Industrial Hygiene in the Workplace

Using Gas Detection & Keeping Workers Safe in Confined Spaces

photo courtesy Industrial Scientific

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Contents

By: **RYAN CANTWELL**, *Contributor*

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Five Best Practices To Make Confined Spaces Safer For Workers

A lot can happen in four minutes, especially in a confined space. Confined spaces are prone to oxygen displacement. After just four minutes without oxygen, you can experience brain damage or even die. It should be no surprise that confined spaces are the leading cause of multiple fatalities in the workplace.

When workers in confined spaces need help, you can't act on impulse – you need to be prepared. Here are five best practices to keep in mind:

photo courtesy Industrial Scientific

1: Have a Plan

To create a plan, you need to understand the rules and regulations for confined space entry and create a clear, written procedure to follow. Workers must also be trained on this plan. This step is crucial to understand how to safely test the atmosphere within a confined space.

2: Know Your Hazards

Knowing the gas hazards that could be present in a confined space is critical. You should identify potential hazards before every confined space entry, because every space is different. It's important to know what hazards may be present in order to respond safely. All too often, workers ignore alarms because they think it's a false alarm – this is extremely risky.

3: Bump Test, Zero, and Calibrate

Once you know your hazards, you can select tools to identify them. Gas detectors are essential tools to have when entering a confined space. Once you select the right sensors, you need to confirm that your monitor is working properly. You need to bump test, zero, and calibrate those sensors. Bump tests show you whether the sensors can identify gas and whether the alarms and on-screen alerts are working. Calibration shows you whether the gas detector is accurately reading gas concentrations.

4: Use a Sampling Pump

The gas detector you use for pre-entry sampling must be equipped with a sampling pump to draw air from the confined space to the gas detector. When workers face the pressure of getting a job done quickly, it's easy to cut corners. Avoid damage to gas monitoring devices with a sampling pump. It's recommended that you follow the 2x2 rule, which is to check levels for two minutes plus two seconds for every foot of tubing.

5: Continuously Monitor

It's not enough to check for gas hazards then throw your monitor back in the truck. Conditions in confined spaces can change rapidly and dramatically, exposing you to new hazards. Continuously monitoring the confined space is one of the best things you can do to prevent accidents. If a confined space starts to fill with gas, continuous monitoring with a pumped gas detector can alert you and others to the hazard before it ever reaches the person inside. This allows them to exit the confined space safely.

But how will others know if a confined space entrant is at risk? Area monitors, like the Radius® BZ1, can help by providing clear audio and visual alarms so everybody in the area knows there is a gas hazard. You can take this a step further with live monitoring. This allows anyone, anywhere, to be alerted when gas hazards put you in danger so that everyone can respond accordingly.

It's estimated that each week, two workers who enter a confined space won't make it home. Are you doing everything in your power to make sure that doesn't happen to your people? Industrial Scientific provides the confined space resources you need. Talk to a confined space expert now and keep your team safe. ■

Ryan Cantwell is a senior product manager at Industrial Scientific.

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Gas Detection Made Easy

Industrial Hygiene in the Workplace *sat down with Jeremy DaValle, Training Manager, Industrial Scientific, to talk about the company's "Gas Detection Made Easy" training program and much more.*

Q Industrial Scientific has "Gas Detection Made Easy" training courses. How do you make gas detection easy?

We make it easy for people to understand gas detection by using clear, common language instead of technical jargon, and by focusing the course on group-led activities, rather than instructor lectures. We believe that the person who is doing the talking is the one who is doing the learning. Therefore, the more group activity we have, the more our attendees learn.

We have also created a *Gas Detection Made Easy* book, a *Confined Space* book, and a Gas Detection Made Easy application, available at no charge for smart devices using iOS or Android, that we use during our class to help make the difficult concepts easy to understand through visuals and other explanations. The training team within Industrial Scientific has roughly 120 years of combined experience, so we have a lot of stories to share to contextualize the concepts we're teaching.

photo courtesy Industrial Scientific

Q Industrial Scientific offers training in many formats: in-person, videos, webinars, mobile apps. Is there one format most popular?

In the past, the Custom Onsite in-person classes were a popular format, because the training team could customize the curriculum to the customer's needs and deliver it to their employees at their own site. However, throughout the Covid-19 pandemic, our Custom Online classes have been hugely popular. Luckily, facilitating classes online is not new to us—we have been using the online format for roughly 11 years. That experience and expertise has allowed us to successfully deliver critical training to our customers, even during these difficult times.

Q How can users assess the effectiveness of their Industrial Scientific training?

We work hand-in-hand to show users the effectiveness of the training they take with us. After attending one of our classes, participants take an assessment that is customized to the learning goals for that class. If a participant passes the assessment, they receive a certificate of completion. These assessments are tailored to each course. For example, we have a How to Use and Maintain Gas Detectors class that teaches the participants how to perform general maintenance on our equipment. With this class, participants take a multiple-choice quiz and then complete a hands-on assessment, where they repair an instrument that we broke for them. The real-time repair test allows us (and the participants) to see whether they have the skills they need to successfully go back to their day-to-day work. Participants know right then and there whether their training was effective.

At the end of each class, participants also complete surveys to share their feedback. As a team, we look at the survey results and determine what's going well; what could be improved; and if there are any countermeasures we should try.

Q Industrial Scientific's library of training courses is extensive, ranging from fundamentals to sensor technology and more. Who are the audiences for your training?

As you said, we have a broad range of courses, so we can train every worker who needs to use gas detection equipment. So many industries require gas detectors to keep their workers safe—from heavy industry, like oil and gas and steel manufacturing, all the way to consumer-facing industries, like paper products (cardboard, diapers, toilet paper), water treatment, utilities, fire departments and more.

Because there are so many people betting their lives on our gas detectors day-in and day-out, it's our job to make sure every single person has the training they need to use the equipment properly. We cover everything from a fundamentals class for anyone new to the concept of gas detection; to an operations class for someone who needs to learn the best methods of using the equipment and the proper steps; all the way up to a technician course for people who repair gas detection equipment. Every single class we offer is customized to the attendees: We identify what will be the most helpful and valuable and teach that material only— we don't believe in one-size-fits-all classes.

Q Gas detection technology is evolving rapidly with various forms of the "connected worker." How does your training make this technology easy to understand for non-tech EHS personnel (i.e., for some Baby Boomers)?

People with all backgrounds from all age groups can use Industrial Scientific equipment—and it's not just due to our work as trainers. Industrial Scientific is intensely focused on designing our equipment to be user-friendly. So, if you take the ease-of-use, paired with the right training, we guarantee that even non-tech EHS personnel can use our equipment. In our in-person classes, we drive this home through hands-on group activities that ensure everyone understands how to use the equipment and the evolving connected safety technology. This approach allows us to give participants individual attention and view their progress in real time. From there, we can either slow down or speed up our lessons to adapt to the learning curve.

Q When you say your training "takes the guesswork out of gas detection," how does the training accomplish this?

There are some maintenance tasks that need to be done routinely to ensure a gas detector is working correctly. No matter what a manufacturer states, users always need to perform some amount of routine maintenance to make sure a gas detector will work when they need it. We call that "the moment," where the user and your monitor are put to the test. To prepare for "the moment," users need to know how to determine whether the gas detectors are functioning correctly. We teach all of those routines and what to look for, so when users grab an instrument off the charger or the docking station, they know what to look for and can trust that it's working as expected.

On top of the maintenance aspect, we also teach our attendees about features designed to make our gas detectors easy to use. Things like alarm action messages, custom alerts, and location tagging are all features designed to give users insights into the gas detectors and their sites so they can consistently make safer decisions.

Q How can Industrial Scientific training be customized for users? Can you cite an example?

We have a lot of examples, but the one that comes to mind is our Custom Online classes. We have been conducting online classes for a while now. Online classes have a bad rep for someone sitting behind a desk sharing their PowerPoint and reading the slides—or even worse, pressing play on a recording and then asking if anyone has questions after the playback. We care about our attendees too much to treat them this way. Our online classes use two webcams at the same time: one focused on the instructor and one focused on the equipment. This simulates a face-to-face session. Alternating between the two cameras shows attendees where they need to focus. These online sessions are recorded and shared with the customer so they can share the information with employees who weren't able to attend and attendees can revisit the training whenever they need it.

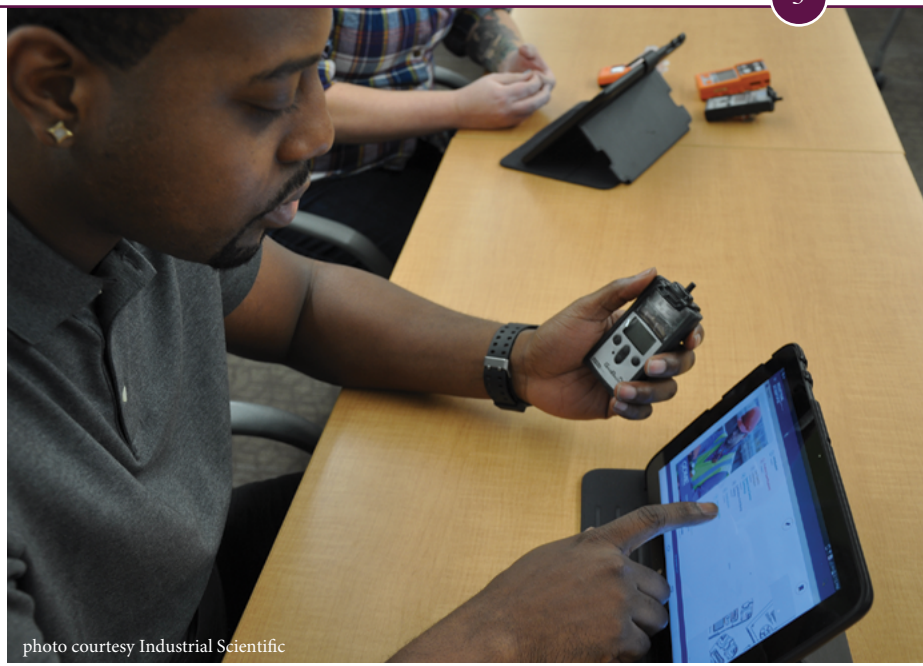
photo courtesy Industrial Scientific

On top of customizing the format to fit the method of instruction, we also customize the topics. We work with the primary contact for each training to build a curriculum with the topics they want to cover. This allows us to focus on what's most important to the customer, so we can guarantee the training is time well spent.

Q Regarding Gas Detection 101, 102 and 103 training courses: Who is the target audience?

All three of these classes are designed for different audiences. The Gas Detection 101 course is designed to help everyone learn the fundamentals of gas detection. It's a great course for someone who just started using gas detection equipment or someone who needs a refresher on the critical topics and concepts around gas detection. Gas Detection 102 builds on the 101 class by showing how to use the equipment. We take all of the concepts from 101 and learn how to perform the associated activities on our equipment. The audience for Gas Detection 102 is anyone who needs to know how to operate the equipment. Gas Detection 103 is for anyone who needs to repair equipment.

Q Why is it essential for Industrial Scientific to offer so much training, in addition to being a multi-line product manufacturer?

Industrial Scientific's vision is to end death on the job by 2050. Training plays a critical role in that vision. We can make gas detectors easy to use, but if a customer doesn't understand how to maintain the equipment; interpret the readings; or use the software properly, the results could be deadly. We also know that one training offering will not work for every customer. We must be adaptable to ensure that we can help every customer, every time. We're incredibly proud that there's no customer we can't serve. To make sure that never changes, we continue to adapt our training content and format to meet our customers' needs. ■

What You Need to Know about Atmospheric Hazards in Confined Spaces

Atmospheric hazards include things such as oxygen deficiencies, dusts, chemical vapors, welding fumes, fogs, and mists that can interfere with the body's ability to transport and utilize oxygen, or that have negative toxicological effects on the human body, according to a University of South Carolina paper on confined space training.

Before entry into most confined spaces, a multi-gas meter is commonly used to determine levels of oxygen, carbon monoxide, hydrogen sulfide, and the concentration of combustible gas. Other types of meters and sensors are available to detect concentration of specific gases (chlorine, sulfur dioxide, etc.) if needed.

The most common atmospheric hazards associated with confined spaces are:

- Oxygen Deficiency
- Oxygen Displacement
- Flammable Atmospheres
- Toxic Gases
- Oxygen Deficiency

Low levels of oxygen can be caused by the consumption of oxygen during open flame operations such as welding, cutting, or brazing. In addition, low levels of oxygen can be present in manholes that are located near garbage dumps, landfills and oxygen displacement:

Some types of gases will "push" or displace oxygen from a confined space. An example of this is nitrogen. Nitrogen is commonly used to purge some types of tanks. If a person were to enter into the space before the nitrogen was properly removed and vented from the tank, death could result in a matter of minutes.

Flammable Atmospheres:

Three components are necessary for an atmosphere to become flammable: fuel, oxygen, and a source of ignition.

Some confined spaces may contain solvents, fuel oil, gasoline, kerosene, etc. which provide the fuel for combustion. In order for an atmosphere to become flammable, it must have the proper mixture of fuel and oxygen. If the concentration of a specific gas is below the lower explosive limit (LEL) it is too lean to burn. If the concentration is above the upper explosive limit (UEL) it is too rich to burn.

Toxic gases:

Toxic gases can be present in a confined space because the type of manufacturing process uses toxic substances as part of the production process, or biological and chemical "breakdown" of the product being stored in a tank, and from maintenance activities (welding) being performed in the confined space.

Common types of toxic gases encountered in confined spaces are:

- Hydrogen Sulfide– "sewer gas" a colorless gas with the odor of rotten eggs. Excessive exposure has been linked to many confined space deaths. Hydrogen sulfide causes a loss of our sense of smell, causing people to mistakenly think that the gas has left the space. Hydrogen sulfide inhibits the exchange of oxygen on the cellular level and causes asphyxiation.
- Carbon monoxide– is an odorless, colorless gas that is formed by burning carbon based fuels (gas, wood). Carbon monoxide inhibits the bodies ability to transport oxygen to all parts of the body.
- Solvents– many solvents, such as kerosene, gasoline, paint strippers, degreasers, etc. are not only flammable, but if inhaled at high concentrations can cause central nervous system (CNS) effects. CNS effect can include dizziness, drowsiness, lack of concentration, confusion, headaches, coma and death. ■

By: **Dante Moore**, *Contributor*

How to Overcome Instincts to Improve Safety

No matter who you are or what you do, one major challenge that we all face is overcoming ingrained behaviors to change our actions. Sometimes, these ingrained behaviors make it difficult for us to remember to do something simple, like run an errand on the way home from work. Other times, our ingrained behaviors can put lives at risk.

As humans, our first instinct is usually an action we take without much thought. When someone around us is in danger, our instinct is to help. We tend to provide aid to others in emergency situations without thinking about the possibility of putting ourselves at risk. In some cases, this behavior is helpful, like when we catch a toddler before he falls and hits his head. Unfortunately, there are plenty of times when this behavior can make a dangerous situation even more dire. For example, even though you have good intentions, slamming on your car's brakes or swerving to avoid hitting a squirrel or other small animal in the road could cause a dangerous multi-car pileup.

While we always want to act swiftly, we also need to be sure that the actions we take to help others won't cause further harm to ourselves or other people around us. What we do and how we decide to do it can ultimately determine the outcome of the situation.

Danger of Relying on Instincts in Confined Spaces

When it comes to working in confined or enclosed spaces, our decision-making process becomes even more important. Whether you work in or around confined spaces regularly or simply work at a site that has them, it's important to understand the additional dangers these spaces can pose. Because of these dangers, agencies like OSHA have issued guidelines to help us understand the requirements for working in these environments.

One of the biggest requirements to which we must adhere is the use of atmospheric gas monitors. We use these monitors to test the quality of the air prior to entry—checking that the space is clear of all toxic and combustible gases and has a safe oxygen level. These pre-entry tests help ensure that when a worker goes into the space, he or she won't face immediate danger before even starting work. After pre-entry sampling, we must also monitor the space continuously, while the worker is inside. Atmospheric conditions can change quickly, and without continuous monitoring, a worker could be exposed to toxic and combustible gases without knowing it.

Even with guidance on how to use gas monitors to safely work in confined spaces, we continue to hear horror stories. The majority of the stories have one thing in common: multiple injuries or deaths when workers rush in to help a fellow worker. When we see a fellow worker in need, our instinct is to rush to save him or her. But this instinct can be life-threatening in the presence of gas hazards. Without thinking twice or taking the time to understand why our teammate has fallen or is unresponsive, we enter the space to provide aid—only to end up lying next to the person we intended to help.

In this situation—even with proper training—our human instinct is often to react immediately and attempt to rescue our teammate, whether we'll make it out alive or not. The sad truth is that this ingrained behavior of helping others is the reason why 60% of confined space deaths are would-be rescuers, or those who are killed or injured while attempting to help another person.

Using Instincts + Insights

When our instincts are fallible and doing nothing is not an option, we can turn to technology to help us make better decisions.

Technology in gas monitors now allows us to make smarter, faster and safer decisions that can help prevent multiple fatalities from a confined or enclosed space. Some handheld and area gas monitors come equipped with wireless connectivity that shares gas, man-down and panic alarms from monitor to monitor. This technology has been designed so that, as soon as the equipment is powered on, it automatically connects with other monitors on the same network to share gas readings from inside the confined space to monitors outside of the space.

When the gas monitors are paired together, we can easily see what our peers are experiencing. If a teammate's monitor goes into alarm, we can readily see whose monitor is in alarm; why the monitor is alarming; and determine what protective measures we need to take—prior to attempting a rescue.

photo courtesy Industrial Scientific

Pre-entry tests/sampling help ensure that when a worker goes into the space, he or she won't face immediate danger before even starting work.

As an example, Jane, who is working inside a confined space, was suddenly exposed to 300ppm of H2S and is now lying unconscious within the confined space. Jane's monitor goes into alarm for the 300ppm of H2S, and her lack of movement triggers a man-down alarm, as well. John, who is currently outside of the confined space, sees Jane's high H2S reading and man-down alarm on his own monitor. Now that John knows the situation, he can quickly decide to contact others, ventilate the area or determine the appropriate equipment to protect himself—before he makes a rescue attempt. Because of the wireless technology that is built into their gas monitors, John can make a smart decision within seconds, based on insights, not just instincts.

Aside from saving lives, one of the biggest advantages to this technology is that it enables connectivity in areas without cellular or wi-fi infrastructure. It is also important to note that the network is built into the monitors and only requires an individual to turn on the monitor to establish communication with other monitors—no IT support needed.

Working in hazardous environments, especially in confined or enclosed areas, will always be a challenge. However, if we learn how to change our behavior and adopt the latest technologies into our practices, we will be able to work more efficiently and save lives. ■

Dante Moore is an Applications Engineer at Industrial Scientific.

OSHA Answers FAQs for Confined Space Compliance in Construction

What is a confined space?

A confined space means a space that (1) is large enough and so configured that an employee can bodily enter it; (2) has limited or restricted means for entry and exit; and (3) is not designed for continuous employee occupancy (see 29 C.F.R. 1926.1202). All three criteria must be met in order for a space to be considered a confined space and covered by the Confined Spaces in Construction Standard (hereinafter "Confined Spaces in Construction Standard" or "Standard").

What is a permit-required confined space?

A permit-required confined space or permit space means a confined space that has one or more of the following characteristics: (1) contains or has the 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 (see 1926.1202).

Paragraph 1926.1203(a) requires that each employer ensure that a competent person identifies all confined spaces in which one or more of the employees it directs may work, and identifies each space that is a permit space, through consideration and evaluation of the elements of that space, including testing as necessary. If the competent person must enter the space to assess its characteristics and potential hazards, must the competent person treat the space as a permit-required confined space?

If the competent person can reasonably foresee the presence of a hazard or potential hazard that would make the space a permit-required confined space (see response to Question 2), the competent person must treat the space as a permit-required confined space when entering the space to assess it. However, if the competent person cannot reasonably foresee the presence of such a hazard, the competent person would not need to treat the space as a permit-required confined space when entering the space to assess it. Of course, if the competent person encounters such a hazard when assessing the space, whether or not the hazard was reasonably foreseeable, the competent person must treat the space as a permit-required space after identifying the hazard.

Does the standard impose additional requirements on "permit-required confined spaces" beyond those imposed for "confined spaces"?

Yes. In fact, the vast majority of the standard's requirements only apply to permit-required confined spaces, and attics, basements, and crawl spaces in a residential home will not typically trigger these requirements. Once the employer's competent person performs an initial evaluation and determines that a confined space does not require a permit (1926.1203(a)), the employer's only further obligations under the standard are to have a competent person reevaluate the space and, if necessary, reclassify it as a permit-required confined space if changes in the use or configuration of the space occur that could increase the hazards or potential hazards to entrants or if the employer has any indication that the initial evaluation may have been inadequate (1926.1203(f)).

If the employer's competent person determines that the space is a permit-required confined space, the following provisions also apply: entry communication and coordination (1926.1203(h)), permit-required confined space program (1926.1204), permitting process (1926.1205), entry permit (1926.1206), training (1926.1207), duties of authorized entrants, attendants, and entry supervisors (1926.1208-1210), and rescue and emergency services (1926.1211).

Does the characteristic "contains or has the potential to contain a hazardous atmosphere" in the definition of "permit-required confined space" refer only to those atmospheres which pose an acute hazard?

Yes. Where employees are exposed to hazardous atmospheres that do not present an immediate danger of death or impairment that could impede the employee's ability to exit the confined space without assistance, OSHA's health standards for those hazards apply, rather than the Confined Spaces in Construction Standard (see 1926.1202 definition of "hazardous atmosphere").

In some residential home building projects, the home builder constructs multiple homes with the same or similar basic configuration. If the presence or absence of any potential hazard in an attic, crawl space, or basement is known, does the standard require a competent person to examine each attic, crawl space, or basement in each home to make a determination as to whether the space is a permit-required confined space?

No. The standard requires a competent person to identify all permit-required confined spaces in which employees may work "through consideration and evaluation of the elements of that space, including testing as necessary." 1926.1203(a). If a competent person can reliably determine whether attics, crawl spaces, or basements with the same or similar configuration contain one of the hazards or potential hazards listed in response to Question 2 without physically inspecting each of the spaces, the competent person need not physically examine each space to make the identification required under 1926.1203(a). ■

By: **Barbara T. Nessinger**, *Chief Editor*

Gas Detection and Monitoring in Confined Spaces

Employees of industrial firms often find themselves, for a multitude of reasons, working in a confined space. Worker health and safety is critically important in these situations. To that end, the U.S. Occupational Health and Safety Administration (OSHA) has many regulations which focus on providing a safe working environment for workers who must work in these confined enclosures.

Having adequate gas-detection equipment is a big part of maintaining awareness and compliance regarding confined spaces. Gasses present a particular risk for workers with little maneuvering room, because they are often odorless and colorless. Therefore, without the proper detection tools, workers can be unknowingly exposed. Such hazards can be mitigated by sufficient personal gas-detection systems.

However, before acquiring solutions, companies should be fully informed on what is required and what is available to help meet the requirements and secure their employees' safety.

WHAT IS A CONFINED SPACE?

According to OSHA's definition, a confined space:

- Has adequate size and configuration for employee entry;
- Has limited means for access or egress; and
- Is not designed for continuous employee occupancy.

A few examples of confined spaces include underground vaults in the telecommunications industry, aeronautical fuel tanks, sewers, silos or coal mines, and other places where it is difficult for employees to enter and exit.

The term "permit-required confined space," as defined by OSHA, is one that meets the definition of a confined space, above, and has one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere;
- Contains a material that has the potential for engulfing the entrant;
- Has an internal configuration that might cause an entrant to be trapped or asphyxiated by inwardly converging walls or by a floor that slopes downward and tapers to a smaller cross section; and/or
- Contains any other recognized serious safety or health hazards.

GAS DETECTION

Per OSHA's rules, companies need to monitor enclosed spaces for gases before allowing workers to step into these areas. OSHA standards require that before an employee enters the space, internal atmosphere must be tested with a calibrated direct-reading instrument for the following conditions: oxygen content, flammable gases and vapors, and potential toxic air contaminants. Additionally, there may be no hazardous atmosphere within the space whenever any employee is inside. This standard is the impetus for using a multi-gas monitor to perform atmospheric testing, prior to entering a confined space.

Employers can install gas-detection machines to measure the level of air contaminants. Proper air monitoring is an OSHA requirement for permit-required confined spaces, because of the potential presence of atmospheric hazards.

Companies can use single-gas monitors or multi-gas monitors to ensure hazardous gases are not present in enclosed spaces, before workers enter. In fact, OSHA clearly dictates that employers perform continuous gas monitoring.

CHOOSING THE RIGHT MONITOR AND SYSTEM

When choosing a monitor to test and continuously monitor a confined space, several attributes should be considered. The most important thing is to have a multi-gas monitor that is capable of monitoring for all OSHA-required hazards (oxygen, flammable gases and potential toxic air contaminants that may be present as a result of the processes that take place in or around the confined space). Next, consider a monitor that has either an internal or external pump that is capable of properly drawing the air sample back to a fresh air-monitoring point during initial testing of the space. The monitor also should have the capability of continuously monitoring the occupied space to ensure workers' continued safety. Other equipment/accessories, such as sampling probes, durable carrying cases and rechargeable batteries, can be complementary and useful.

Most modern monitors are equipped with bright visual and loud audible alarms to warn of potential hazards. An internal datalogger helps employers comply with the documentation of the spaces' hazards. A datalogger is a device containing a microprocessor; it stores information electronically taken from an instrument. The levels of all hazards being monitored can be downloaded from the datalogger to a computer or printed, for reference and record-keeping.

An automated instrument docking system is also extremely helpful when working with confined spaces. Such systems provide a myriad of benefits, including automated calibration/bump-testing (OSHA requires a "calibrated direct reading instrument" to safely detect a hazardous atmosphere); record-keeping; datalogging; and recharging. (Docking systems can be used to charge monitors when not in use. This ensures the monitor is fully charged for its next use). In addition, many automated maintenance systems include technology that helps diagnose potential problems/issues with the monitor.

Portable gas-monitoring systems may be designed for a single substance, or they can be fitted with multiple sensors. Some measure up to six gases and include piercingly audible, attention-getting, 360-degree visual alarms.

An alternative or addition to personal monitors is a transportable area monitor. Many have area monitoring, via diffusion or with a sampling pump; wireless communications capabilities; and a waterproof housing with continuous operation of approximately 60 hours. Extra run time helps increase productivity by minimizing new checks of the atmosphere for each shift change or when the space may be unattended. Portable gas monitors are lightweight and can be as small as a cellphone. They run on either rechargeable or replaceable batteries.

Another important aspect of managing confined space gas-monitoring programs is on-going maintenance. The best way to be

certain a monitor is in peak shape is to utilize the services of a manufacturer's factory service center. Using factory-trained service technicians ensures the monitor will be repaired or serviced by qualified individuals. Some of the key services to look for include in-house calibration and service; maintenance and warranty repair; and on-site mobile service/repair. Leasing or renting an instrument is also an attractive option, especially in cases of shutdowns or planned maintenance, where more instruments might be needed to perform the work within a specific timeframe.

WAY OF THE FUTURE

The global market for gas detection systems has seen notable growth recently, something that Transparency Market Research (TMR) claims will continue into the 2020s. In a recent report, TMR said the worldwide gas-detection equipment market will grow at a compounded annual growth rate of 5.6% to $5.6 billion by 2024. In 2015, the market value was $3.4 billion. TMR cited the rising tide of rule-making and worker safety-focused regulations being enacted—not only in the U.S., but also in the developing world.

The shift toward natural gas is one more factor that is causing greater demand for gas-detection systems. Coal has seen significant declines in recent times (despite recent U.S. promises to "bring coal back"), and natural gas has risen to the top of many consumers' preferences for heating and energy. The increased number of gaspowered installations multiplies the chances where workers might be in enclosed spaces— and increases the possibilities of gas leaks.

Persistence Market Research also found considerable opportunities for market expansion, given the high rate of infrastructure projects in the developing world. Researchers highlighted India and Brazil as countries undertaking particularly large projects that will elevate demand for gasdetection systems.

More companies than ever are investing in gas detection systems. It's important to choose the system that is right for a company's needs to safeguard the health of all employees working in confined spaces. ■

By: **Dan Smith**, *Contributor*

Confined Space: More to Consider

When I hear the words "confined space," my claustrophobia goes out of the way to crank up the anxiety factor a few notches. Clinically, I have been told to accept the anxiety as an "irrational fear." I am working on rewiring my brain to help me recognize and deal with these cognitive distortions.

On the other hand, let us remove the "irrational" factors from the discussion and consider the "rational" fear factors in confined spaces.

By nature, confined spaces carry these fears.

The OSHA1910.146 standard does a good job informing confined space workers by identifying dangers and providing guidelines for managing what I call "rational" fears within permit required spaces.

To start making sense, laid out below is the structure, definition and direction dictated in the OHSA 1910.146 standard[1].

Permit-Required Confined Space Standard 29 CFR OSHA 1910.146

Confined Space

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."*

Permit-Required Confined Space

"... has one or more of the following characteristics:
1. *(1) Contains or has a potential to contain a hazardous atmosphere;*
2. *(2) contains a material that has the potential for engulfing an entrant;*
3. *(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. *(4) contains any other recognized serious safety or health hazard."*

Non-Permit-Required Confined Space

"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."

After confessing my own phobia of confined spaces, I can safely say that, regardless of whether a permit is required or not, all confined spaces can be frightening places.

There is more to consider, in that not all confined spaces are created equally. On its own merit, a permit-required confined space deserves greater recognition because of obvious IDLH hazards identified in detail in OSHA 1910.146. But, a permit-required space does not deserve all of the recognition; non-permitted spaces hold their own undefined and uncontrolled dangers.

Just like irrational fear and rational fear, unidentified dangers are not as easy to manage and control as the dangers in a permit-required confined space.

For instance, working within a permit-required confined space comes along with a complimentary confined space attendant. OSHA 1910.146 dictates the attendant's role as to identify, authorize entry and monitor entrants in one or multiple permit-required confined space; this cannot always be afforded to an entrant in a non-permit required confined space.

Below are excerpts from OSHA 1910.146 (b) Permit Required Confined Spaces standard definitions[2]:

"'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."

Rational vs. Irrational Dangers

You don't have to be a scaredy-cat like me to recognize "rational" dangers. Spiders, snakes, slips, trips, falls, bee stings, heat stroke, cardiac and diabetic events cannot always be predicted, but every one of these dangers can quickly turn a non-permit required, non-IDLH atmosphere into an IDLH atmosphere.

Given these uncontrolled and unplanned dangers, the non-permit-required confined space can involve quickly becoming an IDLH atmosphere—not in the sense of the traditional definition of a permit-required IDLH confined space—but instead fits the spirit of a broader definition of

1 https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.146 1910.146(b)
2 https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.146 1910.146(b)

IDLH. Below is OSHA's definition of the IDLH atmosphere. (Excerpts from OSHA 1910.146 (b) Permit Required Confined Spaces standard definitions[3].)

"*'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."*

Let's go back to the beginning and look at OSHA 1910.146 in a much broader sense, without reference to either permit-required or non-permit-required confined space.

Permit-Required Confined Space Standard 29 CFR OSHA 1910.146

Confined Space

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..."*

How many operations are you a part of that fit with the above?

How many of these operations would never be considered a permit-required IDLH atmosphere?

The best any confined space entrant can hope for is found in either the comfort of having an attendant monitoring them and/or having another means of signaling distress and summoning assistance; preferably, by sending a distress signal to be received immediately by other personnel.

3 https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.146 1910.146(b)

Sending a distress signal would not require the entrant to be conscious and then automatically trigger an alarm by sensing "lack of motion" or a "fall" to automatically send the distress signal. A best practice would also provide an entrant with a device having the means to manually press a button to send a distress signal, when conscious, to summon assistance on their own.

Staying Safe, Rationally

The combination of all these features come together to create a confined space safety monitoring system capable of protecting anyone working alone, working at heights and/or working in confined spaces.

If these devices existed, would you want to learn more?

Regardless of the requirement, as part of permit-required environmental monitoring or simple non-permit-required lone worker confined space monitoring operation, the good news is these systems currently exist today and are available for all who work alone, at heights or in the confined space.

With more to consider, not all confined spaces are created equally, but may carry with them many common dangers demanding our "rational" attention. ■

Dan Smith brings over 30 years of broad experience across several industries, including manufacturing, public safety, land mobile radio design, consulting and personal safety product manufacturing. He is currently Director of Sales and Marketing at Grace Industries, in Fredonia, Penn.

Procedures for Atmospheric Testing in Confined Spaces

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements.

Atmospheric testing is required for two distinct purposes: evaluation of the hazards of the permit space and verification that acceptable conditions exist for entry into that space.

A confined space is one that is large enough to enter and perform assigned work in; it has limited or restricted ways to enter or exit the space; and it was not designed to be occupied continuously by a worker.

Evaluation testing

The atmosphere within a confined space must be tested using equipment that is designed to detect the chemicals that may be present at levels that are well below the defined exposure limits. Evaluation testing is done to:

- determine what chemical hazards are or may become present in the space's atmosphere, and
- identify what steps must be followed and what conditions must be met to ensure that atmospheric conditions are safe for a worker to enter the space.

The testing results and the decisions about what steps must be followed before entry must be evaluated by, or reviewed by, a technically qualified professional like an OSHA consultation service, a certified industrial hygienist, a registered safety engineer, or a certified safety professional. The technically qualified professional must consider all of the serious hazards in his/her evaluation or review.

A permit space is a confined space that has one or more of the following features: it has or may contain a hazardous atmosphere; it contains a material that can engulf a person who enters; it has an inside design that could trap or asphyxiate a person who enters (inwardly converging walls, or a floor that slopes downward to a smaller section); or it has any other serious safety or health hazards.

Verification Testing

Before a permit space that may have a hazardous atmosphere can be entered, the atmosphere must be tested using the steps identified on the permit (developed during evaluation testing). Verification testing is done to make sure that the chemical hazards that may be present are below the levels necessary for safe entry, and that they meet the conditions identified on the permit. Test the atmosphere in the following order: (1) for oxygen, (2) for combustible gases, and then (3) for toxic gases and vapors.2 The testing results — the actual test concentrations — must be recorded on the permit near the levels identified for safe entry.

Duration of Testing

For each test required on the permit, you must allow enough time for the air from the space to be drawn into the equipment and for the sensor (or other detection device) to react to the chemical if it is present. This is considered the "minimum response time" and it will be noted by the manufacturer in the operator's manual. Be aware that you will need to add time to this "minimum response time" if you have attached hosing or a probe extension to the inlet. The additional time is needed to allow the air from the different depths of the space to be pulled into the equipment inlet.

Testing Conditions in Spaces that May Have Layered Atmospheres

For permit spaces that are deep or have areas leading away from the entry point, the atmosphere may be layered or may be different in remote areas. For these spaces, testing must be done in the area surrounding the worker, which is considered four (4) feet in the direction of travel and to each side. If a sample probe is used to do the testing, then the worker must move slowly enough so that testing is completed, keeping the equipment "response time" in mind, before he/she moves into the new area.

Retesting the Space During Entry or Before Re-Entry

Test the permit space routinely to make sure that the atmospheric conditions continue to be safe for entry. ■

photo courtesy Industrial Scientific

By: **Jason Wright**, *Contributor*

Top Four Things to Consider When Renting Gas Detectors

Every day, workers across numerous industries use gas detectors for a variety of applications. From the largest refineries, mines and mills to construction companies and emergency responders, gas detectors are a central part of worker safety.

While many companies purchase their gas detectors outright or use a long-term leasing program, sometimes renting gas detectors on a short-term basis is the best fit for the company and the situation. Renting gas detectors is an ideal solution, no matter the length of the rental period or the quantity of instruments needed.

Renting Equipment

Based on the project, there are certain factors that can impact your decision to rent gas detectors. Be sure to scope out the project and ask the right questions, taking the following into consideration:

What gas hazards will be present where you are working? This will directly affect which sensor or sensors you will need in your gas detector, which will determine which monitor will best suit your needs. For example, you may just need a single-gas monitor with a carbon monoxide sensor, or you might need a multi-gas monitor to detect several toxic and combustible gases at the same time. Gas hazards differ between industries, so there may not be a "one-size-fits-all" solution. It is important to understand the gases that are present and understand the nature of these gases. If you are unsure which gases will be present, contact your safety manager.

How will you maintain your gas detectors during the rental period? Gas detectors require routine maintenance to ensure proper functionality. It is crucial that gas detectors are calibrated monthly and bump tested before each day's use. During a short-term rental, these processes can become a challenge. While rented gas detectors are calibrated before they leave the factory, certain situations (like a sensor overage) can dictate the need for a calibration, before the gas detector reaches its recommended 30-day window. Fortunately, docking stations are also available to rent. Docking stations automatically run calibrations and bump tests on instruments that are docked to ensure functionality, and simplify the maintenance process for the worker. With docking station software, users can also view the results of these tests, along with instrument data that is collected, while the worker is using it. This eliminates the need for safety managers to play a guessing game, when it comes to viewing a worker's gas exposure or ensuring that gas detectors are being calibrated and bump tested appropriately.

How long will the rental period last? Predictability can be a struggle during an emergency situation or unexpected project. Sometimes, you won't know how long the project will last or how long you'll need the gas detectors. Luckily, rental companies can be flexible. Some rental companies offer weekly and monthly rental rates, with the monthly pricing usually at a discounted rate. Through package tracking, some rental companies can start the clock on the rental agreement the day the equipment is received at the facility, and can end the agreement on the day it is shipped back. If an influx of workers or contactors drives the need for additional gas detectors on the rental agreement, rental companies are happy to provide as many gas detectors as needed to keep workers safe.

How can I ensure that I know how to use the gas detector? With new (and sometimes unfamiliar) workers on site, it is important to ensure that they are properly trained on using their gas detectors. Many rental companies offer a variety of training resources to ensure that workers are comfortable with these life-saving devices. Trainers also provide insight on the nature of toxic and combustible gases that may be present in your workspace. Training is available in person, online or through webinars. In-person training gives workers the chance to get a complete, hands-on course by a qualified trainer. Online resources include videos, articles and instructional documents to help users learn how to use their gas detectors. Webinars allow users the chance to interact with a live instructor and get their questions answered immediately.

While there are many available options for keeping a workforce safe from gas hazards, renting gas detectors can be the most efficient and cost-effective. Whether you need 50 monitors for a large project or one gas detector for personal protection, renting can be an efficient, effective way to stay safe in a hazardous worksite. ■

For more information about gas detector rental at Industrial Scientific, contact Rental Manager, Jason Wright at jwright@indsci.com or 412-490-1912.

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