CONFINED SPACE

CONFINED SPACE DEFINITION

- Is large enough & so configured that a worker can bodily enter and perform tasks, \textit{plus}
- Has limited or restricted means for entry or exit, \textit{plus}
- Is not designed for continuous worker occupancy
EXAMPLES

- Bins
- Boilers
- Crawl Spaces
- Ducts
- Excavations/Trench
- Furnaces
- Manholes
- Pipe Lines
- Pits
- Scrubbers
- Sewers
- Silos
- Tanks
- Tunnels
- Vaults
- Vessels
TYPES OF CONFINED SPACES

- Non Permit Required
- Permit Required
CONFINED SPACE Non-Permit

- **Non-permit confined space** means 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.
NON-Permit Confined Space Procedures

- Evaluate space
  - atmospheric and other hazards
- Fill out non permit required form
  - document atmospheric readings
  - turn in to supervisor, forward copy to safety

<table>
<thead>
<tr>
<th>Compound</th>
<th>Acceptable Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>19.5% - 23.5%</td>
</tr>
<tr>
<td>Flammables</td>
<td>zero</td>
</tr>
<tr>
<td>Hydrogen sulfide</td>
<td>one or less</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>ten or less</td>
</tr>
</tbody>
</table>
NON-Permit Confined Space Procedures

- Continuous air monitoring
  - required if ventilation is required to reduce atmospheric hazards
  - recommended in other cases
- Recheck atmosphere
  - > Within 1 hours since last entry
- Recommended attendant
CONFINED SPACE—PERMIT REQUIRED

Permit-required confined space has one or more of the following characteristics:

(1) Contains or has a potential to contain a hazardous atmosphere;

(2) Contains a material that has the potential for engulfing an entrant;

(3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or

(4) Contains any other recognized serious safety or health hazard
CONFINED SPACE – PERMIT REQUIRED
JOB PLANNING

1. What is the nature, type, and size of the confined space?

2. What work is to be performed in the confined space?

3. Is all necessary equipment available (air monitoring, tripod/harness, ventilation, lighting communication, and etc.)?

4. Are there any hazardous sources of energy that require lockout/tagout?
5. Are there any chemical hazards in the confined space or are any chemicals being introduced into the space (welding, grouts, sealers, and etc.)?

6. Are there any physical hazards present in the confined space (heat, noise, slips, trips, and etc.)?
ENTRANT SHALL:

1. **Know the hazards that may occur during the entry.**

2. **Understand the proper use of equipment and follow those guidelines.**

3. **Communicate with the attendant to enable the attendant to monitor entrant status and alert entrant of the need to evacuate.**
4. Alert the attendant when:

   a. Entrant recognizes and warning sign or symptoms of exposure to a dangerous situation.

   b. Entrant detects a prohibited condition.
5. The entrant shall exit permit space when:
   a. an order to evacuate is given.
   b. entrant recognizes any warning signs of dangerous situations.
   c. entrant detects a prohibited condition.
   d. evacuation alarm is activated.
ATTENDANT SHALL:

1. Know the hazards that may occur during entry including signs and symptoms.

2. Is aware of behavioral effects of hazard exposure in entrants.

3. Continuously and accurately maintains identity and count of entrants in space.

4. Remains outside the permit space during entry operations until relieved by another attendant.
ATTENDANT SHALL:

5. Communicate with entrant to monitor status and alert entrant of the need to evacuate.

6. Monitor activities in and outside the space to determine if it is safe for entrant to remain.

7. Orders entrant to evacuate space if:
   a. Attendant detects prohibited condition.
   b. Attendant detects behavioral effects of hazard exposure in entrant.
ATTENDANT SHALL:

7. c. Attendant detects a situation outside space that could endanger entrant.

d. Attendant can not effectively and safely perform all duties.

8. Initiate rescue procedures as soon as an entrant needs assistance to evacuate.

9. Performs non-entry rescue or other rescue services as part of rescue procedure.
ATTENDANT SHALL:

1. When an unauthorized person approaches the space, the attendant shall:
   a. Warn them to stay away from space.
   b. Advise unauthorized persons to exit the space if they enter
   c. Inform entrant and entry supervisor if unauthorized person has entered the space.
ATTENDANT SHALL:

11. Perform no duties that might interfere with monitoring and protecting entrant.
SUPERVISOR SHALL:

1. Know the hazards that may occur during entry including signs and symptoms.

2. Verifies that all tests specified by permit have been conducted.

3. Verifies that all procedures and equipment specified by permit are in place before entry begins.
SUPERVISOR SHALL:

4. Terminates the entry and cancels the permit when:
   a. Operations covered by permit are completed.
   b. A condition that is not allowed arises in or near the space.

5. Verifies that rescue services are available and means of summoning additional services is operable.
SUPERVISOR SHALL:

6. Removes unauthorized persons who enter or attempt to enter space during operations.

7. Ensures that entry operations remain consistent with terms of the entry permit.

8. Ensures acceptable entry conditions are maintained during entry operations.
Permit Required Confined Space - Procedures

- Evaluate space
  - atmospheric and other hazards
- Fill out permit required form
  - document atmospheric readings
- Continuous ventilation required
- Written emergency procedure
- Authorized attendant required - direct communication with entrants
Permit Required Confined Space - Procedures

- Continuous air monitoring
  - required for O\textsubscript{2} and flammables, and for toxics if present in initial monitoring
- Additional standby required if attendant enters space
- Post signs (DANGER - Confined Space, Enter by Permit Only), and copy of permit.
Permit Required Confined Space Procedures - continued

Authorized attendant

- Stays in contact with entrants from outside the space
- Controls Access to the space
- Orders entrants out of space when:
  - hazard or warning signs/symptoms of exposure are present
  - he or she cannot carry out duties
- Contacts rescue team in emergency
- Does not perform rescue
Emergency Procedures

Call dispatch (5955), advise “there is an injury at (give location) confined space, or we have a confined space injury” and make sure dispatch notifies 911 that this is a confined space incident
Permit Required Confined Space procedures cont.

- Where injury is result of atmospheric hazards, or of an unknown cause try to remove the victim from inside the confined space (use harness, etc.) NON ENTRY RESCUE ONLY

- If you cannot remove the victim, place a blower in area to provide clean air, and wait for confined space rescue team

- If employee is severely injured, for example a potential spinal injury, do not move them unless there is an imminent life threatening hazard.
Ventilation

- Equipment must be explosion proof (look for UL or FM label)
- Properly ground equipment
- Don’t exhaust to occupied areas
- Don’t suck in contaminated air
- Place blower away from vehicle exhaust
GENERAL CONFINED SPACE

Procedures

- Warning devices placed for pedestrians and traffic
- Fire suppression systems - disable in accordance with district policy
- Vaults, manholes, etc with energized cable
  - employee stationed at surface
  - automatic reclosers on circuit made non-automatic when: operating a energized switch from inside structure, splicing or patching cable equipment is being energized where newly installed, rebuilt, or modified
ATMOSPHERIC HAZARDS

- **Oxygen Concentration** -
  - < 19.5%, or > 23.5% (deficient - enriched)

- **Flammable Gas, Vapor, Mist or Dust** -
  - 10% LEL (lower explosive limit)

- **Air Contaminants** -
  - Air concentration > PEL-IDLH - created by
    - Hot work (welding fumes, gases, NO₂, ozone),
    - Decomposition of organic matter (H₂S, methane),
    - Engine exhaust (CO)
    - Fire suppression systems (CO₂)
ATMOSPHERIC TESTING

- Users must be trained on the instrument
- Confirm calibration, and do functionality check
- When possible test prior to opening space
- Take readings at top, middle, and bottom of space
  - Take measurements in 4 foot increments Measure
  - Oxygen & Flammables
  - Toxics - hydrogen sulfide, carbon monoxide etc.
### Symptoms of Oxygen Deficiency

<table>
<thead>
<tr>
<th>% Oxygen</th>
<th>Physiologic Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 19.5</td>
<td>OSHA legal limit.</td>
</tr>
<tr>
<td>16 - 12</td>
<td>Increase breathing rate. Accelerated heartbeat. Impaired attention, thinking, and coordination.</td>
</tr>
<tr>
<td>14 - 10</td>
<td>Faulty judgement and poor muscular coordination. Muscular exertion causing rapid fatigue, intermittent respiration</td>
</tr>
<tr>
<td>10 – 8</td>
<td>Nausea, vomiting, inability to perform vigorous movement, or loss of the ability to move. Unconsciousness, followed by death.</td>
</tr>
<tr>
<td>&lt; 6</td>
<td>Instantaneous unconsciousness. Death in minutes</td>
</tr>
</tbody>
</table>
## Symptoms of Carbon Monoxide Exposure

<table>
<thead>
<tr>
<th>PPM Level (CO)</th>
<th>Physiological Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;25 ppm</td>
<td>OSHA Permissible Exposure Limit – no adverse effect</td>
</tr>
<tr>
<td>100 ppm</td>
<td>Headache and discomfort</td>
</tr>
<tr>
<td>600 ppm</td>
<td>Headache and discomfort</td>
</tr>
<tr>
<td>500 ppm</td>
<td>Pounding of heart, dull headache, dizziness, flashes before eyes, ringing in ears, nausea.</td>
</tr>
<tr>
<td>1000 ppm</td>
<td>Pounding of heart, dull headache, dizziness, flashes before eyes, ringing in ears, nausea.</td>
</tr>
<tr>
<td>1200 ppm</td>
<td>Dangerous to life (IDLH)</td>
</tr>
<tr>
<td>4000 ppm</td>
<td>Rapid collapse, unconsciousness and death within a few minutes</td>
</tr>
</tbody>
</table>
## Symptoms of Hydrogen Sulfide Exposure

<table>
<thead>
<tr>
<th>PPM Level (H₂S)</th>
<th>Physiological Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10 ppm</td>
<td>OSHA Permissible Exposure Limit – no adverse effect</td>
</tr>
<tr>
<td>15 – 25 ppm</td>
<td>Headache and discomfort</td>
</tr>
<tr>
<td>50 ppm</td>
<td>Slight eye irritation, respiratory irritation, odor</td>
</tr>
<tr>
<td>100 ppm</td>
<td>Marked irritation. &gt;100 OSHA IDLH</td>
</tr>
<tr>
<td>400 – 600 ppm</td>
<td>Unconsciousness, death</td>
</tr>
<tr>
<td>1000 ppm</td>
<td>Fatal in minutes</td>
</tr>
</tbody>
</table>
# Fatal Occupational Injuries Involving Confined Spaces, 1997-2001

![Figure 1](image)

**Figure 1**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>458</td>
<td>97</td>
<td>81</td>
<td>84</td>
<td>100</td>
</tr>
</tbody>
</table>
FIGURE 2


<table>
<thead>
<tr>
<th>Worker activity</th>
<th>Fatal injuries</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>458</td>
<td>100</td>
</tr>
<tr>
<td>Constructing, repairing, cleaning</td>
<td>246</td>
<td>54</td>
</tr>
<tr>
<td>Repair, maintenance</td>
<td>101</td>
<td>22</td>
</tr>
<tr>
<td>Cleaning, washing</td>
<td>57</td>
<td>12</td>
</tr>
<tr>
<td>Construction, assembling, dismantling</td>
<td>38</td>
<td>8</td>
</tr>
<tr>
<td>Materials handling operations</td>
<td>78</td>
<td>17</td>
</tr>
<tr>
<td>Loading, unloading materials</td>
<td>24</td>
<td>5</td>
</tr>
<tr>
<td>Materials handling, n.e.c.*</td>
<td>28</td>
<td>6</td>
</tr>
<tr>
<td>Using or operating tools, machinery</td>
<td>48</td>
<td>11</td>
</tr>
<tr>
<td>Physical activity, n.e.c.</td>
<td>25</td>
<td>6</td>
</tr>
<tr>
<td>Protective service activities</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Rescuing</td>
<td>25</td>
<td>3</td>
</tr>
<tr>
<td>Vehicular and transportation operations</td>
<td>11</td>
<td>2</td>
</tr>
<tr>
<td>All other activities</td>
<td>23</td>
<td>7</td>
</tr>
</tbody>
</table>

* n.e.c. means “not elsewhere classified.” For example, the category “Materials handling, n.e.c.” is a subcategory of “Materials Handling Operations” that includes anything fitting within materials handling operations that is not elsewhere classified.
FIGURE 5


<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Total (all fatal injuries)</th>
<th>Relative risk *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>458</td>
<td>1.00</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Managerial and professional specialty</td>
<td>22</td>
<td>0.16</td>
</tr>
<tr>
<td>Technical, sales, and admin support</td>
<td>16</td>
<td>0.12</td>
</tr>
<tr>
<td>Service occupations</td>
<td>13</td>
<td>0.21</td>
</tr>
<tr>
<td>Farming, forestry, and fishing</td>
<td>113</td>
<td>9.37</td>
</tr>
<tr>
<td>Precision production, craft, and repair</td>
<td>118</td>
<td>2.40</td>
</tr>
<tr>
<td>Operators, fabricators, and laborers</td>
<td>175</td>
<td>2.85</td>
</tr>
<tr>
<td><strong>Industry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private industry</td>
<td>431</td>
<td>1.10</td>
</tr>
<tr>
<td>Agriculture, forestry, and fishing</td>
<td>111</td>
<td>9.31</td>
</tr>
<tr>
<td>Mining</td>
<td>19</td>
<td>9.71</td>
</tr>
<tr>
<td>Construction</td>
<td>89</td>
<td>3.11</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>92</td>
<td>1.36</td>
</tr>
<tr>
<td>Transportation and public utilities</td>
<td>45</td>
<td>1.69</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>23</td>
<td>1.46</td>
</tr>
<tr>
<td>Retail trade</td>
<td>8</td>
<td>0.11</td>
</tr>
<tr>
<td>Services</td>
<td>43</td>
<td>0.33</td>
</tr>
<tr>
<td>Government</td>
<td>27</td>
<td>0.43</td>
</tr>
</tbody>
</table>

* The relative risks were calculated using the formula \( \frac{n^F}{\text{total}^F} \) where \( n^F \) = fatality rate for the variable in question and \( \text{total}^F \) = 0.07, the fatality rate of the total confined space fatal injuries per 100,000 employed during the period 1997 to 2001. Fatality rates were calculated using the formula \( \left( \frac{f}{e} \right) \times 100,000 \) where \( f \) = fatal occupational injuries for the variable in question and \( e \) = estimate of employment using Current Population Survey (CPS) data.
Confined Spaces - Fatality Statistics

1980-1989:

- Fatality occurrences: deaths/yr 100,000
  - Trans/Utilities 77
  - Construction 90
  - Agriculture 128
  - Manufacturing 152

- An average of 67 deaths occur annually
- Approximately 40% of victims were rescuers
Confined Spaces
Fatality Statistics - continued

- 62% of the fatalities were due to atmospheric conditions:
  - 14% Hydrogen Sulfide
  - 10% Methane
  - 9% Inert Gases
  - 7% Sewer Gases
  - 7% Carbon Monoxide

- 38% of the fatalities were due to mechanical asphyxiation
Confined Spaces
Fatality Statistics - continued

- 95% of all entries were authorized by supervisors.
- 85% of events were in the presence of a supervisor.
- 43% of victims were “would be” rescuers.
- 31% of companies with fatalities had written confined space entry procedures.
- 29% of the fatalities were supervisors.
Confined Spaces

Fatality Statistics - continued

• 15% of all fatalities had completed confined space entry training.
• None of the fatalities followed the written procedures.
• None of the spaces were evaluated or tested prior to entry.
• None of the spaces were ventilated.
• None of the companies suffering fatalities had a rescue plan.

Source: NIOSH, Division of Safety Research