



The Unseen Menace

A Guide to Confined Space Entry



This booklet was designed to demonstrate the atmospheric hazards of confined spaces and the importance of atmospheric testing and monitoring. ***It is not intended to be used as a substitute for training nor is it the complete authority on confined space safety. Follow your company's safety policies and procedures for confined space entry.***

Confined Spaces

The National Institute for Occupational Safety and Health (NIOSH) estimates that millions of workers may be exposed to hazards in confined spaces each year. The Institute's investigations of confined space injuries and fatalities indicate that workers usually do not recognize that they are working in a confined space and that they may encounter unforeseen hazards. Testing and monitoring of the atmosphere is not performed, and rescue procedures are seldom planned.

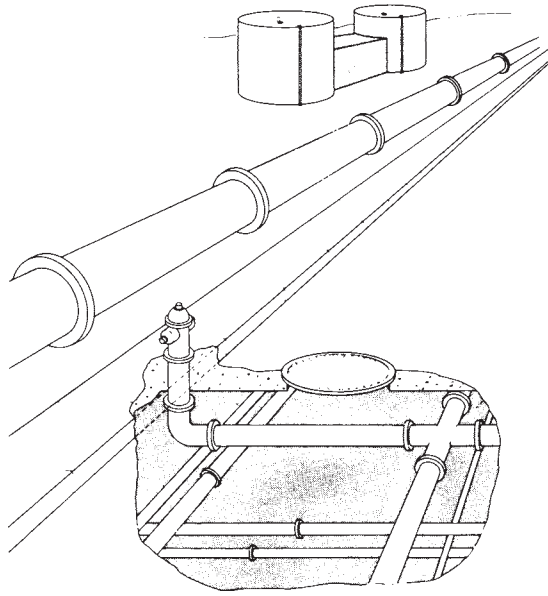
NIOSH's definition of a confined space is "a space which by design has limited openings for entry and exit; unfavorable natural ventilation which could contain or produce dangerous air contaminants, and which is not intended for continuous employee occupancy."

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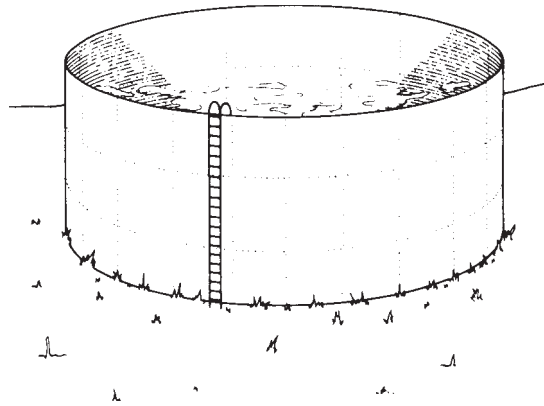
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Some Confined Spaces Are Easy To Recognize.



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

**Some May Not Be
So Easy To Recognize.**

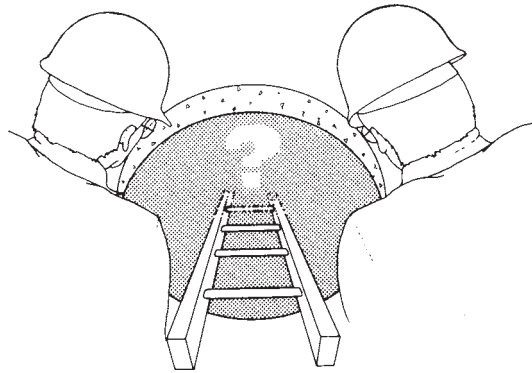


Open-topped water and degreaser tanks, open pits, and enclosures with bottom access are also confined spaces. They prohibit natural ventilation, are potential sources of gas generation and can keep gases from escaping, causing a potentially hazardous atmosphere.

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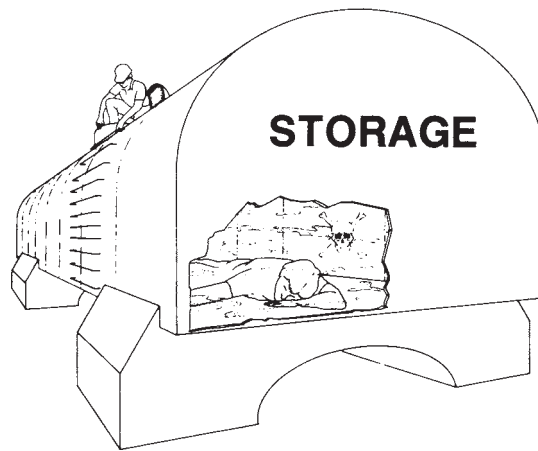
When in Doubt, Expect the Worst.



To recognize a confined space, you must fully understand the potential hazards. The normal safety hazards of the workplace, whether mechanical, electrical or physical, are complicated by the limited area of most confined spaces. Precautions must be taken.

But the most serious threat to the health and safety of the worker concerns the atmosphere of the confined space.

The Atmospheric Hazards of Confined Spaces Cannot Be Seen and Often Prove Fatal.



The unfavorable ventilation of a confined space can cause the atmosphere to be life threatening instead of life supporting.

Explosive and toxic gases (hydrogen sulfide and carbon monoxide are two of the most common toxic gases found in confined spaces) and a lack of oxygen cause the majority of confined space injuries and fatalities. More than 60% of the fatalities occur among would-be rescuers of initial victims.

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The Effects of Oxygen Deficiency are Life Threatening.

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, judgement.
10-12%	Respiration further increases in rate and depth, poor judgement, lips 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, respiration ceases, death.

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

Exposure to atmospheres containing 12% or less oxygen can bring about unconsciousness without warning, and so quickly that the individual cannot help or protect himself.

The Effects of Hydrogen Sulfide are Life Threatening.

POTENTIAL EFFECTS OF HYDROGEN SULFIDE EXPOSURE

PPM*	Effects and Symptoms	Time
10	Permissible Exposure Level	8 Hours
50-100	Mild Eye Irritation, Mild Respiratory Irritation	1 Hour
200-300	Marked Eye Irritation, Marked Respiratory Irritation	1 Hour
500-700	Unconsciousness, Death	½-1 Hour
1000 or More	Unconsciousness, Death	Minutes

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

Although the foul odor (rotten eggs) of hydrogen sulfide is easily detected at low concentrations, it is an unreliable warning because the gas rapidly desensitizes the olfactory (sense of smell) nerves and leads to a false sense of security. In high concentrations of hydrogen sulfide, a worker may collapse with little or no warning.

*PPM — Parts Per Million — volume measurement of gas concentration.

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The Effects of Carbon Monoxide are Life Threatening.

POTENTIAL EFFECTS OF CARBON MONOXIDE EXPOSURE

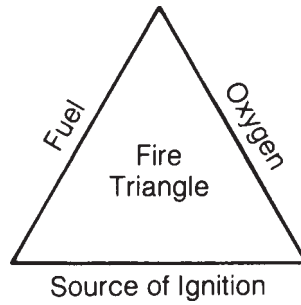
PPM*	Effects and Symptoms	Time
35	Permissible Exposure Level	8 Hours
200	Slight Headache, Discomfort	3 Hour
400	Headache, Discomfort	2 Hour
600	Headache, Discomfort	1 Hour
1000-2000	Confusion, Headache, Nausea	2 Hours
1000-2000	Tendency to Stagger	1½ Hours
1000-2000	Slight Palpitation of the Heart	30 Min.
2000-2500	Unconsciousness	30 Min.
4000	Fatal	Less Than 1 Hour

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

Carbon monoxide is an odorless, colorless gas that may build up in a confined space. In high concentrations of carbon monoxide, a worker may collapse with little or no warning and thus be unable to aid himself.

*PPM — Parts Per Million — volume measurement of gas concentration.

Certain Concentrations of Combustible Gases Can Be Life Threatening.

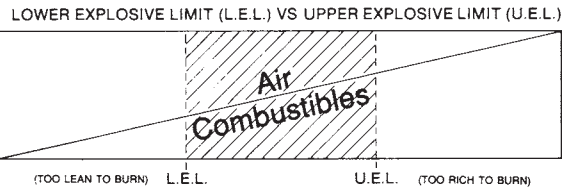


When fuel, oxygen and a source of ignition are present at the same time and in the right mixture, a serious explosion or fire is the result.

If a combustible gas or vapor and air mixture is trapped in a confined space only a source of ignition is necessary to create an explosion. Welding, sparking tools or even static electricity can easily satisfy this requirement.

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All Combustible Gases and Vapors Have a Different Explosive Range.

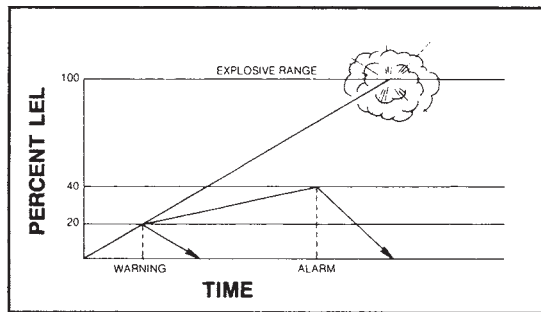


The lowest concentration (air-fuel mixture) at which a gas can ignite is called its Lower Explosive Limit (LEL). Concentrations below this limit are too lean to burn.

The highest concentration that can be ignited is its Upper Explosive Limit (UEL). Above that concentration, the mixture is too rich to burn.

A gas is only combustible between its LEL and UEL, but any concentration of combustible gas should be a concern. Lean mixtures can collect in an area and reach a combustible level, or rich mixtures can be diluted with air to become combustible.

Instruments Usually Monitor for Combustible Gases Below the Lower Explosive Limit.



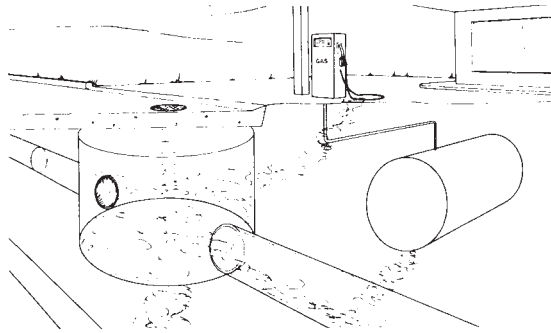
A gas-air mixture becomes explosive at the lower explosive limit (LEL), but the monitoring range of most instruments (0-100% of the LEL) is below this limit to provide advanced warning. Alarm levels may be set at 10% (and 40% for a high alarm) of the LEL to forewarn workers of a potentially hazardous combustible atmosphere.

Hazardous atmospheres in a confined space can be created by many conditions.

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Leaking Gases and Liquids Can Create a Hazardous Atmosphere in a Confined Space.



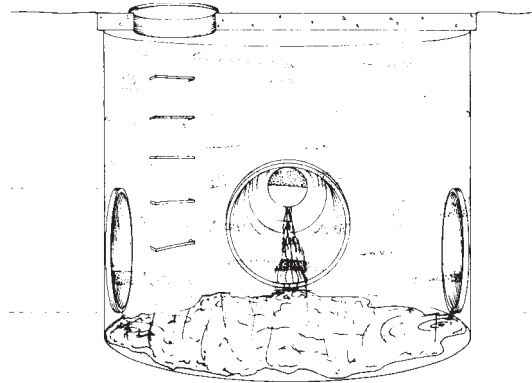
Leaking materials from storage tanks, natural gas lines, underground storage tanks, process flanges and valves, etc. can find their way into confined spaces. A number of hazards can exist depending on the leaking gas or liquid.

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 Can Create a Hazardous Atmosphere in a Confined Space.



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.

Oxygen Deficiency - Oxygen can be consumed by bacterial action or displaced by other gases.

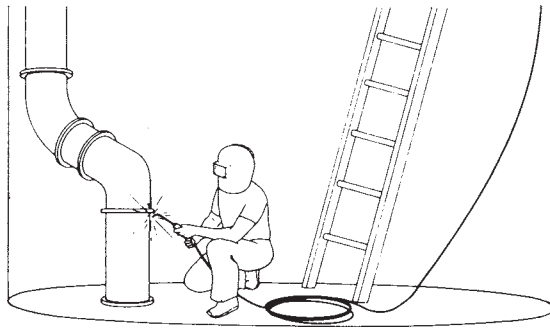
Combustible Gases - The produced Methane, CO or H₂S can reach explosive concentrations.

Toxic Gases - Both Hydrogen Sulfide and Carbon Monoxide are life threatening gases.

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Combustion or Oxidation Can Create a Hazardous Atmosphere in a Confined Space.

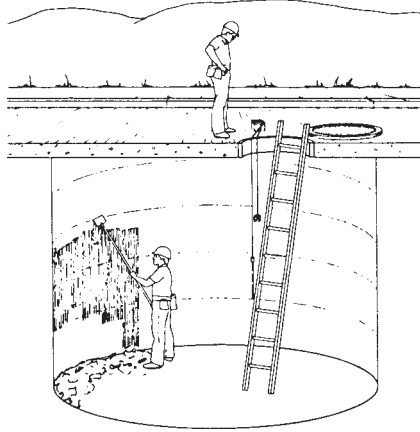


Combustion (welding, heating, gasoline or diesel engines, cutting and brazing) and oxidation (rusting) can create hazards.

Oxygen Deficiency - Oxygen is consumed by the combustion or oxidation process, or displaced by the combustion products.

Toxic Gases - Carbon Monoxide 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 Processes Can Create a Hazardous Atmosphere in a Confined Space



Even after an empty tank has been purged, gases can desorb from porous walls or be liberated from sludge during cleaning.

Oxygen Deficiency - Oxygen can be displaced by other gases.

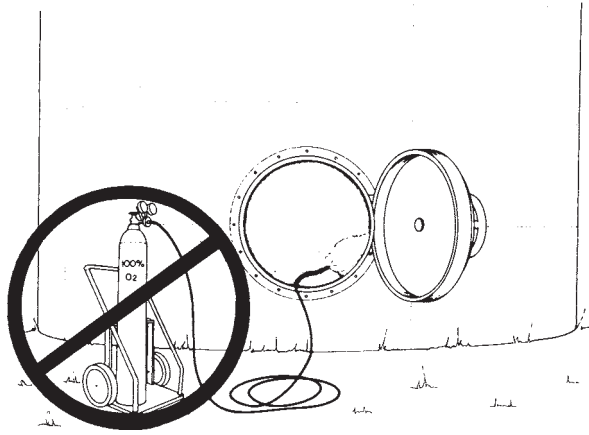
Combustible Gases - Liberated gases can produce a combustible concentration.

Toxic Gases - Toxic gases can be liberated from sludge or from cleaning solvents, or produced by chemical reactions with cleaning solvents and other materials.

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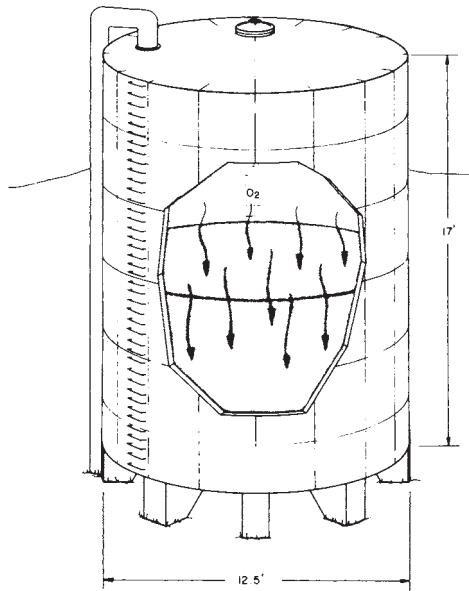
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Oxygen Enrichment Can Create a Hazardous Atmosphere in a Confined Space.



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 Can Create a Hazardous Atmosphere in a Confined Space.

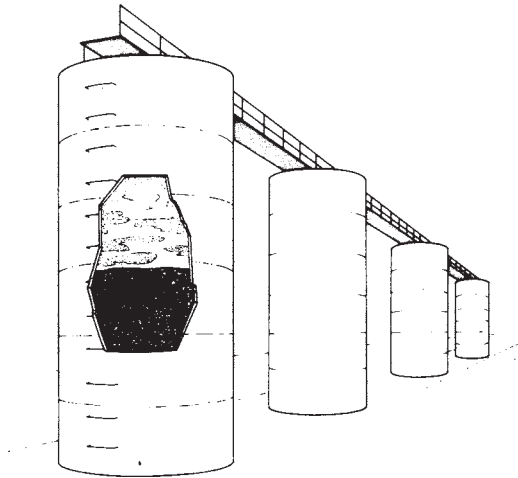


Oxygen can be absorbed by the vessel or the product stored, causing an oxygen deficient atmosphere.

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Combustible Dust Concentrations Can Create a Hazardous Atmosphere in a Confined Space.



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

**Every Possible Atmospheric
Hazard
Which May Be Encountered
in a Confined Space Cannot Be
Listed.**



Your safety depends on your knowledge and application of proper work procedures prior to entering a confined space. Atmospheric testing and monitoring, as well as preplanning of your work and rescue procedures, are all critical aspects of your job safety.

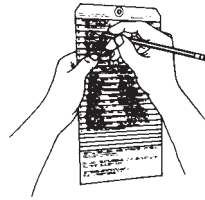
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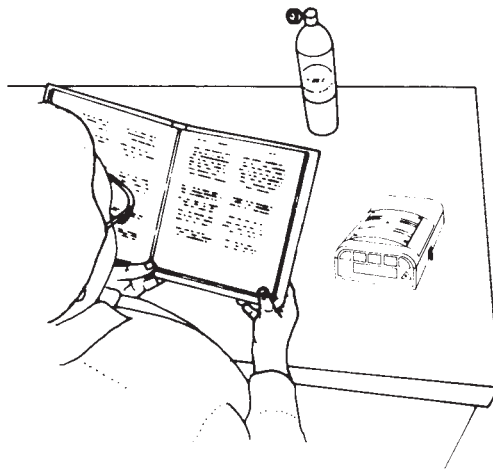
Preplan Your Work by Using Your Company's Confined Space Entry Permit As a Guideline.

Items to be considered:

1. Atmospheric Testing & Monitoring
2. Procedures
 - Initial Plan
 - Standby Person
 - Communications/Observation
 - Rescue
 - Work
3. Preparation
 - Isolate/Lockout/Tag
 - Purge and Ventilate
 - Cleaning Processes
 - Requirements for Special equipment/tools
 - Labeling & Posting
4. Safety Equipment and Clothing
 - Head Protection
 - Hearing Protection
 - Hand Protection
 - Foot Protection
 - Body Protection
 - Respiratory Protection
 - Safety Belts
 - Lifelines, Harness
5. Rescue Equipment



Fully Understand the Operation and Calibration of Your Atmosphere Testing Instrumentation.

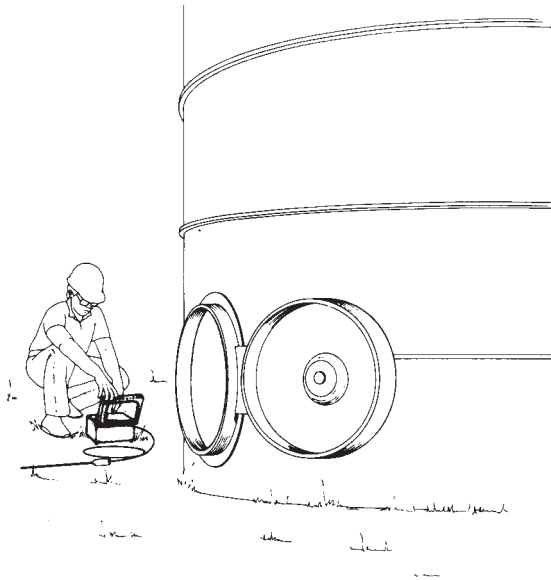


Assure that the instrument is working properly. Follow manufacturers' recommended calibration procedures and intervals. Become familiar with all aspects of operation and any limitations or cautions.

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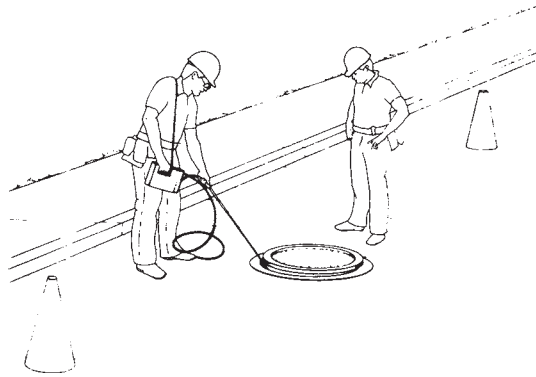
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Zero Your Instrument in Known Fresh Air Prior to Sampling for Suspect Gases or Vapors.



All instruments should first be check for a proper zero indication for combustible and toxic gases and for 20.9% oxygen indication in fresh air.

**Sample Through a
Pick-Hole, or Open
the Cover Slightly
on the Down-Wind Side, Before
Opening the Cover Completely.**

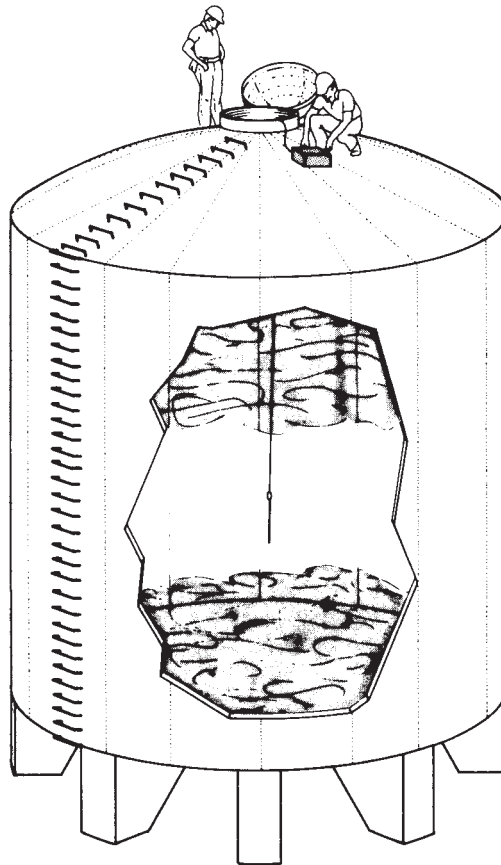


There is the potential for high concentrations of hazardous gases to be present in some confined spaces. Identifying this situation before opening the cover completely can mean the difference between life and death.

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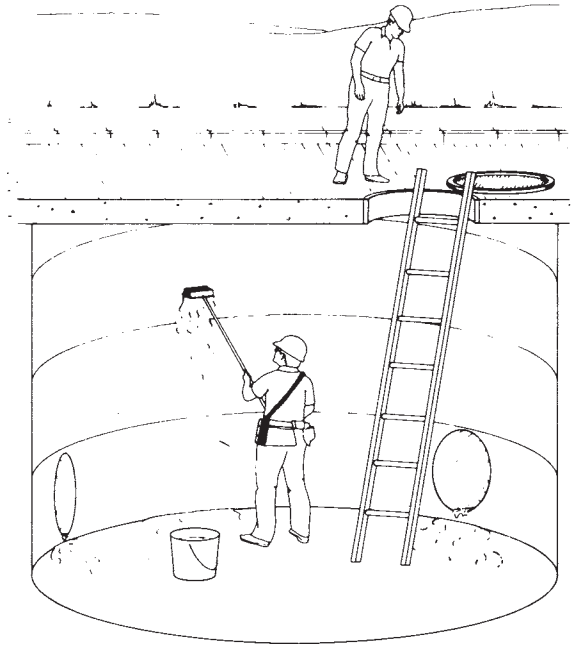
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Sample at all Levels.



The weight of gas varies. Depending on the compound some are lighter than, equal to, or heavier than air. 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.

**Once Work Begins,
Sample Frequently or
Continuously.
Conditions Can Change.**

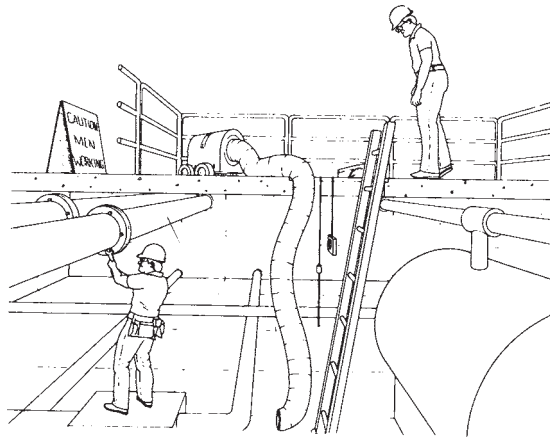


As work progresses, a once-safe atmosphere can become hazardous due to leaks, combustion, cleaning processes or other influencing factors.

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Recognize the Hazards and Work Safely.



When you recognize the potential hazards of confined spaces, preplan your work using your company's entry permit as a guide, conduct proper atmospheric testing, and prepare rescue procedures, the unseen menace can be avoided and you can assure yourself of safe working conditions.

FOR MORE INFORMATION,
PLEASE REFER TO THE
FOLLOWING PUBLICATIONS:

1. A Guide to Safety in Confined Spaces, (NIOSH Publication Number 87-113).
2. Working in Confined Spaces, (NIOSH Publication Number 80-106) December, 1979.
3. ALERT: Request for Assistance in Preventing Occupational Fatalities in Confined Spaces. (NIOSH Publication Number 86-110) January, 1986.
4. OSHA Occupational Safety and Health Standards 29CFR 1910.146 "Permit Required Confined Spaces"

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*“Gas Detection Made Safer Through
Science”*



Scout®

Multi-Gas Monitor Detects Up to 5 Toxic Gases Simultaneously

Advanced electronics and an innovative design, make Scout the next revolution in portable gas detection.

With exclusive ABMT® (Advanced Battery Management Technology), Scout can operate for over 50 hours on a single charge.

Features:

Other features such as Intellishutter mode management, wireless inductive charging and datalogging, and configurable multi-operator software brings incredible functionality for almost any application and for any level of user.

- Modular design permit in-the-field upgrades and service
- Lock & Latch No-Tools Battery Replacement
- Powerful, long lasting micro-pump
- Smart sensor technology



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Mini-SA Portable Single Gas Monitor

A big display in a little package.

Gloved hands, low light conditions, or respirator equipment won't interfere when your people are equipped with the Mini-SA Personal Gas Monitor. Scott/Bacharach engineers have merged simplicity and functionality into a feather-light package that offers the largest backlit display in the industry. An intuitive interface and oversized rubber buttons make operating the instrument easy – even while wearing gloves. The rugged, super-compact package houses many features found in larger, more expensive instruments including audible, visual, and vibratory alarms, automatic calibration, and interchangeable sensors.



Features:

- Rugged, durable and easy to use
- Menu driven push-button operation
- Visual, audible and vibratory alarms
- Large backlit display
- Water resistant
- RFI shielded
- Automatic calibration

Scott Instruments Portable Gas Detectors

*“Gas Detection Made Safer Through
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LeakAlert

Cost effective gas leak detection.

Detect and locate combustible gas with this easy-to-use leak detector from Scott/Bacharach. Superior sensor technology and an easy-to-use design make LeakAlert ideal for gas utility or emergency workers that need sensitive, on-the-spot gas and leak detection, down to as little as 20 ppm. Its flexible 20-inch probe gets into hard-to-reach areas and the audible and visual indicators let the user quickly determine the presence of gas and its location. The LeakAlert instrument is shipped complete with carrying case, batteries, wrist strap, user’s guide and 20-inch flexible probe.

Features:

- Ultra-bright LED Indicators
- Audible indicator
- 30-hour battery life
- Long-life sensor (4+ years)
- Durable construction
- 20-inch flexible probe



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CO Sniffer

On-scene CO detection and poisoning assessment is one easy breath away.

The workhorse of active CO detection, the CO Sniffer is the take-anywhere carbon monoxide solution for hygienists and emergency response crews. The CO Sniffer Emergency Response Kit with Breath Analysis Module provides fast on-site indication of personnel exposure to CO. Simply exhale into the disposable mouthpiece and balloon, and CO levels in the bloodstream are quickly and accurately assessed. With a powerful built-in pump, the CO Sniffer quickly converts to a portable CO detector for on-the-scene hazard assessment.

Features:

- Simple and effective CO poisoning assessment
- Fast, accurate CO readings
- Measures CO from 0-2,000 ppm
- Rugged construction
- Compact design with a large, easy-to-read backlit display
- Internal sampling pump
- FDA Listed



Scott Instruments Fixed Gas Detectors

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SafeSpace Dual Channel Area Monitor

**Continuous toxic and combustible
gas monitoring.**

The SafeSpace Area monitor is the simple package solution for one or two point gas monitoring applications, and can be used to detect a spectrum of toxic or combustible gases. Easy to install indoors or out, SafeSpace sensors can be remotely located up to 1,000 feet away. Built-in alarm relays can be used to quickly activate safety systems, and the loud built-in horn alerts personnel of potential danger.

Features:

- Complete turnkey package
- Large display of gas type and concentration
- Simple to use
- External alarm reset button
- Relays and 4-20 mA outputs
- Suitable for Class 1, Div 2 installation



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Toxic and Combustible Gas Transmitters

Advanced sensor technology
and innovative designs are
installed in thousands of
applications worldwide.



Scott Instruments leads the
industry in offering the widest selection of toxic
and combustible gas detectors available.

Electrochemical - Over 40+ toxic gas sensors
available. Our proprietary ROCK SOLID® sensor
technology make our gas transmitters the fastest,
most selective available.

Infrared - Ultra-reliable combustible and toxics
detection. For state-of-the-art single point and
open path combustible gas detection.

Papertape - Detect acutely toxic gases down to
PPB levels. A leader in phosgene, isocyanates,
and hydrazine detection



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INSTRUMENTS

Scott Instruments Fixed Gas Detectors

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Controllers/ Receivers

From small 1 or 2 applications to large multi-point systems, Scott instruments offers a complete line of controllers and receivers.

QuadScan II

Simultaneously displays from 1 to four channels for any 4-20mA transmitter.



Series 6800

The Model 6800 provides centralized display/ alarming capabilities and loop power for up to 16 Scott gas transmitters and other 4-20mA instruments.



DGMACS

For large, multi-point applications, DG-MACS is a data acquisition and control system that provides the functional versatility of a PC with the security and robustness of a dedicated control system.



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Scott Health & Safety

The Most Trusted Name in Respiratory Protection

Confined space work environments provide unique safety challenges for all workers. Key safety issues include effective respiratory protection and reliable voice communications. Scott Health and Safety, the most trusted name in respiratory protection, offers entrants and attendant a clear choice for their respiratory and communications needs. Fully compatible and easy to use, Scott offers a full line of supplied air, air purifying and communications products to give you the options you want and the protection you need. Because the closer you get, the more you need Scott.

Industrial SCBA (ISCBA)

Industrial users can rely on Scott's tough line of Industrial SCBA as the cost effective solution for respiratory protection. With Scott's E-Z Flo[®] regulator featuring first breath activation, and built on our proven wire form backframe, I S C B A



Scott Health & Safety

The Most Trusted Name in Respiratory Protection

promotes freedom of movement and reduces fatigue. With 30, 45 and 60 minute cylinder options, Scott's ISCBA is the ideal choice for respiratory protection in IDLH or potentially IDLH environments.



Ska-Pak®Plus

Scott's Ska-Pak Plus system features a streamlined profile for easy entry/exit and work in confined spaces. The Ska Pak Plus offers a NIOSH approved system integrating fall protection with a



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Scott Health & Safety

The Most Trusted Name in Respiratory Protection

supplied-air respirator. The result is a high performance respirator with enhanced worker acceptance. Lightweight, low profile composite cylinders improve productivity and reduce worker fatigue. The Ska Pak Plus is available in various configurations offering a range of 5 and 10 minute duration cylinders.



Con-Space®Link

Scott, always concerned with the needs of respirator wearers, has teamed with Con-Space Communications Ltd. to develop the Con-Space Link – the safest solution for confined spaces and wired communications. This innovative product integrates Scott's full line of air-supplied products with all Con-Space hardline confined space communication systems allowing users to enjoy effective, reliable and hands-free voice communications on the job.

