The Basics of Confined Space

“60% or more of confined space deaths came about when friends, relatives and co-workers attempted to save a fallen person.”

Rob Vajko

4/2/2009
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Though real statistics are hard to come by, it is estimated that more than 60 workers died in 1992 from Confined Space related injuries, 85 in 1996. What is even more tragic than these numbers is the fact that 60% or more of those deaths came about when friends, relatives and co-workers attempted to save a fallen person. Only proper training in confined space entry is going to lower these numbers. At issue is the fact that most people simply are not aware of what constitutes a confined space and/or what the specific health risks are in entering or attempting a rescue inside of one.

Defining a “Confined Space”

According to NIOSH, a confined space must meet the following three criteria in order to be considered such:

1. It must have limited openings for entry and exit
2. It must have unfavorable natural ventilation which could contain or produce dangerous air contaminants
3. It is not intended for continuous employee occupancy.

OSHA defines a confined space as “any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere. Confined or enclosed spaces include, but are not limited to, storage to, storage tanks, process vessels, bins, boilers, ventilation or exhaust ducts, sewers, underground utility vaults, tunnels, pipelines, and open top spaces more than 4 feet deep such as pits, tubs, vaults, and vessels.”

It is important to properly understand what this means. While most people understand underground utility vaults to be confined-spaces, many fail to understand that according to this definition, even open air spaces, like trenches can be considered a confined space if they fit the criteria above. The reason that this is important is that understanding what constitutes a confined space will help in avoiding the dangers inherent in them. Trenches, for example, where the walls are too steep to climb out (limited means of egress) and where they are deep enough (more than 4 feet) can accumulate heavier than air gases which even if they are not fatal in and of themselves can displace the oxygen in the trench resulting in an oxygen deficient environment that can be IDLH (immediately dangerous to life and health). Manure and compost pits are a prime example of this type of confined space and one that, because of the gases emitted by the decaying materials, have resulted in many deaths over the years and which, because they are
often part of a farm or family property where individuals are not properly trained in the dangers of confined spaces have resulted in an extremely high percentage of “rescue deaths”.

**OSHA 1910.146(a)(23)** adds a couple of additional criteria:

- It must be large enough for a person to bodily enter it and perform work in it.
- It may contain material with the potential for engulfment of the entrant.
- It contains any other recognized safety or health hazard.

Because of these hazards and the very real possibility of injury or death, OSHA has mandated that all confined spaces be identified and that a “Permit-required confined space program” be drawn up for each one. A “Permit-required confined space program” (sometimes shortened to “permit space program”) includes procedures to identify, eliminate if possible and protect workers who will need to enter the confined space in order to work. It must also outline rescue and retrieval for any and all injured or fallen workers within said confined space.

All confined spaces are considered Permit-required until it can be declassified as a confined space (until it can be shown that, through engineering, the hazards are no longer present.

**Determining the difference between an enclosed space, a confined space and a permit-required confined space**

If an **enclosed space** has the following characteristics:

1. A person can fit into it
2. There is limited egress and entry
3. It is not designed for continuous work by workers

Then it is to be considered a **confined space**.

If the **confined space** has the following characteristics:

1. There is a potential for it to accumulate or contain a hazardous atmosphere
2. There is material in it that has the potential for engulfing a worker or any other personnel
3. There is the potential to trap or asphyxiate a worker because of the nature of the space
4. There are other potential safety and health hazards present

Then it is to be considered a **permit-required confined space**
Identifying the hazards in a confined space

Confined Space Hazards are as follows:

- **Oxygen Deficiency or Surplus** – Either too much oxygen or too little
- **Toxic Gases, Vapors or Fumes** – Hydrogen Sulfide, Carbon Monoxide, etc…
- **Flammable/Explosives Hazards** – This can include gases and vapors but may also include dust and particulates when they are in concentration large enough to ignite
- **Engulfment** – Grain, dirt, liquids, etc… that have the potential of burying a person
- **The Nature and configuration of the space** – Sloping walls or floors that may trap someone
- **Energy Hazards** – Heat, Electricity and machinery for example. Lockout/Tagout is essential for all energy sources that have the potential for harm or death.
- **Noise** – Confined Spaces may amplify noise. Proper hearing protection should be provided.
- **Falling objects** – Especially with an attendant overhead, with other workers possibly working above, etc… proper precautions should be taken and hard hats should be worn.
- **Critters** – Pits, pipes and trenches tend to attract snakes, rates, scorpions and other potentially dangerous animals and insects.
- **Psychological** – Includes claustrophobia, fear of isolation, fear of the dark, panic disorders, etc…

All the above hazards must be identified for each confined space.
Confined Space Procedures
(from Appendix A to the 1910.146 OSHA Standard)

APPENDIX A TO §1910.146—PERMIT-REQUIRED CONFINED SPACE DECISION FLOW CHART

1. Does the workplace contain Confined Spaces as defined by §1910.146 (b)?
   - YES
     - Does the workplace contain Permit-required Confined Spaces as defined by §1910.146(c)?
       - YES
         - Inform employees as required by §1910.146 (c)(2).
         - Prevert employee entry as required by §1910.146 (c)(3). Do task from outside of space.
       - NO
         - Will permit spaces be entered?
           - NO
             - STOP
           - YES
             - Will contractors enter?
               - YES
                 - Task will be done by contractors' employees. Inform contractor as required by §1910.146 (c)(3)(i), (ii), and (iii). Contractor obtains information required by §1910.146 (c)(3)(ii) from host.
               - NO
                 - Will host employees enter to perform entry tasks?
                   - YES
                     - Coordinate entry operations as required by §1910.146 (c)(3)(iv) and (c)(3)(v). Prevent unauthorized entry.
                   - NO
                     - Prevent unauthorized entry. STOP
             - NO
               - Coordinate entry operations as required by §1910.146 (c)(3)(iv) and (c)(3)(v). Prevent unauthorized entry.
         - NO
           - Both contractors and host employees will enter the space?
             - YES
               - Coordinate entry operations as required by §1910.146 (c)(3)(iv) and (c)(3)(v). Prevent unauthorized entry.
             - NO
               - Coordinate entry operations as required by §1910.146 (c)(3)(iv) and (c)(3)(v). Prevent unauthorized entry.
         - NO
           - Coordinate entry operations as required by §1910.146 (c)(3)(iv) and (c)(3)(v). Prevent unauthorized entry.
   - NO
     - Does space have known or potential hazards?
       - YES
         - Not a permit-required confined space. §1910.146 does not apply. Consult other OSHA standards.
       - NO
         - Can the hazards be eliminated?
           - YES
             - Employer may choose to reclassify space to non-permit required confined space using §1910.146 (c)(7). STOP
           - NO
             - Can the space be maintained in a condition safe to enter by continuous forced air ventilation only?
               - YES
                 - Space may be entered under §1910.146 (c)(5). STOP
               - NO
                 - Prepare for entry via permit procedures.
               - NO
                 - Verify acceptable entry conditions (test results recorded, space isolated if needed, rescuers/means to summon available, entries properly equipped, etc.)
                   - YES
                     - Permit issued by authorizing signature. Acceptable entry conditions maintained throughout entry.
                     - Entry tasks completed. Permit returned and canceled.
                     - Audit permit program and permit based on evaluation of entry by entrants, attendants, testers and preparers, etc.
                   - NO
                     - Emergency exists (prohibited condition). Entrants evacuated entry areas. (Call rescuers if needed). Permit is void. Reevaluate program to correct/prevent prohibited condition. Occurrence of emergency (usually) is proof of deficient program. Re-entry until program (and permit) is amended. (May require new program.) CONTINUE
                     - Permit not valid until conditions meet permit specifications.
Step-by-step procedures

1. Identify all confined spaces at all facilities.

2. Make sure all employees and personnel know what areas are considered confined spaces and make sure that they are clearly labeled as such by posting the appropriate signs.

3. Identify all personnel who will be authorized to enter the confined spaces and train them in all the procedures inherent in confined space work.

4. Make sure that all required Personal Protective Equipment (Tyvek suits, respirators, gloves, etc…) are in stock and available for all authorized personnel when they should need it.

5. Plan for and have available all rescue and retrieval equipment necessary for getting worker(s) out of the confined space (conscious or unconscious) if the need should arise.

6. Measure and monitor the air quality inside the confined space before entry and at all times while work is being done inside the confined space using gas monitors. Use ventilation and blowers if necessary to maintain the quality of the air. If the air quality cannot be improved then the confined space should be considered Immediately Dangerous to Life and Health (IDLH) and the appropriate respirator should be used at all time by all workers while in the confined space.

7. Make sure that there is an attendant outside of the confined space at all times in order to provide rescue and retrieval if needed.

8. Make sure that the CONFINED SPACE ENTRY PERMIT (See appendix Two) is properly and completely filled out and signed by the entry supervisor prior to entry by any personnel.

9. Establish proper communication procedures so that all workers are in constant contact with the attendant(s) outside the confined space.

10. Identify, implement and monitor all lockout procedures both inside the confined space as well as those outside the confined space that could potentially have an effect on the conditions inside the confined space and/or on the attendant(s) outside the confined space.
Air monitoring and air quality inside a confined space

It is crucial that the air inside any and all confined spaces be properly monitored and controlled.

1. Prior to any worker entering a confined space, the quality of the air must be determined. This is most often done using a confined space air monitor that measures H₂S, CO, LEL and O₂. Additionally, if there is reason to suspect some other type of gas (ammonia in food processing plants, for example) then steps should be put in place to make sure to monitor for those as well.

2. If the air quality is not acceptable, ventilation should be used to circulate the bad air out and to bring in breathable air.
3. Once the air quality is within the acceptable range, workers may enter the confined space to do the required work. Continued monitoring of the air quality is required for as long as there is still anyone inside the confined space as air quality can change at any time.

Protecting the openings to the confined spaces
It is important to protect the opening to the confined space both for the safety of those inside as well as for the safety of those outside. Especially in public places, it is crucial to make sure that barricades are in place to keep the public away from the opening. Barricades and barriers need to be ADA compliant so that handicapped and visually impaired pedestrians are not at risk and don’t, in turn, risk the safety of those working in the confined space. Make sure that the entry is well lit in low light conditions.

Additionally it is important to protect workers inside a confined space from outside personnel accidentally or mistakenly closing the opening.

Ventilating a confined Space
Confined Space Ventilation falls into two categories:

1. Push Ventilation – This is when fresh air is blown (pushed) into a confined space
2. Pull Ventilation – This is when the bad air is “sucked” out of the confined Space

Whenever possible, push ventilation is preferable as it dilutes the air in the confined space faster than pull ventilation (Think of a leaf blower as opposed to a vacuum cleaner. A vacuum cleaner only affects the items in its immediate vicinity whereas a leaf blower moves leaves in a wide arc).

Pull ventilation, however, has its uses. When, for example, welding is being done, a fume exhaust removes the fumes locally, at the source of the problem. Rather than blowing the fumes over a wide area, the fumes are immediately captured and extracted so that the rest of the air isn’t contaminated. Other instances where pull ventilation would be preferable are in areas where there is only one entry/exit or where heavier than air gases might be present. By running a hose down to the bottom of the confined space and sucking out the bad air which is below the good air, good air is pulled into the confined space. In this instance, blowing clean air in would take much longer to dissipate the fumes or vapors.

If combustible gases are present, there is the extra consideration of making sure that all ventilation systems and blowers are intrinsically safe.

In most cases it is best to contact a ventilation specialist (Coppus, Ramfan or Air Systems, for example specialize in confined space blowers and can help solve many confined space air quality issues).
Rescue and Retrieval in a confined space

As we have already mentioned, it is important to be able to extricate a worker should anything happen. Depending on the nature of the confined space this can be somewhat difficult to plan for. For simple overhead entries, there are several harnesses available with shoulder D-rings that, combined with a Y-Lanyard designed for rescue and retrieval make it simpler to pull out a fallen worker.

There are also a number of great systems that allow for easy set-up and use for getting wenches and Self-Retracting Lifelines in place to aid in the retrieval and rescue.

Tripods have been most commonly used for many years and are still used by some.

Other systems, such as the UCL 5-piece are simple to put together and get in place. It allows for the attachment of a retrieval wench as well as a backup SRL.

UCL also makes a side-entry system as well as a great number of other systems.

For more information see “The Basics of Fall Protection” and/or contact us at (800) 213-7092
Appendix One

Definition of Terms
(Taken from the 1910.146 OSHA Standard)

**Acceptable entry conditions** - means the conditions that must exist in a permit space to allow entry and to ensure that employees involved with a permit-required confined space entry can safely enter into and work within the space.

**Attendant** - means an individual stationed outside one or more permit spaces who monitors the authorized entrants and who performs all attendant’s duties assigned in the employer’s permit space program.

**Authorized entrant** - means an employee who is authorized by the employer to enter a permit space.

**Blanking or blinding** - means the absolute closure of a pipe, line, or duct by the fastening of a solid plate (such as a spectacle blind or a skillet blind) that completely covers the bore and that is capable of withstanding the maximum pressure of the pipe, line, or duct with no leakage beyond the plate.

**Confined space** - means a space that:

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

2. Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry.); and

3. Is not designed for continuous employee occupancy.

**Double block and bleed** - means the closure of a line, duct, or pipe by closing and locking or tagging two in-line valves and by opening and locking or tagging a drain or vent valve in the line between the two closed valves.

**Emergency** - means any occurrence (including any failure of hazard control or monitoring equipment) or event internal or external to the permit space that could endanger entrants.
Engulfment - means the surrounding and effective capture of a person by a liquid or finely divided (flowable) solid substance that can be aspirated to cause death by filling or plugging the respiratory system or that can exert enough force on the body to cause death by strangulation, constriction, or crushing.

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

Entry permit (permit) - means the written or printed document that is provided by the employer to allow and control entry into a permit space and that contains the information specified in paragraph (f) of this section.

Entry supervisor - means the person (such as the employer, foreman, or crew chief) responsible for determining if acceptable entry conditions are present at a permit space where entry is planned, for authorizing entry and overseeing entry operations, and for terminating entry as required by this section.

NOTE: An entry supervisor also may serve as an attendant or as an authorized entrant, as long as that person is trained and equipped as required by this section for each role he or she fills. Also, the duties of entry supervisor may be passed from one individual to another during the course of an entry operation.

Hazardous atmosphere - means an atmosphere that may expose employees to the risk of death, incapacitation, impairment of ability to self-rescue (that is, escape unaided from a permit space), injury, or acute illness from one or more of the following causes:

1. Flammable gas, vapor, or mist in excess of 10 percent of its lower flammable limit (LFL);
2. Airborne combustible dust at a concentration that meets or exceeds its LFL;

NOTE: This concentration may be approximated as a condition in which the dust obscures vision at a distance of 5 feet (1.52 m) or less.

3. Atmospheric oxygen concentration below 19.5 percent or above 23.5 percent;
4. Atmospheric concentration of any substance for which a dose or a permissible exposure limit is published in Subpart G, Occupational Health and Environmental Control, or in Subpart Z, Toxic and Hazardous Substances, of this Part and which could result in employee exposure in excess of its dose or permissible exposure limit;
NOTE: An atmospheric concentration of any substance that is not capable of causing death, incapacitation, impairment of ability to self-rescue, injury, or acute illness due to its health effects is not covered by this provision.

(5) Any other atmospheric condition that is immediately dangerous to life or health.

NOTE: For air contaminants for which OSHA has not determined a dose or permissible exposure limit, other sources of information, such as Material Safety Data Sheets that comply with the Hazard Communication Standard, section 1910.1200 of this Part, published information, and internal documents can provide guidance in establishing acceptable atmospheric conditions.

Hot work permit - means the employer’s written authorization to perform operations (for example, riveting, welding, cutting, burning, and heating) capable of providing a source of ignition.

Immediately dangerous to life or health (IDLH) - means any condition that poses an immediate or delayed threat to life or that would cause irreversible adverse health effects or that would interfere with an individual’s ability to escape unaided from a permit space.

NOTE: Some materials -- hydrogen fluoride gas and cadmium vapor, for example -- may produce immediate transient effects that, even if severe, may pass without medical attention, but are followed by sudden, possibly fatal collapse 12-72 hours after exposure. The victim "feels normal" from recovery from transient effects until collapse. Such materials in hazardous quantities are considered to be "immediately" dangerous to life or health.

Inerting - means the displacement of the atmosphere in a permit space by a noncombustible gas (such as nitrogen) to such an extent that the resulting atmosphere is noncombustible.

NOTE: This procedure produces an IDLH oxygen-deficient atmosphere.

Isolation - means the process by which a permit space is removed from service and completely protected against the release of energy and material into the space by such means as: blanking or blinding; misaligning or removing sections of lines, pipes, or ducts; a double block and bleed system; lockout or tagout of all sources of energy; or blocking or disconnecting all mechanical linkages.

Line breaking - means the intentional opening of a pipe, line, or duct that is or has been carrying flammable, corrosive, or toxic material, an inert gas, or any fluid at a volume, pressure, or temperature
capable of causing injury.

**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.

**Oxygen deficient atmosphere** - means an atmosphere containing less than 19.5 percent oxygen by volume.

**Oxygen enriched atmosphere** - means an atmosphere containing more than 23.5 percent oxygen by volume.

**Permit-required confined space (permit space)** - means a confined space that 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.

**Permit-required confined space program (permit space program)** - means the employer’s overall program for controlling, and, where appropriate, for protecting employees from, permit space hazards and for regulating employee entry into permit spaces.

**Permit system** - means the employer’s written procedure for preparing and issuing permits for entry and for returning the permit space to service following termination of entry.

**Prohibited condition** - means any condition in a permit space that is not allowed by the permit during the period when entry is authorized.

**Rescue service** - means the personnel designated to rescue employees from permit spaces.

**Retrieval system** - means the equipment (including a retrieval line, chest or full-body harness, wristlets,
if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

**Testing** - means the process by which the hazards that may confront entrants of a permit space are identified and evaluated. Testing includes specifying the tests that are to be performed in the permit space.
CONFINED SPACE ENTRY PERMIT

This permit must be completed prior to entry into the confined space. Entry cannot be performed if any boxes are marked "No." This permit is valid for only 8 hours only.

Date of entry: __________________________ Time of Entry: __________________________

Location: ______________________________ Type of space:__________________________

Equipment to be worked on: _____________________________________________________

Work to be performed:  __________________________________________________________

Anticipated time needed to complete work:________________________________________

Anticipated Hazards:____________________________________________________________

Entry personnel: ________________________________________________________________

Attendants: ___________________________________________________________________

Acceptable conditions

1. Atmospheric checks: 
   Oxygen _____% O₂  19.5 % to 23.5 %
   Explosive _____% L.F.L. <10% L.E.L./L.F.L.
   Toxic _______ppm  0-35 ppm Carbon Monoxide
   0-10 ppm Hydrogen Sulfide

   Atmospheric Tester’s Initials:______________________ Time:_____________________

2. Isolation of pumps/lines:  
   N/A  Yes  No
   Pumps or lines blocked, blinked, or disconnected ( ) ( ) ( )

3. Ventilation:  
   N/A  Yes  No
   Mechanical ( ) ( ) ( )

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<tr>
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<tbody>
<tr>
<td>Natural ventilation only</td>
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</tr>
<tr>
<td>4. Hot work permit required</td>
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<tr>
<td>5. Atmospheric checks after isolation and ventilation, if applicable:</td>
<td></td>
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<tr>
<td>Oxygen: % O₂</td>
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<tr>
<td>Explosive: % L.E.L</td>
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<tr>
<td>Toxic: PPM</td>
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<tr>
<td>6. Communication procedures:</td>
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<td></td>
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<tr>
<td>7. Lockout procedures, if applicable:</td>
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<td></td>
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<tr>
<td>8. Entrant(s), attendant(s), and rescue personnel (if applicable) have successfully completed required training.</td>
<td>Yes</td>
<td>No</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Equipment:</td>
<td>N/A</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Direct reading sampling device which is properly calibrated</td>
<td></td>
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<tr>
<td>Safety harnesses and lifelines for entrants and attendants</td>
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<tr>
<td>Mechanical retrieval/hosting equipment</td>
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<tr>
<td>Communication equipment</td>
<td></td>
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<tr>
<td>SCBA or Type C air line respirator</td>
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<td></td>
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<tr>
<td>Personal protective equipment and clothing</td>
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<tr>
<td>Electrical equipment/Lighting/Non sparking Tools</td>
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<tr>
<td>Traffic barriers/entrance covers</td>
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</table>

I have reviewed the work authorized by this permit and the information pertaining to each item. Safety procedures have been received and are understood by all personnel.

Entry Supervisor: ________________________________ Date: _______________
Appendix Three

Oxygen levels and Concentration levels of typical gases potentially present in a confined space

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Alarm Concentrations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxygen</td>
<td>&lt;19.5% or &gt;23%</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>35 ppm</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>5000 ppm</td>
</tr>
<tr>
<td>H₂S</td>
<td>10 ppm</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>3.0 ppm</td>
</tr>
<tr>
<td>Chlorine</td>
<td>0.5 ppm</td>
</tr>
<tr>
<td>Methane</td>
<td>&gt;10% LEL</td>
</tr>
<tr>
<td>Ozone</td>
<td>0.1 ppm</td>
</tr>
<tr>
<td>Combustible Gases</td>
<td>10% LEL</td>
</tr>
<tr>
<td>Particulates</td>
<td>&gt;10% LEL</td>
</tr>
</tbody>
</table>

Final Note: Because of the complexity and variety of factors inherent in confined space issues as well as the seriousness of the injuries and because of the very real possibility of death. This document should not be construed as being anything more than basic guide. It is not to be considered a substitute for proper confined space training.