T echs in the HVACR industry are no stranger to working in cramped spaces with varying job site conditions that can oftentimes be deemed hazardous. Although practicing safe habits and protocols on the job comes with the territory, a recent Occupational Safety and Health Administration (OSHA) ruling now includes attics and crawlspaces as confined spaces. 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. This article focuses on thermal and atmospheric hazards of confined spaces.

IMPLEMENTATION/DETAILS
On May 4, 2015, a new amendment to OSHA Construction Standard was published. On Aug. 3, 2015 this amendment went into effect. This amendment extended the definition of confined spaces to include attics and crawlspaces (amongst other spaces). Up to then, confined spaces were thought of as being more “industrial” in nature.

Enforcement of this amendment was delayed until March 8, 2016 in the 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. The training requirement specifies that all employees required to enter into a confined space should receive instruction on the nature of the hazards, necessary precautions, as well as in 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 about the presence of a person on a jobsite and the conditions on the jobsite, not about the business relationship. To quote 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.”

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 is important to note, even poking your head into a confined space constitutes entry.
2. Not be intended for regular continuous entry. For example, a normally “finished” attic is not a confined space.
3. Be difficult to enter or exit. Things 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 a 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.

When is Permit Required for Confined Spaces? A Confined Space Permit is not a 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.

When is 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 the ability to breathe);
A physical hazard(s) (such as temperature, electricity, oxygen level, flammable materials, animals/insects, etc.); and Physical characteristics that create obstacles to entry or exit (such as 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.

### Table 1: A simplified confined space entry decision tree.

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

Note: This decision table is an exceedingly simplified version of the decision tree on OSHA’s website. For more information, visit 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 the 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.

### MEASUREMENTS

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,” also 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. The human body loses heat through sweating which is evaporative cooling. This speeds up if the relative humidity in the surrounding air is low and slows down if the relative humidity is high. Therefore, 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. Wet-bulb globe temperature (WBGT) meter is the best environmental 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.

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

Oxygen-deficient atmospheres may also be created via the accidental release of flue gases (e.g. carbon dioxide as an oxygen displacer) and refrigerants (see ASHRAE Standard 15) into a space.

Oxygen-enriched atmospheres, with oxygen 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 the all the “normal fuel-to-air ratios” of explosive limits at normal atmospheres are reduced.

Why measure flammable gases? The Lower Explosive Limit (LEL), which is sometimes referred to as 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 due to 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 may be a variety of toxic gases in the work environment, but within the scope of general HVACR, a few are more prevalent. One of the most common and pervasive air toxics is carbon monoxide (CO). This is true because there are so many sources for it in and around the home and places of work. Excessive amounts of CO may be generated by improperly controlled combustion that is usually released via a poorly functioning vent system. Because CO has no taste, smell nor cannot be seen, it is often called the silent killer. Additionally, it can be misdiagnosed, as symptoms mimic that of influenza.

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 ppm over eight hours. The ceiling maximum value over 15 minutes is 200 ppm.

Hydrogen sulfide (H₂S) is a colorless, flammable and very dangerous gas. Most people can smell it at fairly low levels (e.g., less than 2 ppm) 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 areas where there is 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, wastewater treatment, and around paper mills.

The answer depends on your assessment of the hazards presented to workers across all the work you do or may do in the future. As noted above, there are three or four gases very likely to be encountered in HVACR work. So unless you also already have one or to 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 O₂, CO, and a combustible (LEL) gas sensor installed. The fourth gas is most typically H₂S. Multi-gas monitors are more efficient than a series of single gas monitors from the aspects of overall size and shared displays, housings, batteries and calibration. This makes multi-gas units less expensive to buy and maintain.

Another common question is “Do I need the accessory pump (available on some units)?” Since it is required that you check the confined 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 the 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, due to the nature of work in and around combustion appliances 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.

### USING EXISTING ANALYZERS

Typically, techs working in HVACR possess a combustion analyzer and a gas leak detector, which on the surface seem to satisfy the O₂, CO and combustible gas detection needs previously presented. Combustion analyzers are 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. They usually have no alarms. Most importantly, the oxygen and CO sensors start up by referencing to ambient, which is exactly the condition you wish 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. The gas leak detector techs have probably does not measure LEL, but it instead senses changes in concentrations to help locate a fuel-gas leak. Additionally, the OSHA standard requires that the detector be intrinsically safe. While many are, not all gas-leak detectors are designed this way.

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

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 does not cali-
brate the sensors. “Bump gas” test kits are available. Some users bump test daily or prior to use. Other users/devices employ checking 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 considering the type of sensor and product usage, as well as 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.

UPDATES, CLARIFICATIONS AND SAD NEWS

In July 2016, after months of negotiation with OSHA, ACCA stated an agreement had been reached that clarifies that the rule has very limited application in the residential HVAC Industry. To help communicate this information, OSHA has published a rather large list of questions and answers to describe the confined space rule’s application in typical areas encountered in the residential spaces such as crawl spaces, attics and basements. The complete list of Q&As may be found at OSHA’s Confined Spaces FAQ website.5

A key point to understand is that most of the requirements of the confined space rule apply to only permit-required confined spaces and, in most cases, crawl spaces, basements and attics will not trigger these requirements. Also, just having a physical hazard (mechanical or electrical) present does not make the space permit-required unless the person entering the space will be exposed to a serious hazard and the exposure would limit the person’s ability to leave the space without help.

As things settle into place, the ruling on attics has morphed. Attics will now rarely be permit-required confined spaces, since they do not embody hazards or potential hazards as the rule defines. Additionally, OSHA continued the clarification noting that activities outside of an attic would rarely change it from a “confined space” into a “permit-required confined space,” since typical activities would not likely create a physical or atmospheric hazard that could limit the person from safely exiting the space without help. Importantly, the mere presence of asbestos in a confined space in a residential home does not turn it into a permit-required confined space.

The Q&As clarify that the initial evaluation of the space does not require that someone actually be present for a physical survey, rather, the evaluator may make this determination remotely if they possess adequate existing information and experience about the space, per the rule’s requirements.

Yet, in early August 2016, a young A/C worker lost his life in Texas attic after apparently being overcome by heat exhaustion. Perhaps the most important take away here is that everyone involved, from the worker, to the employer, to the government, to trade organizations and publications, must communicate clearly and often on this topic, as the consequences of overlooking the hazards may be fatal.6

References
3 OSHA FAQs, www.osha.gov/OSHAFAQs.html.

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