Confined space working:
Gas Detection - What you need to know

An MSA White Paper

MSA
The Safety Company

WE KNOW WHAT'S AT STAKE.

Concerned about Confined Spaces? Worried about Gas Detection?

More injuries occur in confined spaces as a result of atmospheric conditions than any other issue. Multiple studies have shown this can account for up to 56% of reported injuries[1]. For this reason, safe working procedures and standards for confined spaces necessarily focus on atmospheric monitoring.

Know the hazards

Atmospheres contain a mixture of gases and vapours. Depending of their concentration some are good (such as oxygen) when others are dangerous for health (such as carbon monoxide). In our atmosphere the good normally outweigh the bad, but in confined spaces this is not always the case.

The three risks

When monitoring a work atmosphere, three potential hazards are generally considered:

- Oxygen depletion
- Toxic gases or vapours
- Combustible gases or vapours

Each hazard behaves differently and poses different risks:

- Asphyxiation
- Poisoning
- Explosion/fire

In a simple world, actions can be planned around each observed risk but, when these risks occur in combination, it is not so simple. In fact, many gases have multiple guises or may be hardly noticeable and, as a result, actions can be different based on circumstances.

To illustrate more clearly

Carbon dioxide (CO_2) is generally assumed to be part of the overall atmosphere (0.03 Vol%) and is a gas most people are familiar with. Inerting activities using non-flammable products such as carbon dioxide (CO_2), may displace oxygen within confined spaces.

Most would consider carbon dioxide only an asphyxiate capable of displacing oxygen but it is also a toxic. Without this knowledge some have used oxygen depletion measurement as a measure of safety in respect of carbon dioxide. This is dangerous and has led to fatalities (EN 60079-29-2 clearly states – oxygen detectors must never be used to indicate displacement by CO_2).

Hydrogen sulphide (H_2S) is colourless and smells like rotten eggs; however, the odour cannot be taken as a warning, as smell sensitivity disappears quickly after breathing only a small quantity of H_2S. This gas is often found in sewers, sewage treatment facilities and in petrochemical operations. In addition, H_2S is flammable and explosive in high concentrations. Sudden poisoning may cause unconsciousness and respiratory arrest.

Carbon monoxide (CO) is a colourless, odourless gas generated by combustion of common fuels with insufficient air supply or where combustion is incomplete. CO is often released by accident, through improper maintenance or adjustment of confined space burners and by internal combustion engines. Known as the silent killer, CO poisoning may occur suddenly. Depending upon concentration, CO exposure can lead to headache, dizziness, nausea and death.

Another example

Ethanol (common drinking alcohol) is known to be combustible (we have all seen the cocktail flames at the bar). Most people consider ethanol to be a combustible hazard, however Ethanol has a strong toxic profile as a vapour.

As a combustible, ethanol requires at least a concentration of 3.1 Vol% (31,000ppm) in air to support ignition. In contrast, Ethanol has a toxic exposure limit of 1000ppm or around 3% of the defined LEL (Lower Explosive Limit). Bear in mind this is the maximum allowable limit, and therefore ethanol is toxic before being explosive. If a typical combustible gas detector is used (and correctly calibrated for ethanol) with alarm point at 10% LEL, then the worker is being exposed to a toxic environment long before the first alarm point. This is the wrong tool.

For ethanol a different solution is needed and, in this case, PID technology with high accuracy and low limits of detection for VOC can reliably monitor at toxicity levels. The same scenario occurs for any hydrocarbons such as fuels accumulating in sewers from leakage.

Knowing the gas hazards is as much about understanding not only what is there but also work practices. Almost all gases can be (and are) multifaceted and can exhibit different risks depending on worker PPE and practices.

Testing prior to entry

Clearly before entry or work, an assessment must be conducted to establish the levels of gas to determine potential risk. Once the potential risk sources (gases) have been established, then the next step is accurate assessment.

Warning: Many accidents occur from sources of gases not considered a potential risk. Always assess other possibilities and conduct a preliminary test from a safe area.

What is the important thing here? Firstly, gas detectors are just that and only detect gas or vapour that is present where the sampling is taking place. Seems obvious, but it is a fact that is often overlooked. Sampling multiple spots can help, but again, gas samples must be carefully selected and taken at different levels, particularly with vapours. Vapours are typically often considered in the same way as gases, however their properties hide a risk. A vapour is a gas which typically exists as a liquid or solid at room temperature – for example petrol. These typically have a low vapour pressure, i.e. they stay as liquids and are heavy so often the gaseous phase in the atmosphere considerably underestimates the presence of the liquid or solid.

In order to assist sampling, hand-held multi-gas instruments use built-in pumps to draw samples from the immediate area, or from safely outside of the confined space work area when used with sampling lines. The user views the sensor readout on the instrument's digital display. Regardless of the number of sensors used, the sensors monitor and display readout continuously. Diffusion-type instruments are available for simultaneously measuring combustible gas LEL, oxygen and toxic levels in parts per million (ppm) of H_2S, CO and other toxic gases. Remote sampling pump adapters can be used to convert diffusion instruments into pumped instruments, if remote sampling is not performed frequently.

Remember a gas detector only indicates the state of the atmosphere where tested, and nowhere else.

Comprehensive testing should be conducted in various work area locations. Some gases are heavier than air and tend to collect at the bottom of confined spaces. Others are lighter than air and are usually found in higher concentrations near the top of confined spaces. And then there are gases that have the same molecular weight as air and can be found in varying concentrations throughout confined spaces. Test samples should be drawn at the top, middle and bottom of confined spaces to pinpoint varying concentrations of gases or vapours.

In fact, the vapour pressure of some fuels can be so low that testing any more than a few mm from the surface may not detect the presence of a combustible vapour. If the operation involves hot working where the sparks could reach the floor, failure to properly assess the confined space can easily lead to an ignition with terrible consequences. The choice of technology in this case can assist but not completely alleviate. Photo ionisation detectors are able to detect many vapours at a low concentration (e.g. ppm levels) to warn that further investigation is required. If fuels are involved be cautious about using standard gas detectors.

Extensive testing is needed before entering the area.

Monitor the hazard

Many standards covering confined space activity specify pre-entry and on-going atmospheric monitoring (e.g.: UK HSE, Safe work in confined spaces, Confined Spaces Regulations 1997).

Gas detectors are warning devices that require users to take some action. If not present, incorrectly located or ignored, the consequences can be fatal. On-going monitoring is essential as atmospheres can and do change.

Many factors can result in a change in atmosphere in a confined space. For example, the work undertaken could introduce new hazards such as acetylene for hot work which, if leaked, can rapidly render the site explosive. New hazards can arise from the activity undertaken. For example, hot work can generate Carbon Monoxide or other toxic fumes. Removing sludge can release trapped gases.

In confined spaces, time is critical as by definition, a confided space may be difficult to enter or escape. A back-up plan needs to account for delays or difficulty in escaping and must consider the time taken for the detector to respond. If the change is rapid and catastrophic, it is possible that workers could be at risk before a detector responds. The faster the response of the detector, the greater the chance of taking remedial action to prevent serious consequences.

Choose Carefully

A gas detector is often the only way of detecting impending atmospheric risk in a confined space. Many gases in question are either odourless (e.g. carbon monoxide, methane) or rapidly destroy the body's ability to detect them at dangerous levels (e.g. hydrogen sulphide). A gas detector such as the ALTAIR 4XR is potentially a life saver provided the user responds appropriately.

Select and use the detector well. As potentially the only source of warning in often inhospitable workplaces, consider the following factors:

- Effective availability, make sure it turns on and stays on!!
- Response time, make sure it's fast!!
- Accuracy, make sure it reads the gas in question and does so accurately.

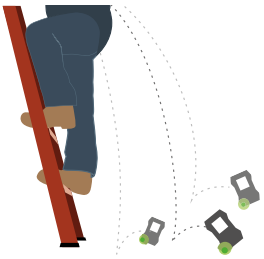
General Rules For Considering Detectors…

Choosing a Gas Detector – The Seven Rules

In today's regulated safety environment, the need for reliable, effective gas detection has never been so important. New players have seen the opportunity to generate cash by jumping on the confined spaces band wagon and making detectors, leaving consumers with a bewildering array of choice.

So how do you choose?

1. Robustness



Strangely this is not the first thing that comes to most people's minds when considering gas detectors, yet it is critical to reliability. If a detector is not working, everything else is irrelevant.

When choosing a detector, you should think of it as a tool of trade. If the product performs like your everyday tools you will face less downtime, lost productivity and cost. The detector must be shockproof, waterproof and robust when removed from any carry case. Ask your supplier to allow you to drop the unit on concrete a few times or knock it firmly on a hard surface when trialling. Check for proof of robustness based on external agency certificates according to relevant standards with reference, for example, to one of the most demanding, the MIL-STD-810 military standard. Drop it in water if water is an issue.

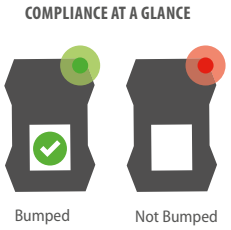
Make sure this done with the unit turned on and tested with gas before and after.

2. Warranty

Always check what the warranty does and does not cover, e.g. drop or immersion. It is not so much what the warranty statement includes but what it does not. For instance, accidentally dropping an instrument may invalidate the warranty. It can also reduce the waterproofness of the instrument. Extended warranties based on old technology sensors which typically have lives of 2-3 years or less will often require additional service and quite significant cost. Time for warranted service requirements may also reduce instrument availability.

The sensors are the heart of the instrument, so when selecting, look for a detector that is equipped with rapid-response digital sensors, and backed by a 4-year warranty.

3. Accuracy

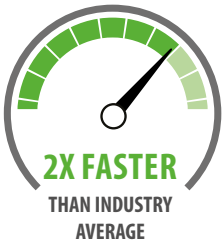


A gas detector should provide a warning to potentially save your life. It must be accurate every time. Watch for false alarms. It's essential to know how accurate and repeatable the detector is. Test the detector regularly with known gas and calibrate if necessary.

This is indicated in European standards (EN 60079-29-2 and German BG RCI code of practices T021 and T023 stipulate a daily functional check for gas detectors before use) but also is the only way to verify ALL sensors read gas. A zero reading does not tell you the sensor will be able to detect gas.

Ensure that dedicated check mark is displayed to confirm that the instrument has been tested and proves that it can sense the gases.

4. Speed



Speed matters! Many detectors respond differently depending on the gas and type of sensor used. Just because products meet a standard doesn't mean there are no differences. Make sure your gas detector meets your standard. It's your life - the slower the response the less time you have to take action or the further you need to go to reach safety.

Do not rely on the industry average, go for the fastest. Always check the written specifications.

5. Alarms

Gas detectors should have basic alarms, including visual, audible and vibration alarms, which will be particularly beneficial in noisy or loud environments where other tools are also being used.

Is that all you might require? Consider all eventualities.

Confined spaces can be dangerous places and accidents can occur, leaving a person overwhelmed. Apart from potential exposure to hazardous gases, workers could suffer a physical injury rendering them unconscious. Fire departments are aware of this risk and carry special extra alarms which activate based on lack of movement. Your detector should be equipped with this type of motion alarm. Since it is based on movement it covers many potential issues and is much more than just a gas detector.

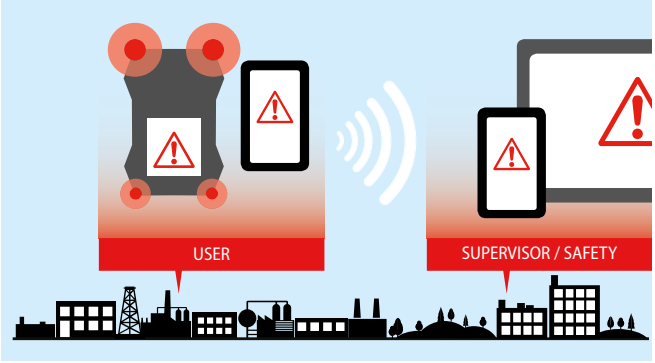
Many confined spaces require workers to wear respirators for protection, which may make it difficult to inform others of a potentially serious issue or situation. How do you raise an alarm at-will if you cannot shout? A built-in panic alarm allows workers to communicate a serious issue without the need to remove vital respiratory protection.

6. Stay connected – Work smarter

Look for innovation in design. The innovative new solution that alerts you to a potentially hazardous situation uses wireless detection and cloud-hosted management software. Android-based Bluetooth connectivity is the basis for these solutions together with mobile application on a paired phone, allowing the gas detector to be turned into an enhanced safety and productivity tool.

Real-time monitoring makes it much easier to identify when and where a worker is experiencing issues.

More importantly, it makes the response time exponentially faster, reducing the risk of accidents, disasters, and even loss of life.



7. Functionality

A gas detector is your tool to assist you to do your job safely. Like any good tool it should be simple and easy to use. This includes accessing all standard functions used daily. It is not helpful to have to push multiple buttons or sequences to access everyday functions.

Nowadays connectivity with mobile applications simplifies operation and allows for quick configuration and updating of detector settings. It also adds another layer of functionality with generating e-mail reports and access to compliance reminders.

For further information please also visit our website:
Confined Space Entry: The MSA Difference

1.Occupational Health and Safety, We Must Change the Statistics of Confined Space Injuries and Fatalities

MSA—**The Safety Company**

Our business is safety. We've been the world's leading manufacturer of high-quality safety products since 1914. MSA products may be simple to use and maintain, but they're also highly-sophisticated devices and protective gear—the result of countless R&D hours, relentless testing and an unwavering commitment to quality that saves lives and protects millions of hard working men and women each and every day. Many of our most popular products integrate multiple combinations of electronics, mechanical systems and advanced materials to help ensure that users around the world remain protected in even the most hazardous of situations.

Our Mission

MSA's mission is to see to it that men and women may work in safety and that they, their families and their communities may live in health throughout the world.

MSA: WE KNOW WHAT'S AT STAKE.

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