Confined Space Entry
Know Your Gas Detection Requirements

> "There are no second chances with confined space entry. It has to be right first time"

IDENTIFYING A CONFINED SPACE...

The HSE Confined Space Regulations 1997 define a confined space as:

"A space of an enclosed nature where there is a risk of death or serious injury from hazardous substances or dangerous conditions"

Whereas some confined spaces are easy to identify others are less obvious and often disregarded as a confined space – examples of this include; open topped / combustion chambers, roof spaces, road tankers and refrigerated store rooms

It is also important to know that a confined space is not necessarily restricted to industrial applications; a confined space can range from cellars to enclosed sewers and drains and to canals.

If a space has a large enough space for someone to enter and work in but;

- Has limited restriction of entry / exit
- Volume of less than 100 m^3
- No means of ventilation
- Below two metres in length, width and height

Then it can then be defined as a confined space, and cautionary action must be taken to ensure the safety of the worker.

In approaching a confined space the first step is to carry out a risk assessment in accordance with The Management of Health and Safety at Work Regulations 1999 guidelines. Once this has been carried out the worker must ask themselves:

1. Can this work be carried out from an outside point?
2. Can it be altered so that entry isn't necessary?

If the answer to both of these questions is no and all options have been exhausted and the confined space must be entered then the necessary action and equipment should be put into place for personnel protection.

What does the law say?

You must carry out a suitable and sufficient assessment of the risks for all work activities to decide what measures are necessary for safety (under the Management of Health and Safety at Work Regulations 1999, regulation 3). For work in confined spaces this means identifying the hazards present, assessing the risks and determining what precautions to take. In most cases the assessment will include consideration of:

- the task;
- the working environment;
- working materials and tools;
- the suitability of those carrying out the task;
- arrangements for emergency rescue.

HSE - Confined spaces: A brief guide to working safely

FACING THE HAZARDS OF A CONFINED SPACE...

No matter what the application or the space, there is always the risk of extra hazards that arise as a result of work being carried out in a confined space;

- Limited volume in a confined space is extremely harmful as it leads to a build up of gases. Inadequate air leads to an oxygen deficiency and a replacement of harmful gases such as H_2S or CH_4 (depending on the application).
- Fires and explosions become a lot more volatile in smaller spaces and as a result a larger impact, the results of which are disastrous to personnel.
- Free flowing liquids and gases can be disturbed as a result of using heavy duty machinery or even carrying out basic tests. Extra care must be taken to ensure all physical breaks in pipe work and electrical have been isolated.
- A build up of temperature, a less apparent risk but if the space is gradually overheated then the workers body temperature is at risk of rising to unnatural levels.
- Use of machinery poses a threat, have all electronics been isolated by locking off isolating switches or removing fuses? Extra precaution should be taken such as dust extraction or precautions against electric shocks.

CONFINED SPACE CHECKLIST...

If you cannot avoid entering the confined space then a confined space strategy must be implemented;

- ☐ First things first; appoint a job supervisor to establish all items on the list are checked and the process runs as smoothly as possible
- ☐ A signed permit - a permit is more than a box ticking exercise, not only does it provide traceability but a permit will identify the correct procedure for work in a confined space.
- ☐ Ensure the work space is mechanically & electrically isolated
- ☐ Employee training - this should address; the company's policy and confined space program; recognising the confined space warning and identification signs; changes in use or configuration of non-permit spaces that could require the space to be reclassified as a permit-required space.
- ☐ An escape route! Although it seems obvious, it can be overlooked, remember confined spaces don't necessarily share the same entrance / exit
- ☐ Check the size of the space, taking care to note; Have the entry / exit points been tried and tested? Can the staff be rescued in the case of an emergency?
- ☐ Adequate communication system to allow two way communication inside & outside the space. Or more importantly to aid in escaping the space.
- ☐ Pre-entry atmospheric tests of LEL's in the air. Testing should be carried out by a competent person using a suitable gas detector which is correctly calibrated. Be aware that continuous monitoring of the air may be needed.

Rules to live by

Ask yourself these two questions for safe entrance into a confined space;

? How long has the space been closed
Asking this can help to determine the state of stratification

? What (if anything) has been stored in the space
This will help determine the atmospheric condition of the space

KNOW YOUR GASES...

The atmosphere in confined spaces can very rapidly become extremely hazardous because of the lack of natural air and ventilation. Although the gases below are common gases, the build up in a small space is deadly. Many processes such as welding not only consume oxygen but replace the oxygen in the air around to create gaseous containments.

Flammable Gases

May be present in the confined space, and could cause fire or explosion if ignited. These can be from gases, fumes, vapours and dusts and may come from the confined space contents or from the materials being used to clean the confined space, for example a flammable liquid base or propellant gases of aerosol sprays.

In addition to the possibility of the presence of the above materials, detritus and discarded materials from repair operations in confined spaces can also be ignited by hot work operations. Where there is a possibility of flammable substances being present in a confined space then suitable equipment, including electrical equipment, will have to be specified to eliminate the risk of a spark or ignition source.

Static electricity can also be a source of ignition in confined space operations where flammable gases and vapours are present as can incorrectly specified electrical equipment.

Toxic Gases

Toxic gases, fumes and vapours can be identified using correctly specified confined space testing equipment.

Consideration should be given to the possibility of gases trapped within residues and sludge. For example, wastewater treatment plants which may not have been identified by initial atmospheric testing and may be disturbed and released by someone having recently entered into the confined space.

Where work in excavations is taking place then the contamination can come from hazardous substances previously deposited in the ground from natural sources. Hydrogen Sulphide often results from the bacterial breakdown of organic matter in the absence of oxygen gas, such as in swamps.

Oxygen Depletion & Enrichment

The normal oxygen level is 20.9%, the maximum is 23.5%, levels above this figure can increase the risk of fire. Oxygen depletion has serious effects, more so in confined spaces. 19.5% is the minimum legal working level, below which harm can occur to anyone in the confined space. When oxygen depletes to concentrations of about 10% or less, the worker will begin to experience nausea and vomiting, leading to a loss of consciousness.

At levels <6% the user will struggle with respiration and heart action will cease. A lack of oxygen will affect the functioning of the brain quite quickly and reduce the affected person's ability to respond to their environment. Oxygen can be diminished by the presence of rust or the contents of the confined space or by operations such as welding or burning. Materials such as wet grain can also deplete oxygen.

SELECTING THE RIGHT GAS DETECTORS FOR CONFINED SPACE ENTRY...

Now that you've read about the effects of each gas you should realise the importance of gas detectors. The tricky part is deciding which gas detector is for you?

Gas detectors have been around for a long time, since the early days when a canary in a cage dying signified gas was present. Although the canary didn't provide a visual or audio alarm, the importance of a detector was ever present.

Sensor Selection

Considering what type of detector is required for your confined space rests on the choice of sensor. Make sure the instrument chosen for confined space entry can accommodate the types and number of sensors. The types of sensors selected should reflect the known and potential atmospheric hazards associated with the confined spaces to be monitored.

Most confined space gas detectors employ an oxygen sensor, a catalytic sensor for flammable/ combustible gases and one or two electrochemical sensors for detecting specific toxic gases. You may need to add an infrared sensor for the detection of carbon dioxide or methane in confined space.

An increasing number of gas detectors additionally include a photoionization sensor (PID) for VOC gas measurement.

NOTE: if you are unsure of what gas hazards are potentially present, a1-cbiss can help conduct a hazard assessment before you purchase those new instruments.

Alarms

Alarms are put in place to alert the user by a visual, audible and vibration alarm the moment one or more limit values of the substances to be measured are reached or exceeded. Alarms should be in excess of 90dB and highly visible to attract the attention of the worker. Wireless communication capabilities enable access to real-time instrument readings and alarm status (including Man-Down alarm) from any location (control room or outside of the confined space) for better visibility and faster incident response. This can help facilitate faster, data-driven decision-making to save lives and protect assets.

> "Selecting the right gas detector could be the single most important decision you ever make"

Sampling method

In confined space testing there are two primary means of exposing the sensor to the gases present;

- A sample draw uses a pump to draw a sample back into the instrument for analysis. Drawing a sample protects the user by eliminating any need to enter the space or by providing pre-entry checks if the space has to be entered.

a1-cbiss recommend buying an "attachable" pump for a confined space detector which permits users to remove the pump and operate the instrument in diffusion mode when a sample pump is not required. This technique is not only more cost effective but it can enhance battery lifetime too.

- Most recommended gas detector sensors operate by diffusion, they rely on the inherent movement of the air to direct a sample to them. Diffusion detectors can stand up to the challenge of toxic gases. If you need to be free of moving parts and pumps, diffused pumps are the perfect fast response solution for confined spaces.

Approvals

As your detector is designed to help detect explosive gases, it is essential that it is ATEX approved and designed to be intrinsically safe.

You must ensure your detector displays the ATEX logo; Intrinsically safe detectors are required to keep electrical energy at a minimum, In doing so, the detector can guarantee that there won't be enough power to spark.

Consideration must be given to the application where the gas detector is to be used. In the marine industry, a confined space monitor must be used in accordance with the amendments to SOLAS regulation XI-1/7 contained in IMO Resolution MSC.380 (94):

- Every ship to which SOLAS Chapter I applies shall carry an appropriate portable atmosphere testing instrument or instruments;

- As a minimum, these shall be capable of measuring concentrations of oxygen, flammable gases or vapours, hydrogen sulphide and carbon monoxide prior to entry into enclosed spaces;

Data logging

There are two types of data storage: datalogging and event logging. Event logging will only show alarm events. Gas detectors that have event logging will only have capability for a certain number of events. Datalogging allows data to be recorded at given intervals over a period of time.

The capability to provide documentation of proper use can significantly reduce liability exposure, and in the long run save much more than the cost of including datalogging in the instrument at the time of purchase.

Aside from keeping records, using your detector for data logging will allow you to recognise any potential dangerous trends in both exposure and detector usage.

How it's worn

In normal operation, most confined space instruments are worn on the belt or a helmet, used with a shoulder strap or chest harness, or held by hand.
Tip: All gas detectors should be worn within 30cm of the wearer's mouth for effective personal safety.

Batteries

Different gas detectors utilise different rechargeable battery technologies. Commonly used types of rechargeable batteries include nickel metal hydride (NiMH), lithium ion (Li-ion) and lithium polymer batteries.

The primary advantage of rechargeable batteries is overall cost-effectiveness. Frequent replacement of disposable batteries can be very expensive. On the other hand, while alkaline batteries may not be the most cost-effective approach, having the ability to use them in an instant is a strong design advantage. Some detection instrument designs offer interchangeable rechargeable and alkaline battery packs.
Other designs allow the optional use of either alkaline or "off the shelf" rechargeable batteries.

Accessories

Depending on the type of confined space being accessed, Be sure to verify which accessories are included in the purchase price for the instrument. If the gas detection instrument includes a rechargeable battery, does the price include a battery charger? Do the accessories include a sample draw kit or automatic pump. Concussion proof boot? Clips or straps? Calibration cup?

Be sure to factor in the extra cost of accessories when considering your purchase!

Choosing from the vast range of detectors is a hard job, so we've put together some of our own recommendations.

GAS DETECTION PRODUCT SELECTION

a1-cbiss have over 25 years experience in the gas detection industry and are on hand to offer you high quality and reliable advice where gas detection is concerned. As well as this we have an extensive catalogue of gas detection products suitable for confined space detection.

Area Detectors

If you're looking for a rugged, durable area monitoring solution, then the BM25 from Oldham will cater for your needs. The BM25 provides the security and reliability of a fixed gas detector, but it is a transportable multi-gas detector with over 1000 different sensor combinations. The flexibility of the BM25 allows this detector to be setup and used in a variety of different confined space applications with ease.

The main benefit that the BM25 boasts in confined space protection is its additional parasitic sampling pump – it allows the monitor to be used both for remote sampling applications in confined spaces providing clear alarm signalling to the area outside of the confined space. The BM25 is often used by maintenance teams working within confined spaces.

Personal Monitors

One of the more popular choices for confined space monitoring is the ISC Ventis MX4. The Ventis is compact and lightweight yet rugged, it's simple to use and has up to 4 different sensor options to detect a variety of gases. The Ventis comes with an optional brightly coloured, high visibility orange casing, meaning if it's dropped or misplaced, it's easier to detect in the darkness of a confined space.

Product Name	**ISC Ventis MX4**	**BW GasAlertMicroClipX3**	**RAE QRAE 3**
Sensors - Catalytic, Oxygen & Electrochemical	LEL, O_2, CO/H_2 low, CO, H_2S, NO_2, SO_2	LEL, O_2, CO, H_2S,	LEL, O_2, CO, H_2S, NO_2, SO_2 HCN, NH_3, PH_3, Cl_2
Sampling Method	Slide-on pump or diffusion	Manual aspirator pump kit or diffusion	Built-in pump or diffusion
Battery Type	Rechargeable lithium-ion	Rechargeable lithium polymer battery	Rechargeable Li-ion
ATEX and IP Ratings	Ex ia IIC T4 Ga and Ex ia I Ma IP66/67	Ex ia IIC T4 Ga and II 1 G IP68 – up to 45 minutes at 1.2m	IECEx/ATEX (II 1G Ex ia IIC T4) Pumped: IP65, Diffusion: IP67
Typical Battery Life	12 hours typical	18 hours; recharges in less than 6 hours	14 hours continuous non-wireless, diffusion
Advanced Features	Slide on pump	3 Year Warranty*, 5 Year Lifetime*	Wireless, Man-Down Alarm
Price Guide (gas dependant)	££	£	££

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Ready to buy? Buy online at www.a1-cbiss.com to view our product range or contact +44(0)151 666 8300 for more information