Construction Industry Gas Detection Issues and Answers

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GfG Instrumentation

World-wide manufacturer of fixed and portable gas detection solutions

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Construction Project Gas Detection Questions

- "Construction" is a very broad category!
- Construction managers deal with extremely wide range of atmospheric hazards, monitoring applications and activities.
- Hazards can be generally present or associated with specific activities (like CS entry).
- A unique challenge is that hazards can change from day to day as different teams are engaged in different activities.
- Managers to anticipate critical requirements ahead of time!

What are your most urgent concerns and problems?

- The more detailed grasp you have of the activities and risks that involve atmospheric hazards, the better.
- Drill down to make sure you understand what is most important.
- Are you currently meeting all requirements?
- Where do you need to make improvements?
- Gas detection issues are not necessarily limited to safety!
  - Toxic exposure limits are getting lower every year!

Construction managers are involved with all types of safety and hygiene gas detection

- Personal exposure monitoring
- Confined space
- Hot work
- Toxic materials, vapors and gases
- Hazmat and emergency response
- Other activity-based monitoring

Short term portable or longer-term fixed solution?

- When hazards are generally present or associated with specific activities (like CS entry) gas detection solutions focus more on portable instruments.
- When hazards are chronically present, or present in specific areas, (like exhaust gases) removeable or short-term fixed gas detection system may be better solution
- Solutions implemented during construction often carried over into long term use

What are general causes of atmospheric hazards at construction sites?

- Where is the construction site?
- What is being constructed?
- What kinds of activities are going on at site?
- What kinds of equipment / materials being used?
- Human factors:
  - Who's in charge?
  - How is communication managed between contractors and teams?
  - How are hazards mitigated / controlled?
  - How are conditions monitored to ensure workers not exposed to hazardous conditions?
- Employer responsibility:
  - General duty clause
    - Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees - OSH Act of 1970

What are specific causes of atmospheric hazards at construction sites?

- Pre-existing hazards at site
- Demolition
- Hot work
- Working in or near confined spaces
- Tunneling / underground construction
- Trenching / excavations
- Application or use of solvents, paints, sealants and foam insulation
- Exhaust from diesel and gasoline powered engines and equipment
- Road construction
  - VOCs / asphalt / sealants / paint / CO / NO_2
- Unique hazards associated with specific project
  - Personal example: Metal plating tank-line at commercial aviation manufacturing plant (HCN)

What are some examples of pre-existing hazards?

- On-going or prior activities during plant expansions
  - Refinery / chemical plant / steel mill / foundry / pulp mill / power generation stations
  - Types of gas hazards: H_2S, VOC, SO_2, CO, Cl_2 / NO_2 / combustible gas
- Industrial / soil remediation sites
  - Soil contamination / buried waste
  - Types of gas hazards: H_2S, VOC, CO, NH_3, Cl_2, combustible gas
- Landfills
  - Combustible and CO_2 gas pockets
  - O_2 deficiencies
  - Odors
- Marine sediments / swamps
  - H_2S, combustible gas, O_2 deficiencies

Presence of atmospheric hazards may not be related to construction: are there special monitoring issues just to get on site?

- Facilities
  - Battery charging (generation of hydrogen)
  - Combustible liquid cabinets
  - Gas storage areas
  - Spills
  - Leaks
  - Fueling stations (hydrogen or propane)
- Combustion
  - Stack gas (SO_2, acid gas, NO_2, NO, CO, CO_2)
  - Engine exhaust (CO, NO_2, NO, CO_2)
  - Accidental or intentional release of contaminants
- Deliberate creation of potentially dangerous atmospheric conditions
  - Nitrogen purging
  - Curing ovens
  - Inert gas actuation

What atmospheric hazards are associated with demolition and hot work?

- Hot work
  - Riveting, welding, flame cutting or other fire or spark-producing operation
  - Welding gases and byproducts:
    - CO
    - NO_2
    - SO_2
    - O_3
    - Welding fuels (acetylene / ethylene / propylene)
    - Inert gases (argon)
    - O_2 displacement
- Demolition
  - Residual contents in old vessels / tanks / boilers
  - Release (desorbtion) of toxic or combustible gas trapped in vessel materials

What atmospheric hazards are associated tunneling / underground construction?

- May fall under MSHA rather than OSHA
  - Monitoring equipment may require additional MSHA certification
  - Hazards include:
    - CO
    - O_2 deficiencies
    - Combustible gas
    - NO_2
    - H_2S
    - VOC gases and vapors

What about heavy equipment / vehicle exhaust hazards?

- Composition of exhaust depends on the type of engine, the type of fuel, available oxygen, and whether the engine is cold or fully warmed up

- Cold engines produce higher emissions of hydrocarbons, nitrogen oxides and carbon monoxide, which diminishes as the engine reaches operating temperature.

What kinds of hazards are in engine exhaust?

- Exhaust gas from diesel and gasoline engines primarily consists of nitrogen (N_2), water vapor (H_2O), and carbon dioxide (CO_2)
- A relatively small part of the exhaust consists of toxic materials such as:
  - Particulate contaminants (soot)
  - Carbon monoxide (CO) from incomplete combustion
  - Hydrocarbons from unburnt fuel
  - VOCs from incomplete combustion
  - Nitrogen oxides (NOx)

What types of construction materials can cause dangerous atmospheric conditions?

- Paints, sealants and coatings used in construction
  - Polymers
  - Paints
  - Resins
  - Sealants
  - Solvents
  - Glue
  - Foam insulation
- Process(es) used to transform or cure materials
  - Chemical reactions
  - Curing / drying
    - May require and consume O_2 during curing
  - Materials may continue to release toxic contaminants over time
    - Example: particle board and formaldehyde

Do confined space rules apply to construction?

- In 1993 OSHA enacted 29 CFR 1910.146 “Permit-Required Confined Spaces”
  - Provisions applied only to general industry work
  - 1910.146 does not apply to industries with their own vertical standards:
    - Agriculture
    - Construction
    - Shipyard employment
- Original intent was to extend 1910.146 to include construction
- However, it was quickly recognized that 1910.146 did not fully address issues unique to the construction industry, such as:
  - Higher employee turnover rates
  - Worksites that change frequently
  - Multi-employer business model

29 CFR 1926 Subpart AA: Confined Spaces in Construction

- Until recently, this left a gap in construction related CS procedures
- As of 2015, Construction finally has its own standard: 29 CFR 1926 Subpart AA “Confined Spaces in Construction”

Does the Construction CS rule differ with the General Industry CS rule?

- The Construction CS rule is similar in content and organization to the general industry confined spaces standard, but incorporates additional provisions that address construction-specific hazards

- Includes a permit program designed to protect employees from atmospheric and physical hazards associated with work in construction confined spaces

Characteristics of Confined Spaces

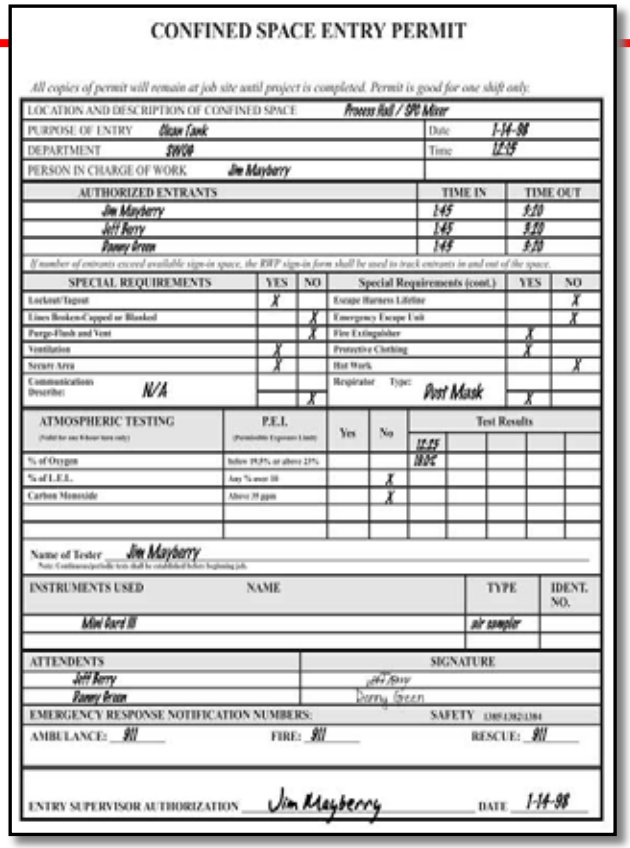
- Large enough for worker to enter
- Are not designed for continuous worker occupancy
- Limited openings for entry and exit

Are all confined spaces permit required confined spaces?

- Permit confined spaces characterized by one or more additional hazards:
  - Hazardous atmosphere (known or potential)
  - Material with the potential for engulfment
  - Inwardly sloping walls or dangerously sloping floors

    or

  - Contains any other serious safety hazard



CONFINED SPACE ENTRY PERMIT

All copies of permit will remain at job site until project is completed. Permit is good for one shift only.

LOCATION AND DESCRIPTION OF CONFINED SPACE	Process Roll / 990 Mixer
PURPOSE OF ENTRY	Clean Tank
Date	1-14-98
DEPARTMENT	8900
Time	12:15
PERSON IN CHARGE OF WORK	Jim Mayberry

AUTHORIZED ENTRANTS	TIME IN	TIME OUT
Jim Mayberry	1:45	9:20
Jeff Berry	1:45	9:20
Danny Brown	1:45	9:20

If number of entrants exceed available sign-in space, the RWP sign-in form shall be used to track entrants in and out of the space.

SPECIAL REQUIREMENTS	YES	NO	Special Requirements (cont.)	YES	NO
Lockout/Tagout	X		Escape Harness Lifeline		X
Lines Broken/Capped or Blanked		X	Emergency Escape Unit		X
Purge-Flush and Vent		X	Fire Extinguisher	X	
Ventilation	X		Protective Clothing	X	
Secure Area	X		Hot Work		X
Communications (Describe) N/A		X	Respirator Type: Dust Mask	X	

ATMOSPHERIC TESTING	P.E.L. (Permissible Exposure Limit)	Yes	No	Test Results				
				12:15				
% of Oxygen	below 19.5% or above 23%			20.8%				
% of L.E.L.	Any % over 10		X					
Carbon Monoxide	Above 35 ppm		X					

Name of Tester Jim Mayberry

Note: Continuous/periodic tests shall be established before beginning job.

INSTRUMENTS USED	NAME	TYPE	IDENT. NO.
Mini Rae III		air sampler	

ATTENDENTS	SIGNATURE
Jeff Berry	Jeff Berry
Danny Brown	Danny Brown

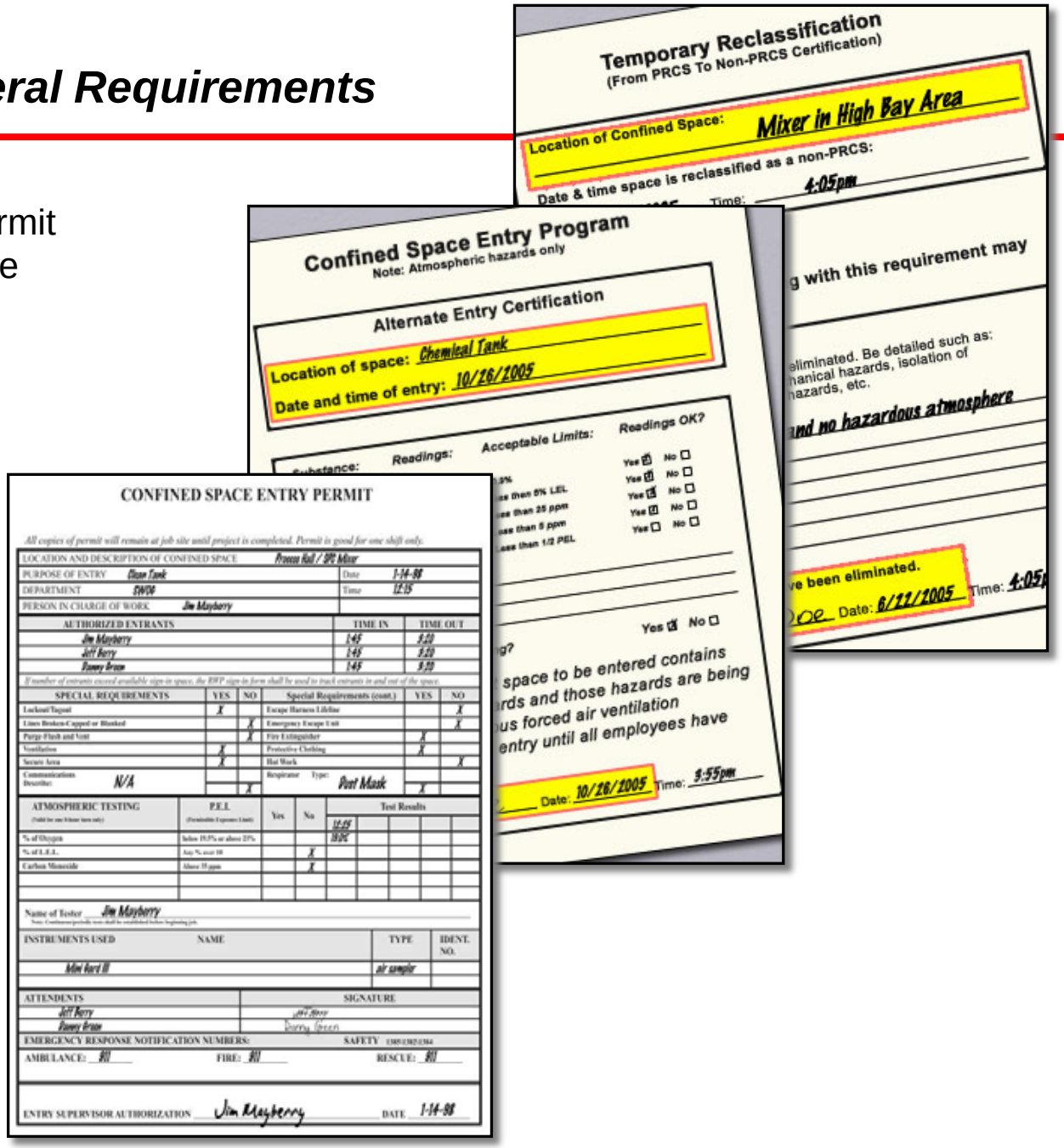
EMERGENCY RESPONSE NOTIFICATION NUMBERS: SAFETY 1305-1382-1384

AMBULANCE: 911 FIRE: 911 RESCUE: 911

ENTRY SUPERVISOR AUTHORIZATION Jim Mayberry DATE 1-14-98

General Requirements

- Options for entry into Permit Required Confined Space (PRCS)
  - Reclassification
  - Alternate entry procedures
  - Permit program



Temporary Reclassification
(From PRCS To Non-PRCS Certification)
Location of Confined Space: Mixer in High Bay Area
Date & time space is reclassified as a non-PRCS: 4:05pm

Confined Space Entry Program
Note: Atmospheric hazards only
Alternate Entry Certification
Location of space: Chemical Tank
Date and time of entry: 10/26/2005

CONFINED SPACE ENTRY PERMIT
All copies of permit will remain at job site until project is completed. Permit is good for one shift only.
LOCATION AND DESCRIPTION OF CONFINED SPACE: Process Roll / SPC Mixer
PURPOSE OF ENTRY: Clean Tank — Date: 1-14-98
DEPARTMENT: EWDR — Time: 12:15
PERSON IN CHARGE OF WORK: Jim Mayberry

Under 1910.146, <u>after construction</u>, these are normally non-permit confined spaces

- Large enough for worker to enter
- Are not designed for continuous worker occupancy
- Limited openings for entry and exit
- However, there are no other serious safety hazards

Under 1926 Subpart AA, <u>during construction,</u> these can easily be permit confined spaces!

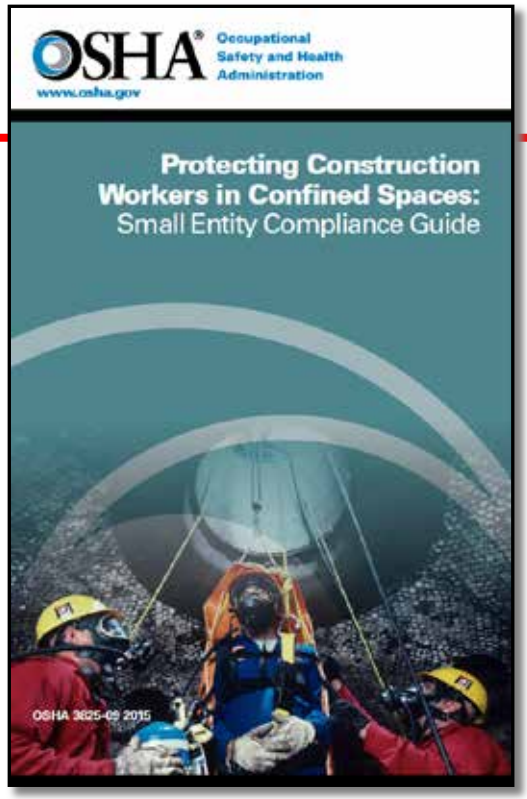
- It depends on what is being done at that moment in the construction process
- For example:
  - Sealant is being applied in the crawl space, the atmosphere may be hazardous due to toxic vapors
  - O_2 catalyzed sealants and freshly poured concrete absorb oxygen while curing, which can lead to O_2 deficiency

Types of confined spaces covered by 1926 Subpart AA

- 29 CFR 1926 includes a lengthy list of confined spaces that are covered by the new rule
- The list includes many types of spaces that are not usually deemed to be permit confined spaces under the general industry rule (29 CFR 1946)

Have you made a complete survey of the permit confined spaces at the site?

- Boilers
- Manholes (sewer, storm drain, electrical, communication, utility, etc.)
- Precast concrete manhole units
- Tanks (fuel, chemical, water, other liquid, solid or gas)
- Incinerators
- Concrete pier columns
- Sewers and storm drains
- Transformer vaults
- Heating, ventilation, and air-conditioning (HVAC) ducts
- Cesspools
- Mixers/reactors
- Bag houses
- Turbines
- Silos
- Chillers



https://www.osha.gov/Publications/OSHA3825.pdf

Are confined spaces always fully enclosed?

- Open-topped water tanks
- Digesters and lift stations
- Bins
- Degreasers
- Pits (elevator, escalator, pump, valve, etc.)

https://www.osha.gov/Publications/OSHA3788.pdf

OSHA® FactSheet

Confined Spaces in Construction: Pits

Confined spaces can present conditions that are immediately dangerous to workers if not properly identified, evaluated, tested, and controlled. This fact sheet highlights many of the confined space hazards associated with pits and how employers can protect their workers in these environments.

OSHA has developed a new construction standard for Confined Spaces (29 CFR 1926 Subpart AA)— any space that meets the following three criteria:

- Is large enough for a worker to enter it;
- Has limited means of entry or exit; and
- Is not designed for continuous occupancy.

A space may also be a **permit-required confined space** if it has a hazardous atmosphere, the potential for engulfment or suffocation, a layout that might trap a worker through converging walls or a sloped floor, or any other serious safety or health hazard.

Fatal Incidents

Confined space hazards in pits have led to worker deaths. Several tragic incidents included:

- Two workers suffocated while attempting to close gate valves in a valve pit.
- A worker lost consciousness, fell, and was killed while climbing down a ladder into an unventilated underground valve vault to turn on water valves.
- While replacing a steam-operated vertical pump, an equipment repair technician died from burns and suffocation after falling into an industrial waste pit.

Training

The new Confined Spaces standard requires employers to ensure that their workers know about the existence, location, and dangers posed by each permit-required confined space, and that they may not enter such spaces without authorization.

Employers must train workers involved in permit-required confined space operations so that they can perform their duties safely and understand the hazards in permit spaces and the methods used to isolate, control or protect workers from these hazards. Workers not authorized to perform entry rescues must be trained on the dangers of attempting such rescues.

Safe Entry Requirements

The new Confined Spaces standard includes several requirements for safe entry.

Preparation: Before workers can enter a confined space, employers must provide pre-entry planning. This includes:

- Having a competent person evaluate the work site for the presence of confined spaces, including permit-required confined spaces.
- Once the space is classified as a permit-required confined space, identifying the means of entry and exit, proper ventilation methods, and elimination or control of all potential hazards in the space.
- Ensuring that the air in a confined space is tested, before workers enter, for oxygen levels, flammable and toxic substances, and stratified atmospheres.
- If a permit is required for the space, removing or controlling hazards in the space and determining rescue procedures and necessary equipment.
- If the air in a space is not safe for workers, ventilating or using whatever controls or protections are necessary so that employees can safely work in the space.

Ongoing practices: After pre-entry planning, employers must ensure that the space is monitored for hazards, especially atmospheric hazards. Effective communication is important because there can be multiple contractors operating on a site, each with its own workers

Does the construction CS rule apply to crawl spaces and attics?

- Even if the space is not a PRCS after construction, it may represent a dangerous permit space at certain stages during construction
  - The rule includes residential as well as commercial and industrial construction
- Confined space hazards in crawl spaces and attics have led to worker deaths:
  - Two workers died while applying primer to floor joists in a crawl space. They were burned when an incandescent work lamp ignited vapors from the primer.
  - A flash fire killed a worker who was spraying foam insulation in an enclosed attic. The fire was caused by poor ventilation.

What are the General Requirements?

- Employers Must:
  - Identify Confined Space hazard areas
  - Inform employees by posting signs where feasible
  - Prevent entry by unauthorized persons

What are the General Requirements?

- Employers must ensure the required equipment is available:
  - Testing and monitoring
  - Ventilation
  - Communications
  - Lighting
  - Barriers
  - Other personal protective equipment
  - Any required rescue and emergency equipment

- Employers Must:
  - Establish procedures and practices to allow safe entry (Permit system)

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What are the General Requirements?

- Employers Must:
  - Protect entrants from external hazards
  - Enforce established procedures
  - Ensure procedures and equipment necessary for rescue
    - Calling 911 after the accident occurs is not a plan!

https://www.osha.gov/Publications/OSHA3849.pdf

OSHA® FactSheet

Is 911 your Confined Space Rescue Plan?

Permit-required confined spaces can present conditions that are immediately dangerous to workers' lives or health if not properly identified, evaluated, tested and controlled.

OSHA has developed a standard for Confined Spaces in Construction (29 CFR 1926 Subpart AA) for any space that meets all of the following criteria:

- Is large enough for a worker to enter;
- Has limited means of entry or exit; and
- Is not designed for continuous occupancy.

One provision of the standard requires employers to develop and implement procedures for summoning rescue or emergency services in permit-required confined spaces. An employer who relies on local emergency services for assistance is required to meet the requirements of §1926.1211 — *Rescue and emergency services*.

OSHA recognizes that not all rescue services or emergency responders are trained and equipped to conduct confined space rescues. When employers identify an off-site rescue service, it is critical that the rescuers can protect their employees. The emergency services should be familiar with the exact site location, types of permit-required confined spaces and the necessary rescue equipment.

For Employers

Calling emergency responders to provide rescue services can be a suitable way of providing for rescues in a permit-required confined space. Pre-planning will ensure that the emergency service is capable, available and prepared.

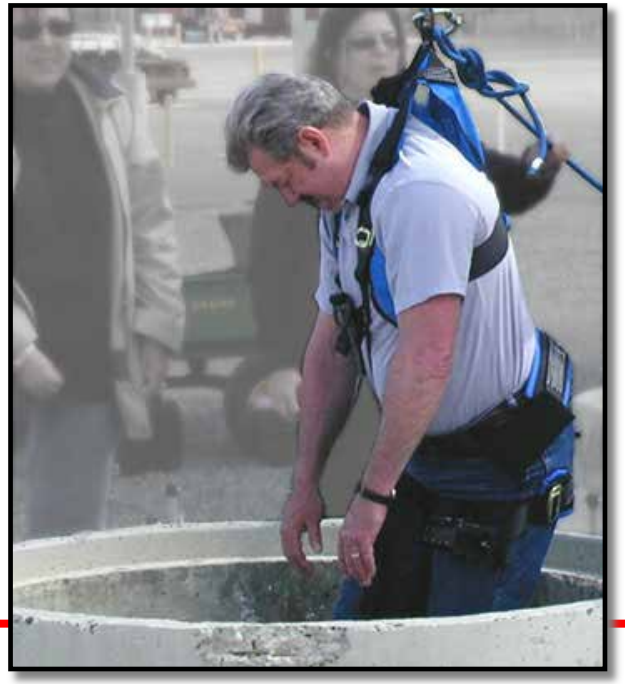
Prior to the start of the rescue work operation, employers must evaluate prospective emergency responders and select one that has:

- Adequate equipment for rescues, such as: atmospheric monitors, fall protection, extraction equipment, and self-contained breathing apparatus (SCBA) for the particular permit-required confined spaces.

- The ability to respond and conduct a rescue in a timely manner based on the site conditions and is capable of conducting a rescue if faced with potential hazards specific to the space. Such hazards may include:
  - Atmospheric hazards (e.g., flammable vapors, low oxygen)
  - Electrocution (e.g., unprotected, energized wires)
  - Flooding or engulfment potential
  - Poor lighting
  - Fall hazards
  - Chemical hazards
- Agreed to notify the employer in the event that the rescue team becomes unavailable.

Employers must also:

- Inform the emergency responders of potential hazards when they are called to perform a rescue at the worksite; and



What are the requirements for rescue plans and procedures?

- Self rescue: Entry procedures should aim at getting workers out under their own power BEFORE conditions become life threatening
- Non-entry rescue: Second best approach is to use procedures that allow rescue without having to enter the space
- Rescuer entry: Least desirable, highest risk, most equipment and personnel intensive approach

1926 Subpart AA: Increased emphasis on training

- Dangers associated with construction confined spaces can change from day-to-day because of the work being performed
- Even more important that workers are trained to recognize potential dangers!
- Employer must ensure employees possess knowledge and necessary skills and are competent for the safe performance of their assigned duties
  - Understand the hazards and the methods used to isolate, control and protect employees
  - Understand the dangers of attempting rescues unless trained, equipped and authorized to do so!

1926 Subpart AA: Increased emphasis on communication

- Workers and contractors at construction site can change from day to day
- The Entry Employer must ensure that all Entry Supervisors, Authorized Entrants and Attendants are properly trained, and that they properly follow the requirements of the Employer's confined space entry program
- Whenever responsibility for a PRCS is transferred the Entry Supervisor determines that entry operations remain consistent with terms of the entry permit and that acceptable entry conditions are maintained

1926.1203(e)(2): Requires calibrated direct reading instrument

- Perform “bump test” or “calibration check” on all sensors before each day’s use
- Calibrate and maintain instrument per manufacturer requirements
- Maintain records that prove these requirements are being met
- GfG Application Note 1007: Calibration and Bump Test Requirements

http://goodforgas.com/wp-content/uploads/2014/09/AP1007_calibration_requirements_for_direct_reading_portable_gas_monitors_8_AUG_14.pdf

AP 1007:
Calibration and Bump Test Requirements for Direct Reading Portable Gas Monitors

Manufacturers and regulatory agencies agree the safest and most conservative approach is to perform a functional test by exposing your gas detector to test gas before each day's use.

Oxygen deficiencies, explosive atmospheres, and exposure to toxic gases and vapors injure hundreds of workers every year. The atmospheric conditions that lead to these accidents and fatalities are usually invisible to the workers who are involved. The only way to ensure atmospheric conditions are safe is to use an atmospheric monitor. The only way to know whether an instrument is capable of proper performance is to expose it to test gas. Exposing the instrument to known concentration test gas verifies that gas is properly able to reach and be detected by the sensors. It verifies the proper performance of the instrument's alarms, and (if the instrument is equipped with a real-time display), that the readings are accurate. Failure to periodically test and document the performance of your atmospheric monitors can leave you open to regulatory citations or fines, as well as increased liability exposure in the event that a worker is injured in an accident.

There has never been a consensus among manufacturers regarding how frequently direct reading portable gas detectors need to be calibrated. However, manufacturers do agree that the safest and most conservative approach is to verify the performance of the instrument by exposing it to test gas before each day's use. Performing a functional "bump test" is very simple and takes only a few seconds to accomplish. It is not necessary to make a calibration adjustment unless the readings are found to be inaccurate. The regulatory standards that govern confined space entry and other activities that include the use of direct reading instruments are in agreement with this approach.

However, the definition of "bump test" has always been a little slippery. Some manufacturers differentiate between a "bump test" that provides a qualitative evaluation of the instrument's ability to detect gas and a "calibration check" that verifies that the response of the sensor(s) when exposed to known concentration test gas are within the manufacturer's requirements for accuracy. All manufacturers agree that instruments that fail either a "bump test" or "calibration check" should be put through a "full calibration" before further use.

ISEA Statement on Validation of Operation for Direct Reading Portable Gas Monitors

The International Safety Equipment Association (ISEA) is the leading international organization of manufacturers of safety equipment, including environmental monitoring instruments. The ISEA is dedicated to protecting the health and safety of workers through the development of workplace standards and the education of users on safe work practices and exposure prevention. In 2010 the ISEA updated their protocol for, *"Validation Procedures of Operation For Direct Reading Portable Gas Monitors"* to clarify the Association's recommendations for the procedures used to verify proper operation, and the accuracy of the readings.

The protocol was designed to reemphasize to OSHA and other standards writing bodies the importance of verifying the calibration of instruments used to monitor the atmosphere in potentially hazardous locations, to clarify the differences

Figure 1: Performing a functional "bump test" by exposing the instrument to test gas takes only a few moments perform.

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Bump test and calibration definitions and requirements

- OSHA definition of “bump test”
  - Exposure to test gas to activate alarms for all sensors
  - No adjustment of sensors
  - Required “Before each day’s use”
- OSHA definition of “calibration check”
  - Instrument exposed to known concentration calibration gas
  - Sensor readings must stabilize within tolerance of manufacturer specification
  - No adjustment of sensors
- Calibration
  - Two steps: adjustment of sensors to fresh air values, then adjustment of sensors using calibration gas
  - Calibrate whenever instrument fails daily check or as specified by manufacturer

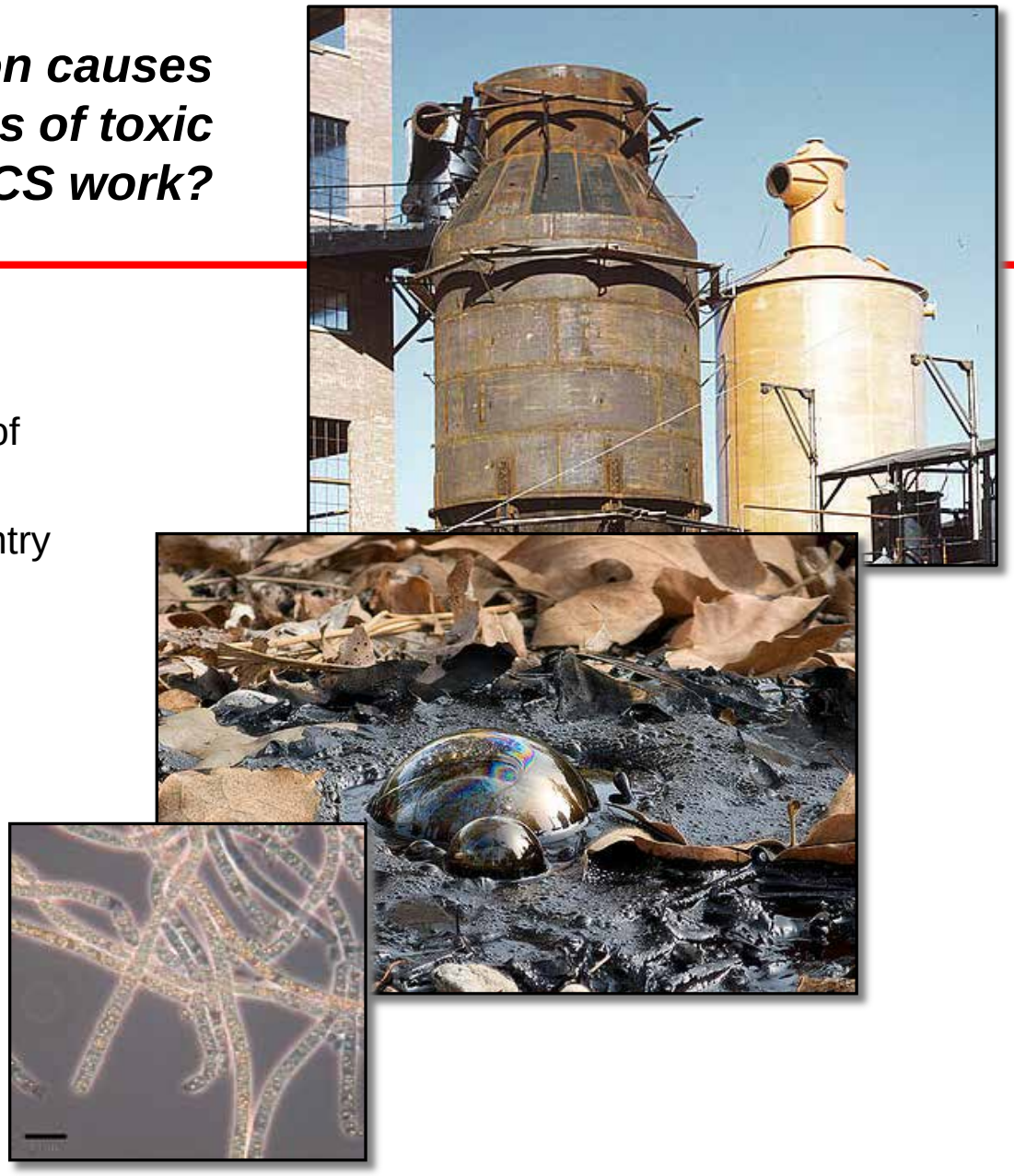
https://www.osha.gov/dts/shib/shib093013.html

What are the most common CS atmospheric hazards?

- Oxygen deficiency
- Oxygen enrichment
- Presence of toxic gases
- Presence of combustible gases
- Typically use a 4 gas or 5 gas detector with:
  - LEL
  - O2
  - CO
  - H2S
  - PID

What are common causes common causes of toxic gases during CS work?

- Contents that were stored in the space
- Compounds absorbed into walls of the space
- Contents being disturbed upon entry
- Work being done in the space
- Adjacent areas
- Natural process(es)
  - Decomposition
  - Oxidation
- Confined space entry activities
  - Hot work
  - Scraping
  - Mucking
  - Paints and sealants
  - Displacement



What are volatile organic compounds (VOCs)?

- VOCs are organic chemicals or mixtures characterized by tendency to evaporate easily at room temperature
- Familiar VOCs include:
  - Solvents
  - Paint thinner
  - Nail polish remover
  - Gasoline
  - Diesel
  - Heating oil
  - Kerosene
  - Jet fuel
  - Benzene
  - Butadiene
  - Hexane
  - Toluene
  - Xylene
  - Many others

Why use photoionization detector equipped instruments?

- For most VOCs, long before you reach a concentration sufficient to register on a combustible gas indicator, you will have easily exceeded the toxic exposure limits for the contaminant
- PID equipped instruments are generally the best choice for measurement of VOCs at exposure limit concentrations
- Whatever type of instrument is used to measure these hazards, it is essential that the equipment is used properly, and the results are correctly interpreted

There are <u>many</u> new developments in gas detection!

- New products
- New sensors
- Wireless communication
- Integrated fixed and portable networks
- Third party support through call centers
  - Emergency response
  - Record keeping and notifications
  - Internet based maintenance programs

What brand(s) and model(s) of gas detection equipment do you currently use?

- Before making a change or investigating new products, make sure you understand your current products and requirements
  - If you are not sure, make sure to find out the brands and models currently in service.
  - Make sure you understand the capabilities; the strong points as well as the weak points, of the products you are currently using.
- Ask the manufacturers or distributors of the products you work with (or are interested in) for help.
  - Download specifications and comparison charts if the manufacturer has them.
  - Discuss ways the manufacturer and distributor can help meeting your needs with regards to product, capabilities or support.

How well is your current equipment performing?

- This is a critical starting point in the conversation.
  - Are you generally happy?
  - Are you experiencing problems?
  - How old is your current equipment?
  - What features have you heard about that you are interested in?
  - What brand(s) and model(s) of gas detectors are you considering?
  - What are the alternatives?
- Distributors are a great source for product information!
- When in doubt, or with regards to advanced technical questions, ask the manufacturer!

Avoid being overly focused on price!

- Eventually, the decision of whether to proceed involves price and affordability.
- However, there is a difference between the initial purchase price and the true cost of ownership.
  - The questioning process is designed to uncover your needs, and what would provide the optimal solution.
  - Once you fully identify the problems and how the new product is going to help, it's easier to understand the costs.
  - Once you have clarified the tradeoff between benefits and costs is when to widen or restrict choices as a function of price.

Identify "cost of ownership" issues

- Are you spending a fortune keeping your current equipment in service?
- Are you being charged a monthly fee for reports and factory support?
- Do you trust your gas detectors?
- Do you have many sensor failures?
  - If so, what kinds of sensors are failing?
- Do you have battery problems?
  - Do the instruments run long enough on a single charge or set of batteries?
- How often do you test and calibrate your instruments?
  - Do you do it yourself or use a service?
- Are there any special conditions or contaminants that are causing problems?
- <u>Do you feel you are currently getting a good deal?</u>

Do you have plans to update, replace or change the equipment you are currently using?

- If you have relationships with gas detection manufacturers and distributors you trust, get them involved!
  - Distributors generally have more than one manufacturer option.
  - Gas detection manufacturers are happy to discuss issues directly with end-user customers.
  - The Internet and social media are terrific tools for finding out what's new, and what customers have to say.
  - You have multiple sources of information!
- Gas detection decisions are often made by a group of individuals who have different roles in the decision process, including process or facilities management, safety, hygiene, purchasing, and (often) union representatives.
  - Make sure you don't leave anyone out!
  - The same issue often looks considerably different to a manager with different responsibilities.

Who is currently looking after your instruments?

- Do you do it yourself, use a third-party service, or work directly with the factory?
- If you like the equipment you are currently using, and want to keep it in service, you might want to talk about maintenance agreements or refurbishment programs.
- Ask your local distributor whether they offer calibration or repair services.
- Ask your current manufacturer whether they have factory maintenance programs, or a loaner or replacement instrument policy.
- You should expect excellent after the sale support!

In terms of units sold, personal protection is the largest gas detection segment

- For personal protection instruments do you mostly use:
  - Single gas H_2S?
  - 4 gas meters?
  - Other single gas meters?
  - H_2S is still the most common single gas instrument, with CO a distant second, but don't overlook other toxic gases that may be present at a particular site.
- Some of the other most-commonly used personal single gas instruments include:
  - NO_2
  - SO_2
  - Ozone
  - PID
  - As well as many others!

What sensor configurations do you currently use for confined space entry?

- Do you have the right configuration, or are you thinking about a change?
- How many / what kinds of sensors are installed in your instruments?
  - Traditional 4 gas (LEL / O_2 / CO / H_2S)?
  - 5 gas with PID?
  - Some other sensor configuration?
- What type of sensor are you using (or interested in using) for LEL?
  - Traditional CC LEL?
  - IR LEL?
  - MPS?
- Does the type of LEL sensor require changes in use or types of the other installed sensors?
  - Do you use different multi-sensor instruments for different activities or types of CS entry?
  - Confined spaces that contain VOC vapors?
  - CS entry into inerted vessels?

Multi-gas portable instrument considerations

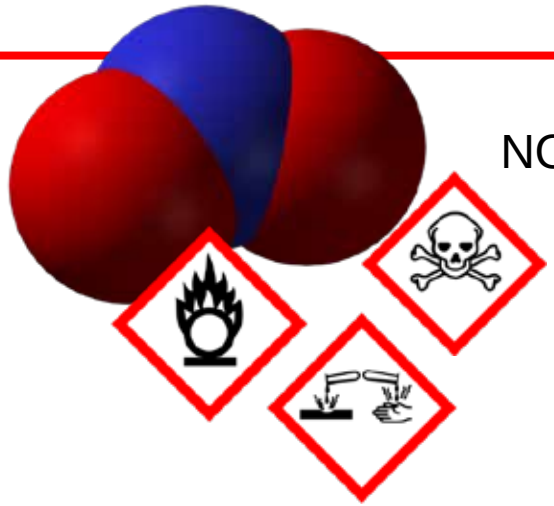
- Do you have other gases of concern beyond the basic four most common atmospheric hazards (O_2, LEL, CO and H_2S)?
  - SO_2?
  - VOCs?
  - Benzene?
  - Hydrogen?
  - CO_2?
  - NO_2?
  - Other gases?

Even more multi-gas questions

- Do you have alcohol, heavy fuels or VOCs on site?
  - VOC vapors are potentially explosive, but toxic at much lower concentrations.
  - Especially true for VOCs like benzene, hexane, toluene and xylenes.
  - Consider including a PID sensor in multi-gas instruments used for fuel spills and other situations that involve VOC vapor.
- Do you encounter VOCs during confined space entry?
  - If so, your CS instruments should have PID sensor as well.

Does your instrument have the correct capabilities to accomplish what you need to do?

- Consider NO_2
  - What exposure limits do you follow?
    - US OSHA PEL: Ceiling = 5 ppm
    - US NIOSH REL: 15 min. STEL = 1 ppm
    - ACGIH TLV (since 2012): 8 hr. TWA = 0.2 ppm
  - If you follow the OSHA PEL 0.1 ppm resolution is fine, if you follow the TLV you need much better resolution (0.02 ppm would be advisable).
  - Are you required to report exposure history?
    - Does the instrument have datalogging?
    - How much information can the instrument retain?
    - How easy is it to download?
    - Do you depend on (or would you prefer) a third-party service?

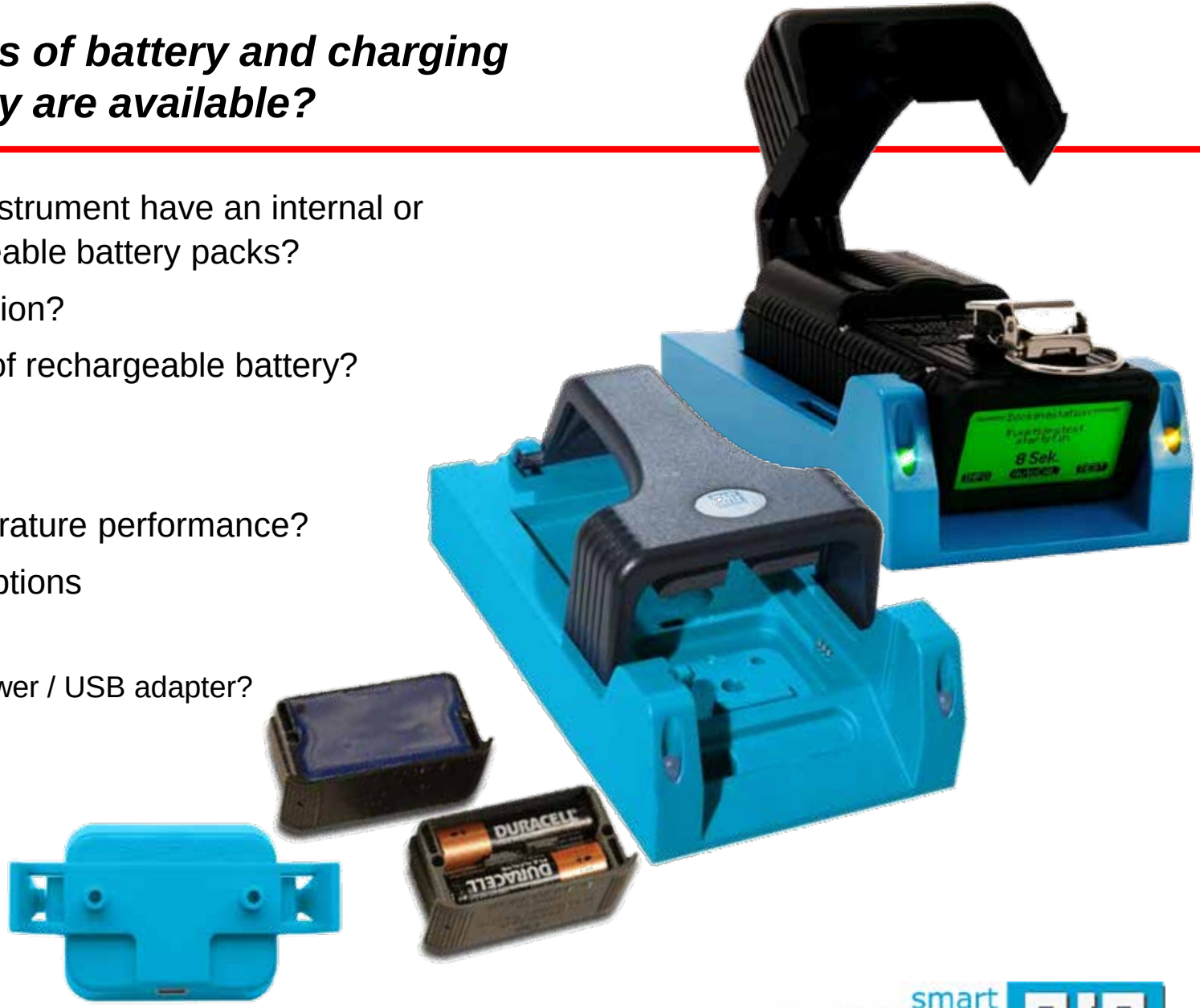


How do you sample the atmosphere from within the confined space?

- Is the instrument a diffusion only design?
- Does the instrument have an attachable sample pump?
- Does the instrument have a built-in pump?
- Does the instrument have the option of switching from diffusion to sampling by means of the built-in pump?

What types of battery and charging technology are available?

- Does the instrument have an internal or interchangeable battery packs?
- Alkaline option?
- What type of rechargeable battery?
  - Li Ion?
  - NiMH?
- Cold temperature performance?
- Charging options
  - Cradle?
  - Wall power / USB adapter?



What about periodic testing and calibration?

- How often do you perform a bump test?
  - Before each day's use?
  - Do you keep bump test kits (with gas) with the instruments?
  - How do you prove your instruments have been bumped?
  - What do you do if you fail a bump test?
- How often do you perform a full calibration?
  - Do you use a docking station for bump tests and calibrations?
  - How do you prove your instruments are properly maintained and calibrated?
  - How do you retain maintenance and calibration records?
- Is your current strategy working?
  - Is it easy?

Are your gas detectors wirelessly enabled (or are you considering this option)?

- Most manufacturers now offer a “wireless” communication option.
  - Each manufacturer has its own strategy, with its own benefits and limitations.
  - Make sure you understand the wireless options and competitive benefits!
- Common communication methods:
  - Blue Tooth
  - Cellular
  - ISM RF
- Do you intend to use wireless communication during CS entry?
  - How do you get the information out of the space?

Have you addressed "third-party" issues?

- Do you intend to use a remote call center service to coordinate emergency response?
- Do you intend to use a third-party rescue service (such as a corporate emergency response team, or the local fire department)?
- How will you coordinate real-time emergency information with all involved parties?

What about after the sale support?

- Satisfaction is a function of ongoing support.
  - Atmospheric monitors and systems are life critical safety equipment.
  - Customers should expect excellent after the sale support.
- Don’t forget to consider:
  - Warranty
    - Sensors
    - Instrument
- Technical support
  - Is your vendor there to provide help?
- Training
  - Videos?
  - In person?
  - Internet resources?

Questions?

Thank you!

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