust cyclones
  - inwardly converging walls
  - floors which slope downward and taper to smaller cross section
PHYSICAL HAZARDS

What leads to confined space fatalities?

- Failure to recognize and control the hazards associated with confined spaces.
- Inadequate or incorrect emergency procedures.

CONFINED SPACE FATALITIES

Confined Space Fatalities

- Five members in 3 generations of 1 family wiped out in minutes when first person entered manure pit to replace shear pin.
- Driller and rig helper die after entering hydraulic fracturing tank to monitor fluid level and well head pressure.
- Supervisor and worker killed after entering manhole at municipal swimming pool to switch from one pump to another.
Confined Space Fatalities

- DPW worker and volunteer firefighter died in a sewer manhole
- Feed mill worker dies in a grain bin
- Engineer killed in landfill manhole retrieving flow meter
- Farm worker dies during grain bin auger entanglement
- Fire kills two at wastewater treatment plant

- Wastewater treatment plant operator drowns in recirculation tank
- Five contract painters die after being trapped by chemical fire inside a hydroelectric plant tunnel
- Plumber dies after the collapse of a trench wall
- Construction worker permanently disabled after exposure to CO in created confined space

Common Conditions

- Personnel enter with inadequate training, equipment, and hazard assessment
- Hazardous atmospheres not identified or ventilated
- Hazards not removed from the confined space
- Hazards brought into the confined space not identified
- Rescue plans inadequate or non-existent
PROTECT YOURSELF

We have learned enough over the years that the fatalities are preventable.

- Know how to identify a confined space.
- NEVER enter an area that could be a confined space to perform work tasks. Contact your supervisor if you have 
  ts.
- Do not rely on your senses to determine if a confined space has no hazards. Never take the atmosphere for 
  granted or rely on someone else for your safety.
- NEVER enter a confined space to try to rescue another worker.

The End

Thanks for your time and attention
Any Questions?????

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