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*Protection for life.*



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# Applications Guide

## Confined Space Hazards

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# INTRODUCTION

Confined spaces are a breeding ground for toxic and explosive gases. They are poorly ventilated and can easily cause the atmosphere to become life-threatening, rather than life-supporting. A lack of sufficient oxygen is the major cause of injuries and fatalities within confined spaces. More than 60 percent of these fatalities occur among would-be rescuers of the initial victims.

Setting a new industry standard for performance and value, the Models G20 and G40 Portable Gas Detectors, as well as the TS420 Oxygen Deficiency Fixed Gas Detector, offer unsurpassed safety monitoring in confined spaces. A breakthrough design provides highly reliable monitoring and data logging of toxic gas, combustible gas and oxygen-deficiency.

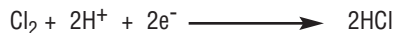
The G20/G40 simultaneously monitor up to two or up to four gases, respectively. Alarms are announced by an audible sounder, LCD display and flashing LEDs. A unique flip-screen allows the LED screen to be read from any angle while secured to your belt.

Recorded sensor data is easily downloadable to a personal computer via an RS-232 connection (on the battery charger). Out of the box, both the G20/G40 deliver reliable protection features in an easy-to-use detector.

## ***Electrochemical Cell Sensing***

General Monitors' gas detectors measure a wide variety of gases, including: hydrogen sulfide (H<sub>2</sub>S), carbon monoxide (CO), oxygen (O<sub>2</sub>) deficiency, and combustible gas. Our G20/G40 Portable Gas Detectors and our TS420 Oxygen Deficiency Detector are designed with a modular electrochemical sensor consisting of a sensing electrode, a counter electrode and a reference electrode separated by electrolytes. The gas to be detected diffuses through a capillary diffusion barrier, which controls the amount of gas reaching the sensing electrode. The target gas reacts

at the surface of the sensing electrode by either oxidation or reduction. Reactions are catalyzed by specifically developed electrodes. For example, the reaction for Chlorine (Cl<sub>2</sub>) is:



Electrochemical sensors designed for other toxic gases will produce similar gas-specific reactions. The G20/G40's integral electronics provide temperature compensation and measure the current flow translating it to gas concentration. The number of electrons given off is proportional to the gas concentration, resulting in alarm conditions announced by a combination of audible, LCD or LED alarms.



# DEFINING CONFINED SPACE

A confined space is a space that:

- Is large enough so that a person can bodily enter and perform assigned work
- Has limited or restricted means for entry or exit
- Is not designed for continuous employee occupancy

Additionally, a permit-required confined space is defined as a confined space that has one or more of the following characteristics:

- Contains or has the potential to contain a hazardous atmosphere
- Contains material with the potential for engulfment
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or a floor which slopes downward and tapers to a smaller cross section
- Contains any other recognized serious safety or health hazard

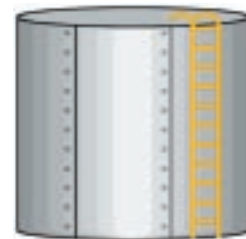
Some confined spaces are easy to recognize:

Manholes, sewers, boilers, silos, vessels, vats, pipelines, tunnels, storage tanks, ship compartments and underground vaults are classified as confined spaces.



## Atmospheric Hazards

Unfavorable ventilation of a confined space can cause the atmosphere to become life threatening instead of life supporting. Explosive and toxic gases, along with a lack of oxygen, cause the majority of confined space injuries and fatalities. Hydrogen sulfide and carbon monoxide are two of the most common toxic gases found in confined spaces. Additionally, lack of oxygen has reportedly caused the majority of confined space injuries and fatalities.



Some confined spaces are not as easy to recognize. Open-topped water and degreaser tanks, open pits, and enclosures with bottom access are also confined spaces. They prohibit natural ventilation, are potential sources of gas generation, and can keep gases from escaping. These unique characteristics can create a potentially hazardous atmosphere.



## Meeting OSHA Standards

**29 CFR 1910.146 - "Permit-required confined spaces."** This section of the Code of Federal Regulations contains requirements for practices and procedures to protect employees in general industry from the hazards of entry into permit-required confined spaces.

**CPL 2.100 - "Application of the Permit-Required Confined Spaces (PRCS) Standards, 29 CFR 1910.146."** This Compliance Directive provides additional information and instruction for OSHA personnel for use in answering questions and to ensure uniform enforcement of 1910.146.

**Part 1915 Subpart B - "Confined and Enclosed Spaces and Other Dangerous Atmospheres in Shipyard Employment."** This Subpart of the Code of Federal Regulations applies to work in confined and enclosed spaces and other dangerous atmospheres in shipyard employment.

### Oxygen Deficiency

Potential Effects of Oxygen Deficient Atmospheres	
Oxygen Content % by Volume	Effects and Symptoms (At atmospheric pressure)
19.5%	Minimum permissible oxygen level
15-19%	Decreased ability to work strenuously. May impair coordination and may induce early symptoms in persons with coronary, pulmonary or circulatory problems.
12-14%	Respiration increases in exertion, pulse up, impaired coordination, perception and judgement.
10-12%	Respiration further increases in rate and depth, poor judgement and lips turn blue.
8-10%	Mental failure, fainting, unconsciousness, ashen face, blueness of lips, nausea and vomiting.
6-8%	8 minutes-100% fatal, 6 minutes-50% fatal, 4-5 minutes-recovery with treatment.
4-6%	Coma in 40 seconds, convulsions and respiration ceases followed by death.

*Note: These values are approximate and vary as to the individual's state of health and physical activities.*

## Hydrogen Sulfide Gas

At low concentrations, hydrogen sulfide (H<sub>2</sub>S) can be detected by a distinct smell of rotten eggs. However, because H<sub>2</sub>S rapidly desensitizes the olfactory nerves, which provide the sense of smell, odor recognition alone is an unreliable warning. A worker may be exposed to H<sub>2</sub>S, but may be lulled into a false sense of security because the odor is not present. With little or no warning at all, high concentrations of H<sub>2</sub>S may cause them to collapse.

### Exposure To Hydrogen Sulfide Can Be Life Threatening

Stages of Hydrogen Sulfide Exposure		
ppm*	Warning Signs	Exposure Time
10	No effect	8 Hours
25	Strong, unpleasant odor	---
50-100	Mild eye irritation, coughing, loss of smell	2 to 5 Minutes
200-300	Marked eye irritation, respiratory tract irritation	1 Hour
500-700	Loss of consciousness, possibly death	30 to 60 Minutes
1000 or More	Unconscious almost instantly, death in a few minutes	Instantly

*Note: These values are approximate and vary as to the individual's state of health and physical activities. \*ppm — parts per million — Gas concentration volume measurement.*

## Carbon Monoxide Gas

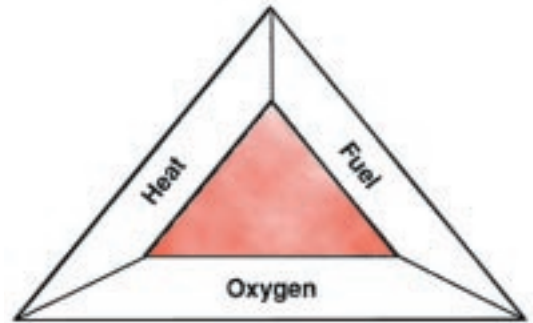
Carbon monoxide is an odorless, colorless gas that is prone to building up in confined spaces. Formed by burning carbon-contained fuels, such as wood, paper, oil or gasoline, this toxic gas attacks hemoglobin and prevents it from carrying oxygen to the brain. High concentrations of carbon monoxide can render a victim unconscious in a matter of minutes and can be fatal.

### Warning Signs Of Carbon Monoxide Poisoning

Stages of Carbon Monoxide Poisoning		
ppm*	Warning Signs	Exposure Time
50	No Effect	8 Hours
200	Possible mild frontal headache	2 to 3 Hours
400	Frontal headache and nausea	1 to 2 Hours
400	Occipital headache and nausea	2.5 to 3.5 Hours
800	Headache, dizziness, and nausea	20 Minutes
1,600	Collapse, possible death	2 Hours
3,200	Headache and dizziness	5 to 10 Minutes
3,200	Unconscious and in danger	10 to 15 Minutes
128,000	Unconscious Almost Instantly, Death Imminent	1 to 3 Minutes

*Note: These values are approximate and vary as to the individual's state of health and physical activities. \*ppm — parts per million — Gas concentration volume measurement.*

## Certain Concentrations Of Combustible Gases May Result In A Flammable Atmosphere



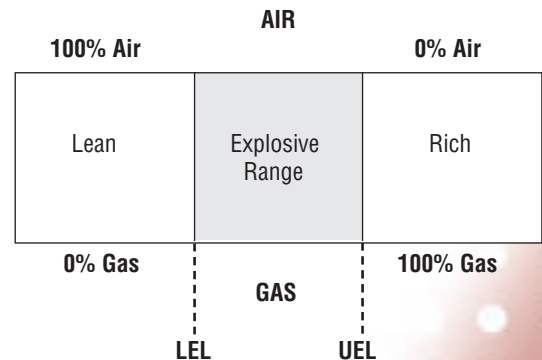
The fire triangle

### Combustible Gas

If a combustible gas is met with oxygen and an ignition source, explosion or fire can result. However, in the case of confined spaces, oxygen is no longer necessary. All that is needed is a combustible gas and an ignition source to create an explosion.

#### Causes of Ignition

- Electricity (including static)
- Flame
- Sparking metal tools
- Welding



## ***Explosive Limits Show The Flash Point Of Combustible Gases***

The Lower Explosive Limit (LEL) is the lowest concentration of gas or vapor that must be present in order for combustion to occur if ignited.

Concentrations below this limit are considered too lean to burn.

The Upper Explosive Limit (UEL) is the highest concentration of a gas or vapor that must be present in order for combustion to occur if ignited. Those concentrations above the UEL are too rich to burn.

Substances with a wide explosive range can be ignited over a wide range of circumstances. Thus, these materials are known to be more hazardous. However, care should be taken around any concentration of combustible gas, since changing conditions can alter its potential for combustion.

Due to the unpredictable stability of combustible gases, the monitoring range of most detectors is set below the lower explosive limit. Alarm levels vary from 10% to 40% of the LEL to provide an extra layer of protection in a potentially dangerous atmosphere.

## **EXAMPLES OF CONFINED SPACE**

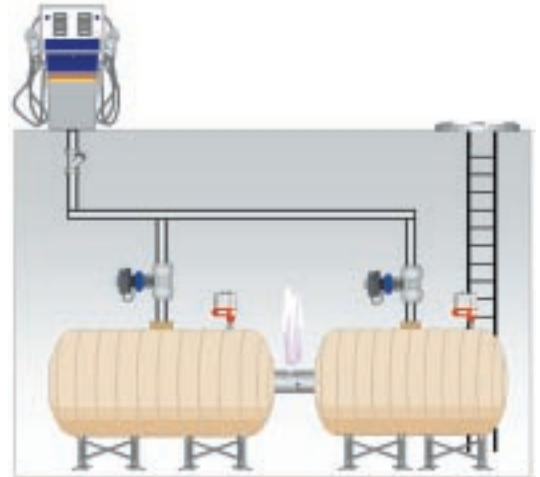
### ***Leaking Gases And Liquids***

Leaking materials from storage tanks, natural gas lines, underground storage tanks, process flanges, valves, and so on, can find their way into confined spaces. A number of hazards can exist depending on the leaking gas or liquid.

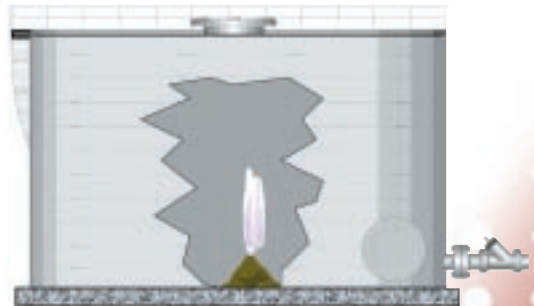
Oxygen Deficiency – Leaking gases or vapors can displace available oxygen.

Combustible Gases – Leaking gases or vapors can produce explosive concentrations.

Toxic Gases – Leaking gases or vapors can be immediately dangerous to life or health.

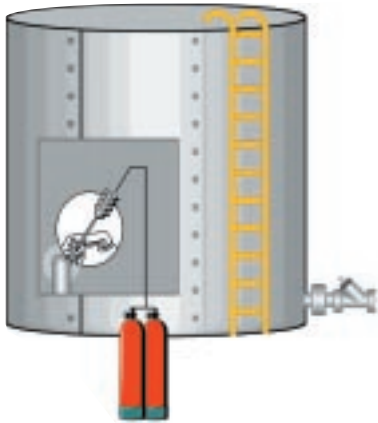


Decomposing organic matter, such as domestic waste and plant life, can produce methane, carbon monoxide, carbon dioxide, and hydrogen sulfide and can consume existing oxygen levels.



## ***Combustion and/or Oxidation***

Combustion (welding, heating, gasoline or diesel engines, cutting and brazing) and oxidation (rusting) can create hazards. Oxygen deficiency occurs because oxygen is consumed by the combustion or oxidation process and toxic gas is produced by incomplete combustion. Other gases can be produced by the material heated; i.e., cutting cadmium plated bolts with a torch releases a toxic vapor.



### ***Cleaning Process***

Even after an empty tank has been purged, gases can desorb from porous walls or become liberated from sludge during cleaning. Dangers include: oxygen deficiency and the build-up of toxic or combustible gas.



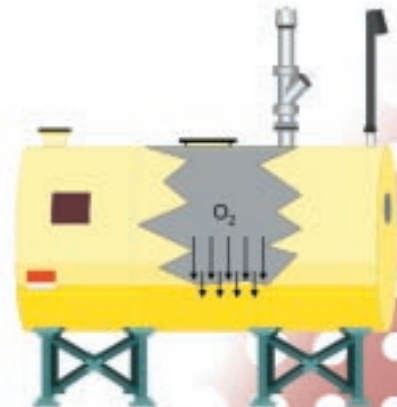
## ***Oxygen Enrichment***

Oxygen above the normal level of 21% increases the flammability range of combustible gases or material and causes them to burn violently. Do not purge confined spaces with oxygen in place of air. Improper blanking off of oxygen lines can produce oxygen enrichment.



### ***Absorption of Oxygen***

Oxygen can be absorbed by the vessel or the product being stored, causing an oxygen deficient atmosphere.



## ***Combustible Dust Concentrations***

Carbon, grain, cellulose, fibers, plastics, and most finely ground combustible materials can create explosive atmospheres.



## **SAFETY WITH PORTABLE DETECTORS**

Set up and calibration of G20/G40 Portable Gas Detectors is exceptionally easy, thanks to our smart Operating System. Menu-driven screens help you read gas data with minimal scrolling. Exporting data is a snap with our Microsoft® Windows™ compatible software. G20/G40 gas cells also are interchangeable with our TS400/TS420 fixed gas detectors for convenient maintenance.

### ***Pre-Plan Your Work***

You can pre-plan your work by using your company's Confined Entry Permit as a guideline.

Steps to pre-planning confined space entry:

#### **Atmospheric testing and monitoring**

##### **Procedures to follow:**

- Formulate an initial plan
- Designate a standby person
- Pay attention to communications and observations
- Pre-plan rescue
- Begin working

#### **How to prepare:**

- Isolate, lockout, and tag
- Purge and ventilate
- Complete cleaning processes
- Know requirements for special equipment and tools
- Labeling and posting

#### **Wear safety equipment and clothing:**

- Head protection
- Hearing protection
- Foot protection
- Body protection
- Respiratory protection
- Safety belts
- Lifelines and harnesses

#### **Have rescue equipment ready**

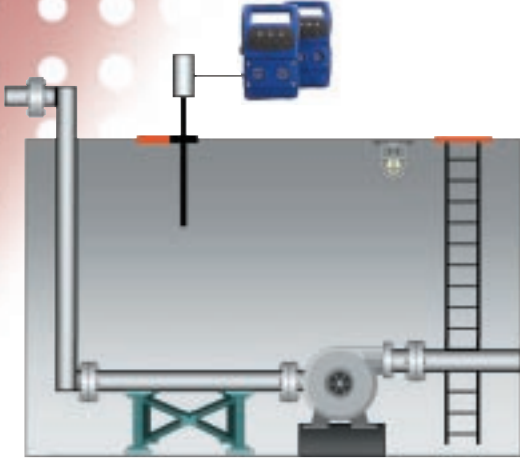
You must also ensure that your gas detector is working properly. To do this, follow the manufacturer's recommended calibration procedures and intervals. You should know how to operate the instrument as well as be familiar with any limitations it has.

### ***Zero Your Instrument***

It's important you zero your instrument in known fresh air prior to sampling for gases or vapors. Instruments should first be checked for a proper zero indication for combustible and toxic gases and for a 20.9% oxygen indication in fresh air.

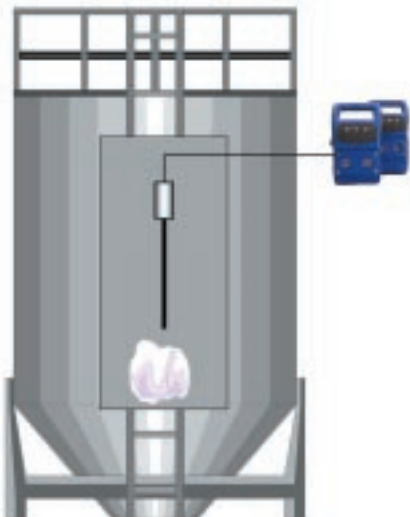


Sample through a pick-hole, or open the cover slightly – down wind side – before opening cover completely.



### ***Sample At All Levels***

Some gases are lighter than air and some are heavier. The lack of normal ventilation in a confined space allows gases to collect at one level depending on their vapor density (weight compared to air). Do not sample at one level only. Take several samples at varying levels. TAKE NO CHANCES.



### ***Sample Frequently Or Continuously. Conditions Can Change.***

As work progresses, a once-safe atmosphere can become hazardous, due to leaks, combustion, cleaning processes, or other influencing factors.



### ***Recognize Hazards And Work Safely***

When you recognize the potential hazards of confined spaces, pre-plan your work using your company's entry permit as a guide. Be sure to conduct proper atmospheric testing and prepare rescue procedures. Catastrophes can be avoided and you can assure yourself of safe working conditions.



# CONFINED SPACE APPLICATIONS

Hazardous atmospheres are often encountered in confined spaces. Some spaces may include:

## **Wastewater Facilities**

- Sewers
- Digesters
- Wet/dry wells
- Lift stations
- Tank and other vessels
- Pits

## **Municipal Departments**

- Electrical vaults
- Manholes
- Storm drains
- Tunnels
- Pits
- Excavations

## **Oil Production/Refining and Chemical Plants**

- Vessels
- Tanks
- Pipelines
- Leaking valves
- Pits
- Excavations
- Containment berms

## **Power Stations**

- Vessels
- Tanks
- Pipelines
- Pits
- Coal tunnels
- Bins

## **Pulp and Paper Mills**

- Vessels
- Tanks
- Pipelines
- Pits
- Stock chests

## **Construction**

- Vessels
- Tanks
- Manholes
- Vaults
- Sewers
- Storm Drains
- Pipelines
- Pit
- Excavation

## **Diesel and Propane Exhaust**

# GLOBAL SERVICE ANYTIME, ANYWHERE

No matter where you are, 24-hour technical service and support is available from General Monitors. We have two manufacturing and six sales and service facilities located strategically worldwide for efficient support:

- Lake Forest, California
- Houston, Texas
- Republic of Ireland
- Singapore
- United Arab Emirates
- United Kingdom

## ***Quality Commitment***

General Monitors brings our reputation for quality and reliability excellence to the confined space market. We are ISO 9001 certified, utilizing continuous process improvement quality programs.

.....  
26776 Simpatica Circle  
Lake Forest, California 92630  
+1-949-581-4464 • Fax: +1-949-581-1151  
**www.generalmonitors.com**  
**email: sales@generalmonitors.com**

**Houston • Ireland • Singapore**  
**United Arab Emirates • United Kingdom**

9776 Whithorn Drive  
Houston, TX 77095  
USA  
Phone: +1-281-855-6000  
Fax: +1-281-855-3290  
email: gmhou@generalmonitors.com

Ballybrit Business Park  
Galway  
Republic of Ireland  
Phone: +353-91-751175  
Fax: +353-91-751317  
email: postmaster@gmil.ie

No. 2 Kallang Pudding Road  
#09-16 Mactech Building  
Singapore 349307  
Phone: +65-748-3488  
Fax: +65-748-1911  
email: genmon@singnet.com.sg

P.O. Box 61209  
Jebel Ali  
Dubai, United Arab Emirates  
Phone: +971-4-8815751  
Fax: +971-4-8817927  
email: gmme@emirates.net.ae

Heather Close  
Lyme Green Business Park  
Macclesfield, Cheshire  
United Kingdom SK11 0LR  
Phone: +44-1625-619583  
Fax: +44-1625-619098  
email: info@generalmonitors.co.uk