AP1003:

Choosing the best confined space gas detector

The "best" confined space gas detector doesn't come from any one manufacturer; it's the instrument that best fulfills the requirements for your confined space program.

The ways in which gas detectors are used can vary widely between different confined space programs. The instrument that provides the best service and value for one program may not be the best choice for another.

Gas detection equipment manufacturers put a lot of emphasis on their confined space products. There are numerous models to pick from, with widely varying features, price points and capabilities. The perfect product for your program is "out there". The key is understanding which features are the ones that are needed for the way you will be using the product, then choosing the design that best fulfills the requirements for your specific program.

Price should not be the sole determinant
Price is very important, however, the purchase decision should not be driven exclusively by price. The true price you pay for an instrument is not simply the initial purchase price; it is the cost-of-ownership over the life of the instrument. The initial purchase price is only one of a number of factors that should be considered. Remember to evaluate the cost of replacement components, (like batteries and sensors), the standard warranty coverage that comes with the instrument, cost of calibration stations and other calibration materials, cost of factory service, (if required), as well as the willingness of the manufacturer to stand behind the product if you experience a problem.

All of these factors can dramatically increase or reduce the true cost of purchasing and owning an instrument. Most importantly, make sure that the instrument includes the capabilities that are needed per your specific confined space procedures. An instrument with a low purchase price that does not include the capabilities that you need, or an expensive instrument with unneeded features or complexity are equally bad choices.

Which features and capabilities are the most important is a function of many factors including:

- The atmospheric hazards that need to be measured
- The monitoring environment in which the instrument will be used
- The sampling strategy
- The level of sophistication and training of the workers who will be using the instruments
- The requirements for record-keeping
- Other performance criteria specific to your program

The good news for instrument buyers is that whatever you paid the last time you purchased a confined space instrument; expect to pay less this time around.

Figure 1: Multi-sensor confined space instruments almost always include sensors for the measurement of O_2, combustible gas, CO and H_2S. Make sure the design supports any additional sensors that may be required, such as IR combustible gas, PID and other toxic gas sensors.

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Criteria for instrument selection:

1. Sensor selection

Make sure the instrument chosen for a specific application can accommodate the needed 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 instruments include an oxygen sensor, a catalytic (pellistor) sensor for the measurement of percent LEL combustible gas, and one or two electrochemical sensors for detecting specific toxic gases. An increasing number of detectors additionally include a photoionization detector (PID) for "broad-range" toxic gas measurement. Some specialized instruments include infra-red (NDIR) sensors for direct measurement of carbon dioxide or percent volume methane. The number of possible sensor configurations is very large.

Figure 2: Portable confined space instruments can measure up to seven atmospheric hazards at the same time. Besides standard O_2, LEL, CO and H_2S sensors, the instrument can be equipped with IR combustible gas, PID, IR CO_2, and a wide variety of substance-specific electrochemical toxic gas sensors.

Before deciding on the sensors to include, make sure you know what you need to measure. If the confined space to be monitored is characterized by the known or potential presence of a specific toxic contaminant, the best and safest approach is a substance-specific sensor. Substance-specific sensors are available for a wide range of contaminants including hydrogen sulfide, carbon monoxide, ammonia, chlorine, sulfur dioxide, nitrogen dioxide, phosphine, cyanide, and many others.

Make sure that the sensors and programming used in the instrument permit you to set the alarms at the necessary levels. For instance, if your CS program requires taking action at the 2011 TLV© exposure limit for H_2S of 1.0 ppm, the instrument will need to be able to provide readings in sub parts-per-million-increments.

If you need to measure low parts-per-million concentrations of volatile organic compounds (VOCs) such as solvents, gasoline or diesel vapor, you might consider an instrument that includes a PID. If all you need to measure is combustible range concentrations of methane or natural gas, however, a simple catalytic percent LEL (lower explosive limit) sensor may be all that is required.

Some instruments are designed for use exclusively with a limited set of the most commonly specified sensors (typically LEL, O_2, H_2S and CO). Instruments with a limited selection of sensors frequently carry the lowest initial purchase price. They are perfect for many applications where these are the only hazards that will ever need to be measured.

If requirements change, however, you may be left with an unusable product. If you suspect that requirements may change, field configurability is highly desirable. Adding an additional sensor is not difficult, as long as the design gives you the option.

Most importantly, if you are unsure of what hazards are potentially present, it's time to conduct whatever additional hazard assessment is necessary to nail this down before you purchase those new instruments.

2. Sample-draw versus diffusion

In normal operation, most confined space instruments are worn on the belt, used with a shoulder strap or chest harness, or held by hand. Once turned on, the instrument operates continuously until the battery is exhausted.

Diffusion instruments utilize natural air currents to bring the atmosphere being sampled to the instrument. "Pumped" instruments mechanically draw the atmosphere being monitored into the instrument. The air may be drawn directly into an inlet port on the instrument, or ducted through a length of sample tubing from a remote location.

Pumped instruments may include a built-in (internally housed) motorized pump or an "attachable" motorized pump that is physically secured to the instrument. "Attachable" pump designs permit users to remove the pump and operate the instrument in diffusion mode when a sample pump is not required. Some pumps operate continuously whenever the instrument is turned on. Other designs include a slide switch or "shutter" that allows the instrument to be operated in either "diffusion" or "sample-draw" mode simply by sliding the switch into the correct position.

Each configuration has both advantages and disadvantages. If you purchase a diffusion instrument, make sure to include a sample-draw kit to use during pre-entry or remote sampling procedures. Availability of such a kit should be an important consideration when purchasing an instrument.

3. Classification for intrinsic safety

Devices classified as "Intrinsically Safe" prevent explosions in hazardous locations by employing electrical designs that eliminate the possibility of ignition. The classification for intrinsic safety carried by the instrument references the severity of the explosive hazard of the flammable atmosphere in which the instrument was tested. For example, many confined space instruments sold in North America are "Classified as Intrinsically Safe for use in Class I, Division 1, Groups A, B, C, and D Hazardous Locations."

This means that the testing included evaluation for use in "Group A" atmospheres containing an explosive mixture of acetylene. "Group B" atmospheres contain hydrogen or gases or vapors of equivalent hazard. "Group C" includes gases such as ethylene, while "Group D" includes methane and natural gas, or gases of similar explosive hazard. Some confined space instruments also carry a classification for use in Class II, Groups E, F, and G Hazardous Locations. These Class II Groups refer to

Figure 3: In diffusion operation the atmosphere reaches the sensors by diffusing through openings in the instrument housing. The openings are protected by moisture barrier filters. "Attachable" motorized pumps are physically secured to the instrument. A shutter switch permits operation of the in either "diffusion" or "sample-draw" mode.

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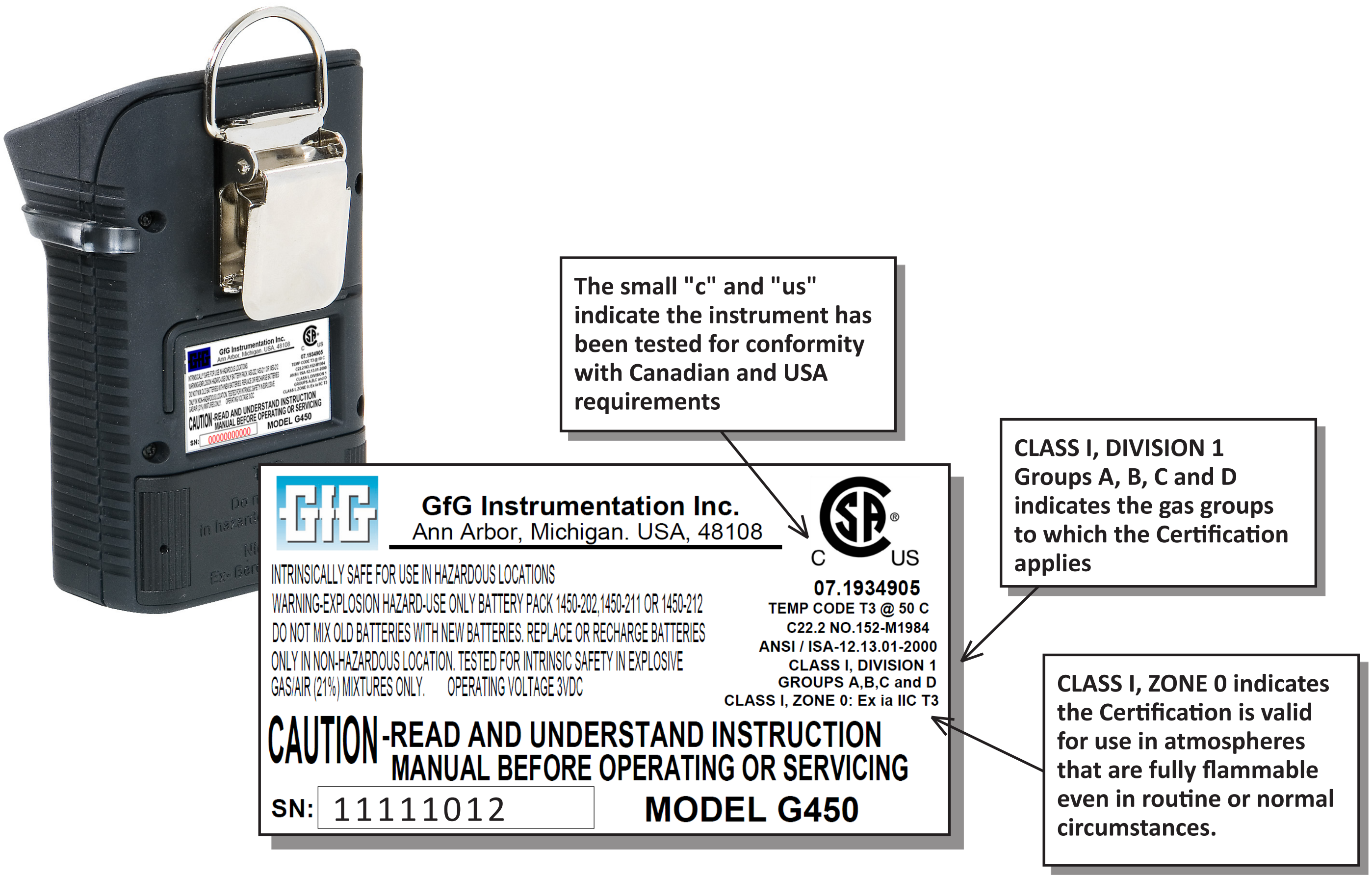

Figure 4: The instrument label includes Certifications and Markings carried by the product. Space on the label is limited! Consult the owners manual for a complete description of all the Certifications, Classifications, Listings and Markings carried by the product.

combustible or "explosible" dusts. Instruments used in some applications (such as grain silos) may be required to carry this additional classification.

Many instruments sold in North America additionally carry IEC Ex or ATEX Certification for Intrinsic Safety. European and harmonized international IEC Ex certifications are based on a slightly different classification scheme for explosively hazardous atmospheres that is based on Zones, Gas Groups and Temperature Codes. The string of letters and numbers that define the scope of the "Ex" Certification provides a great deal of information. It's worth spending a little time to verify exactly what the certification covers.

The instrument label should carry the logo or "Mark" of the testing laboratory that conducted the evaluation (such as UL®, CSA®, FM®, EXAM®, DEMKO®, KEMA® etc.) as well as the hazardous atmospheres and temperatures for which the Classification or Certification applies.

The evaluation methods used to determine Intrinsic Safety may vary between different test standards. For instance, a small "us" next to the testing laboratory logo indicates that the instrument has been tested for conformity with the United States National Electric Code (NEC) requirements contained in Underwriters Laboratories® UL-913, "Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations". A small "c" next to the logo indicates that the instrument has been tested for conformity with Canadian requirements. Canadian Standards Association C22.2 No. 152-M1984 (R2001), "Combustible Gas Detection" covers the construction, performance and test procedures for portable instruments used to detect or measure combustible gases in hazardous locations characterized by the presence (or potential presence) of combustible gas. CSA 22.2 includes rigorous performance testing of the combustible sensor that may or may not be included in instruments that do not carry the small "c" in their Classification Mark.

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Figure 5: The availability of interchangeable rechargeable and alkaline battery packs is a strong design advantage.

4. Batteries

Confined space instruments may be designed to use only disposable alkaline batteries, rechargeable batteries, or may be able to use both types. The primary advantage of rechargeable batteries is overall cost effectiveness. Frequent (or daily) replacement of disposable batteries can be very expensive, and is increasingly viewed as environmentally objectionable. On the other hand, while alkaline batteries may not be the most cost effective approach, having the ability to use them “in a pinch” is a strong design advantage. Some instrument designs offer interchangeable rechargeable and alkaline battery packs. Other designs allow the optional use of either alkaline or “off the shelf” rechargeable batteries.

Different designs utilize different rechargeable battery technologies. Commonly used types of rechargeable batteries include nickel cadmium (NiCad), nickel metal hydride (NiMH), lithium ion (Li-ion) and lithium polymer batteries. Each type of rechargeable battery has its specific advantages and limitations. The weight of the instrument, run time, time to recharge the battery and the number of charging cycles that the battery can survive without loss of capacity are all affected by the type of battery included in the design. Less obviously, the temperature code and operating ambient temperature range over which the IS classification applies are also affected (or limited) by the type of batteries used in the design.

Figure 6: “Smart” charging cradles include a “trickle charging mode” that prevents damage to the battery pack once charging is complete

Figure 7: Confined space instruments should be easy to use, ergonomically well designed, and feel as if they can handle rough usage.

Battery manufacturers, as well as manufacturers of battery charging systems have made major improvements in design over the last few years. Today's "smart" battery chargers contain electronics for assessing the condition of the battery pack during charging, and to drop from a "fast" charge rate to a "trickle" the moment charging is complete. The "trickle" charging rate is too low to produce damage or loss of capacity due to heating. As result, instruments containing rechargeable batteries can be recharged in a very short period of time, while still being left on the charger for long periods of time without damage.

While rechargeable Nickel metal hydride batteries may be left on the charger for prolonged periods of time without damage, they still benefit from periodically being deep-discharged, and most instruments that include this type of battery also include an automatic deep discharge cycle.

5. Durability

Confined space instruments have to be durable. Unfortunately, many designs are less robust than they may appear on the surface. Consider asking the following questions:

- Is the instrument designed to minimize the effects of radio frequency interference (RFI) and electromagnetic interference (EMI)?
- What are the effects of high and low temperatures on the design?
- How water resistant is the design? Ask the manufacturer to document the "IP" (ingress protection) rating of the product. The IP rating is composed of two numbers; the first refers to protection against solid or particulate objects, and the second against liquids. The higher the number, the better the protection.
- Does the instrument feel flimsy or provide unstable readings when picked up and turned on? Don't underestimate the amount of information the "feel" of an instrument can sometimes provide.

Confined space instruments should be ergonomically well designed, and feel as if they can handle rough usage.

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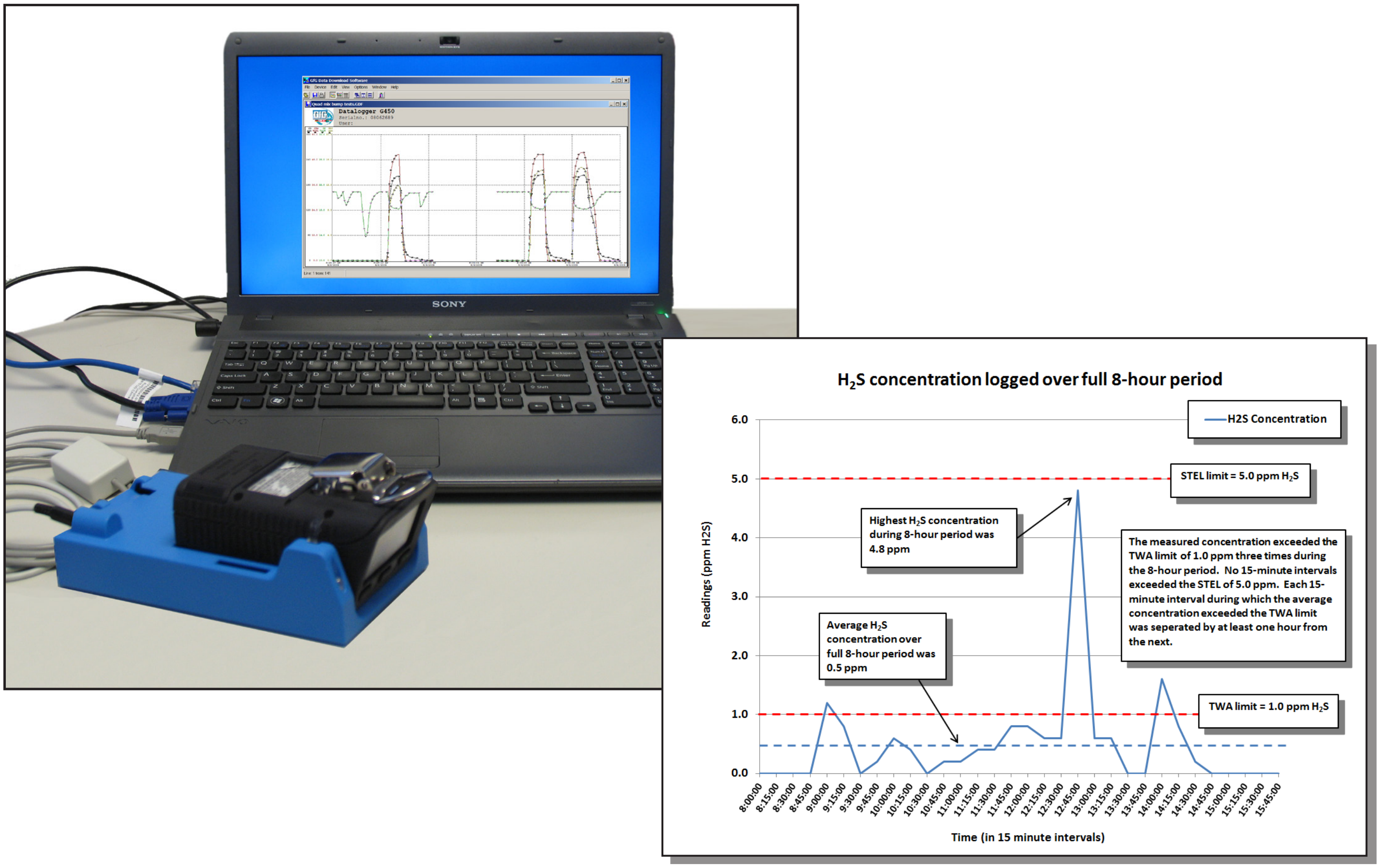

Figure 8: Datalogging instruments automatically record moment by moment measurements, as well as any exposure "events" that trigger the instrument alarms. They also provide a record in the event of an accident.

6. Datalogging versus non-datalogging

Datalogging is an available option or a standard feature with most confined space instruments. Datalogging instruments are usually set up to retain monitoring information whenever turned on. The utility of this information for compliance and record-keeping purposes is obvious. In the event of an accident or unusual occurrence, datalogging instruments are also useful as "black box" recorders of the conditions at the time of the event. 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.

In the past, successfully downloading datalogged information from the instrument to a computer sometimes required a high degree of operational expertise. Today the procedure is nearly automatic.

7. Included accessories

Be sure to verify what accessories are included in the purchase price for the instrument. If the instrument includes a rechargeable battery, does the price include a battery charger? Do the accessories include a sample draw kit or motorized pump? Carrying case? Training video? Calibration materials? Necessary accessories that are not included in the purchase price can considerably add to cost and user frustration.

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Figure 9: Visual LED alarm indicators should be visible from any direction (360°)

8. Warranty

A high quality instrument should carry an excellent warranty. The most expensive replaceable components in the instrument design are usually the sensors, (rechargeable battery packs come in as a close second). You should not have to spend extra money for an "extended" warranty to cover replacement of these components. Most manufacturers now offer a "limited lifetime warranty" on the parts of the instrument that are not consumed or degraded in normal operation, with a two-year or three year-warranty on the most commonly used types of sensors. If you decide to buy an "extended service agreement", make sure that you factor this in when you calculate the true "cost-of-ownership" over the life of the instrument.

9. Operability

Probably the most important factor of all in the selection of an instrument is ease-of-operation. If the person on the shop floor is unable to use the instrument because of unnecessary complexity, difficulty in calibration or operation – they won't.

10. Instrument performance specifications

Performance specifications published by manufacturers are a valuable tool for purchasers. Unfortunately, it sometimes takes a practiced eye to interpret specifications when comparing one instrument design to another. A significant problem is the terminology used by manufacturers to explain the performance of their products. While some terms are straightforward and have a uniform meaning throughout the industry, other terms have specific meanings to a particular manufacturer. Conservative firms often minimize performance capabilities in written specifications, preferring to err on the side of caution. Less conservative manufacturers may use the " best case" or optimal performance to define the capabilities of their products. The best advice is to conduct a field trial prior to purchase! There is no substitute for hands-on experience.

11. Alarms

Alarms should be loud, highly visible, and sufficient to grab the attention of the instrument user. Besides audible buzzers, flashing lights, numerical readings and explanatory messages, many confined space instruments additionally include built-in vibrator alarms for use in high noise areas.

Figure 10: Automatic "docking stations" make calibration and record keeping completely automatic

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12. Calibration

Calibration should be simple and straightforward. Given the requirement for documentation, the capability of instruments to log or automatically retain calibration information is highly desirable. Most datalogging confined space instruments automatically update and store dates and other calibration information. This is one more reason to select a datalogging design.

Most manufacturers now offer automatic calibration or "docking" stations that can automatically calibrate, recharge and store instrument calibration records. The availability – and price point – of automatic calibration stations can have a significant effect on both the usability as well as cost-of-ownership of the instrument over the life of the product. Make sure to find out about the availability – and cost – of calibration and docking stations before rather than after you purchase the equipment.

13. Evaluate before purchase

No matter what performance criteria you decide on beforehand, nothing replaces actually trying out the instrument in the field. Most leading instrument manufacturers, or their distributors, have evaluation instruments available for this purpose. But even if you have to rent an instrument, you will be better off in the long run if you try it out under circumstances similar to the ones in which it will be actually used prior to purchase. The best instrument in the world is the one that's the best for your own individual conditions of use.