Pre-entry survey before entering attic

OSHA Confined Space Rule: Atmospheric & Temperature Hazards

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Techs in the HVACR industry are no stranger to working in cramped spaces with varying job site conditions that can often be deemed hazardous. Although practicing safe habits and protocols on the job comes with the territory, a recent Occupational Safety & Health Administration (OSHA) ruling now includes attics and crawlspaces as confined spaces in many cases.

This will require new processes and on the job techniques to address the confined space hazards. This means more training and new routines and may require some new tools.

We will focus this article on thermal and atmospheric hazards.

Implementation and details

On May 4, 2015, a new amendment to OSHA Construction Standard was published. On Aug. 3, 2015, the amendment went into effect. It extended the definition of confined spaces to include attics and crawlspaces (among other spaces). Up until then, confined spaces were thought of as being more "industrial" in nature, such as these in the following list from the actual Code:[1]

- Bins; boilers; pits (such as elevator, escalator, pump, valve or other equipment)
- Manholes (such as sewer, storm drain, electrical, communication or other utility)
- Tanks (such as fuel, chemical, water or other liquid, solid or gas)
- Incinerators
- Scrubbers
- Concrete pier columns
- Sewers
- Transformer vaults
- Heating, ventilation and air-conditioning (HVAC) ducts, etc.

Enforcement of this amendment was delayed until March 8, 2016 in residential construction industry, if good faith efforts were being made *and* as long as the employer was in compliance with the training requirements of the standard.[2]

The training requirement specifies that all employees required to enter into confined spaces should receive instruction on the nature of the hazards and necessary precautions, as well as the use of protective and emergency equipment.

In the most general sense, OSHA rules apply if there is an "employee-employer" relationship. What is more critical (and what makes most sense) is that it is about the presence of a person on a job site and the conditions on the job site, not about the business relationship. Quoting an OSHA FAQ:

> *Host employers need to treat temporary employees as they treat existing employees. Employers must assure that all workers—whether temporary or existing—are provided with a safe workplace and all required training and protections. Temporary staffing agencies and host employers share control over the employee and are therefore jointly responsible for temp employee's safety and health.* [3]

What is a Confined Space?

There are three mandatory characteristics of a Confined Space:

1. It must be large enough for a worker to enter it (It is important to note that even poking your head into a confined space constitutes entry).
2. It is not intended for regular continuous entry (For example, a normally "finished" attic is not a confined space).
3. It is difficult to enter or exit (Places like joist-only walkways or areas requiring belly-crawls to move about are considered "difficulties").

What is a Permit for Confined Spaces?

A Confined Space Permit is not like a building or construction permit. It is not filed with any governing body. Instead, it is a document that you keep on file at your business and at the work site. Most importantly, a confined space permit is written specifically for each and every work site.

Cramped conditions in crawlspace

When is a Permit Required for Confined Spaces?

A Confined Space can become a Permit Required Confined Space with presence of the following factors:

- A hazardous or potentially hazardous atmosphere
- Potential for engulfment or suffocation (basically robbing a person of the ability to breathe)
- Physical hazard(s) (e.g. temperature, electricity, oxygen level, flammable materials, animals/insects, etc.)
- Physical characteristics that create obstacles to entry or exit (e.g. joist-only floor, converging walls, a sloping floor, etc.)

It is important to note that a Hot Permit does not necessarily mean a thermally hot area. "A 'Hot work permit' means the employer's written authorization to perform operations (for example, riveting, welding, cutting, burning and heating) is capable of providing a source of ignition."

	YES	NO
Is it a confined space?	Must evaluate confined space for known or potential hazards.	Work as normal.
If it is a confined space, have you detected potential hazards?	Can eliminate hazards or MUST prepare a Confined Space Entry Permit.	Continue to monitor the space for hazards.
Is this a confined space and you working under an authorized Confined Space Entry Permit?	Must abide by permit conditions including recording of test results, isolating the space if needed, rescuers/ means to summon available, entrants properly equipped, etc.	Entry not permitted.

The above decision table is an exceedingly simplified version of the decision tree on OSHA Website.
For details: www.osha.gov/Publications/osha3138.html

Confined Space Entry Requirements

Once identified as a confined space, a pre-entry plan is required. This involves determining if it is simply a Confined Space or a Permit Required Confined Space. Appropriate entry and exit points must be assessed and ventilation methods (as required) should be determined. The main point for people in our trade is to control or eliminate all potential hazards in the space, thus removing the need for a Confined Space Permit.

In order to determine if there are atmospheric hazards, employers should ensure the air in a confined space is tested for oxygen levels, flammable gas concentrations and concentrations of toxic substances in the air.

If a confined space permit is required, rescue procedures, rescue personnel and appropriate rescue equipment must be determined in advance. It is also critical to monitor the confined space while occupied for changes and ensure compliance throughout the period of occupation/work.

Why measure temperature and humidity?

We measure temperature and humidity in a confined space to avoid heat stress affecting those in the space. Heat stress is an early stage of a dangerous and deadly condition called Hyperthermia, sometimes known as Heat Prostration or Heat Exhaustion.

The bottom line is, body temperatures above 104°F can be life-threatening.

As someone working in and around HVACR, you are likely familiar with the process of evaporative cooling (e.g. swamp coolers). The human body loses heat through sweating, which is evaporative cooling. It speeds up if the relative humidity in the surrounding air is low and slows down if the relative humidity is high. Therefore, both ambient temperature *and* humidity factor into heat stress situations.

Using the Wet Bulb Temperature of the air is a good first step; monitoring heat index is better, but it is primarily used for heat stress assessment in the shade. A Wet Bulb Globe Temperature meter (WBGT) is the best measurement as it takes into account radiant heat from the sun and other radiant sources such as building surfaces (e.g. attic roofs and walls) as well as wind effects.

Ultimately, individuals may respond differently to these environmental conditions, so the very best way to monitor for heat stress is via skin temperature, as it tells a more complete story about an individual's heat stress. Luckily, a new, unique and patented product called the HotDot has become available.

A HotDot is applied to the skin at a pulse point to monitor blood temperature as a good estimate of the body's core temperature. A thermochromatic indicator embedded in the HotDot reversibly changes color from black to yellow when the wearer's body is approaching a danger zone for heat stress. A dot lasts for 24 hours.

Why measure oxygen?

Oxygen concentration in a normal atmosphere is between 20.8% to 21.0% (by volume). When an atmosphere becomes oxygen-deficient, within a concentration of less than 19.5% oxygen, individuals are in danger of passing out.

Oxygen-deficient atmospheres may be created when oxygen is displaced by inerting gases, such as carbon dioxide, nitrogen,

Hot Dot application

Flue gas CO testing with attached NO_x filter

argon or chemicals used in a firefighting system. Oxygen can also be consumed by rusting metal, ripening fruits, drying paint, coatings, combustion or bacterial activities. Oxygen deficient atmospheres may also be created via the accidental release of flue gases and refrigerants into a space (see ASHRAE Standard 15).

Oxygen-enriched atmospheres, with concentrations above 22%, present fire and explosion hazards. Oxygen-enriched atmospheres may be produced by certain chemical reactions and in industrial settings caused by leaking oxygen hoses and torches. Oxygen-enriched atmospheres present a significant fire and explosion risk as all the "normal fuel to air ratios" of explosive limits at normal atmospheres are reduced.

Why measure flammable gases?

The Lower Explosive Limit (LEL, or sometimes the Lower Flammable Limit, LFL) is the "minimum concentration" of vapor in air, below which propagation of a flame does not occur in the presence of an ignition source. Rising above the LEL presents a clear danger of fire or explosion.

Additionally, explosive gas concentrations can rapidly change due to air currents and pressure changes. That is why the typical alarm point for explosive gases is 10% of the LEL.

Why measure toxic gases?

There are many toxic gases in the environment, but within the scope of general HVACR, there are a few that are more prevalent.

One of the most common and pervasive air toxins is Carbon Monoxide (CO), which emanates from many sources in and around the home and places of work. CO is generated from improperly controlled combustion that is usually released via a poorly functioning vent system. Because CO has no taste or smell, nor can it be seen, it is often called the "silent killer". Additionally, it can be misdiagnosed as symptoms that mimic influenza (the flu).

CO is a cumulative poison that builds in a victim's system over the time of exposure. That is why the exposures are tracked as time-weighted averages (TWAs). CO poisoning interferes with oxygen transport and absorption and can effectively debilitate the victim physically and mentally. The OSHA Permissible Exposure Limit (PEL, by TWA) is 50 parts per million (ppm) over eight hours. The ceiling maximum value over 15 minutes is 200ppm.

Hydrogen sulfide (H_2S) is a colorless, flammable and very dangerous gas. Most people can smell it at fairly low levels (e.g. less than 2ppm) as it has a "rotten egg" smell. It is commonly called sewer gas, swamp gas or manure gas. In nature, you will find it in crude petroleum, natural gas and hot springs. Additionally, hydrogen sulfide is produced by bacterial breakdown of organic materials as well as human and animal wastes (e.g. sewage). It is also prevalent in certain industrial activities such as petroleum/natural gas drilling and refining, waste water treatment and around paper mills.

Even though most people can smell H_2S, the nose is not a reliable sensor. If one is around certain smells for long enough, one can experience olfactory fatigue, get used to the smell and perhaps let their guard down.

Respiratory effects include eye, throat and lung irritation, which is worse for anyone with asthma or other breathing difficulties. Increasing levels of exposure will result in worsening symptoms up to the point of unconsciousness or death. For general industry, the ceiling limit of exposure is 20ppm, with a peak limit of 50ppm for up to 10 minutes, if no other exposure happens during a work shift.

Selecting a gas monitor

Look for a gas monitor for confined space entry that is designed to be a "personal monitor" for health and life safety applications. Look to the manufacturers and distributors of these products to point out these features and benefits, such as ruggedness, alarm types and strength, battery type and life, ease of calibration and the range of available accessories.

The first common question is *Do I get a single gas or multi-gas unit?* The answer depends on your assessment of the hazards presented to workers currently or in the future. As noted above, there are three or four gases very likely to be encountered in HVACR work; unless you also already have one or two types of single gas monitors that qualify as personal monitors, you are better set to consider a multi-gas monitor.

For our industry, the typical three-gas unit has an Oxygen (O_2), a Carbon Monoxide (CO) and a Combustible (LEL) gas sensor installed. The fourth gas is most typically Hydrogen Sulfide (H_2S). Multi-gas monitors are more efficient than a series of single gas monitors from the aspects of over all size and shared displays, housings, batteries and calibration. This makes multi-gas units less expensive to buy and maintain.

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Another common question is *Do I need the accessory pump?* (This is available on some units).
It is required that you check the space before entry; the most efficient way is to connect or activate the pump to evaluate the space for atmospheric hazards before entry.

Some units come with or have available a multi-hole probe and long hose attachment so the confined space may be evaluated before entry by throwing the hose into the space and dragging it back to determine if any gas hazards are present in your entry path. Once in the space, this process can be repeated to clear subsequent zones in the space.

Long battery life is also essential, as rules require you to periodically check for changes in conditions in the space. Some leave the unit on continuously when in the space, for maximum protection. Interestingly, the Building Performance Institute's Standard 1200: Standard Practice for Basic Analysis of Buildings, requires the use of a continuous, dedicated monitor for ambient CO levels while in the work environment, regardless of whether it is a confined space or not.

Can I use any of the analyzers I have?

Typically, those working in HVACR work may posses a combustion analyzer and a gas leak detector, which on the surface seem to satisfy the O_2, CO and combustible gas detection needs previously presented.

Combustion analyzers are purpose-built to measure flue gas combustion. They usually have probes and hoses required to operate, that will get in the way of the work if used as a personal monitor, and will always need to have the pump running, perhaps beyond its battery life for a confined space work period. They usually have no alarms. Most importantly, the oxygen and CO sensors start up by referencing to ambient, which is exactly the condition you are trying to measure!

It is also important to note some ambient CO meter manufacturers actually state in their instruction manuals that they are not to be used as personal safety devices.

Intrinsically safe gas leak detecton

The gas leak detector you have probably does not measure LEL, but it instead senses changes in concentrations to help you locate a fuel gas leak. Additionally, the OSHA standard requires that the detector be intrinsically safe and, while many are, not all gas leak detectors are designed this way.

The bottom line here is you should use the right tool in the right place for its designed purpose.

To achieve optimum performance in their role as life safety devices, products must be used as intended and be maintained. Instrument users/owners need to "own" this topic using resources such as the manufacturer's recommended operating instructions and other industry research.

One key test is called a "bump test, which verifies "the performance of the gas detector and ensures that sensors are responding to their target gas." A bump test, however, does not calibrate the sensors. "Bump gas" test kits are available and some users bump test daily or prior to use. Other users/devices employ checking a pumped sampling system to see that they are leak-free and to ensure no blockages obstruct the sample flow. Other steps include testing for operation at each start-up and periodically testing during a survey.

Calibration is crucial for reliable use of instruments. Calibration intervals are usually set by manufacturer's recommendations and instructions. Instruments are typically calibrated after any repair or replacement of parts, and then on a regular schedule based on sensor type and product usage. Additionally, it should be calibrated any time you suspect the instrument's calibration has changed. In critical applications, instruments are often checked for calibration as often as once per month.

Sensor replacement can often be done by the end-user, noting that calibration (and the associated calibration equipment) will also be required. ICM

Disclaimer

TruTech Tools, LTD provides this information strictly as an educational resource and is not responsible for the interpretation of the OSHA Confined Spaces in Construction rule.

We recommend that you contact the OSHA Office nearest you for guidance or an interpretation of specific questions regarding situations that contractors or technicians may find themselves in.

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Spohn is majority owner of www.TruTechTools.com and runs a consulting business, William P. Spohn, LLC, which engages in HVACR Expert Witness work, technical education and e-commerce consulting.

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[1]www.osha.gov/confinedspaces/tempenforcementpolicy_0116.html
[2]www.osha.gov/confinedspaces/1926_subpart_aa.pdf
[3]www/osha.gov/OSHA_FAQs.html