



YOUR GUIDE TO GAS SAFETY IN MINING

White Paper



WE KNOW WHAT'S AT STAKE.

YOUR GUIDE TO GAS SAFETY IN MINING

Despite the intense focus on safety in mining, the industry still faces challenges in keeping up with the changing nature of operations and processing technologies and consequently how these new methods interface with the workforce.

It is well recognised that workers in the mining industry are exposed to extreme mental and physical challenges in what can be particularly harsh environments. This exposure to unique health and safety hazards requires robust safety management systems and processes, reinforced by a robust regulatory environment. Ultimately the evolving management of safety and environmental issues are not only about compliance, nor should they negatively impact operations, but should be about a sustainable approach to achieving best practice and meeting the continuous improvement goals of the organisation towards creating the safest workplace possible.

These challenges extend to safety manufacturers where R&D departments continuously work towards developing new equipment and engineering to best manage the new safety paradigms. A prime example is where new gas monitoring and tracking technologies are emerging to help improve operational efficiency and increase employees' safety.

Mining Industry the Worker Safety Scenario



350
Operating Mines

260.000
Workers

Based on current statistics, Australia has over 350 operating mines (1) and employs more than 260K people, which accounts approximately for 2% of the total Australian workforce. (3). With such a long history in the region, mining's prominence and economic influence makes it very high-profile industry when referring to safety management best practice.

It is not just the changing nature of mining process that presents challenges to managing the safety of the workforce. The cyclical nature of the mining industry combined with pressure from external forces on mining operations has been felt many times over the last decade, and the consequential effects on safety management has meant a more progressive and innovative approach has been required.

Some examples of these external factors include:

- *Volatile Commodity Prices*
- *Economic downturns*
- *Productivity pressure*
- *Budget Constraints*
- *Environment impact concerns*
- *Lack of experienced workforce*
- *Community expectation*

Those challenges have put increased pressure on mining companies in Australia to provide operational efficiencies from both a production and processing perspective, alongside the resultant increased strain on safety and human resources. There are incidents in the region resulting in fatalities that cannot be directly attributed to this efficiency shift, but the nature of the incidents certainly contributes to the drive to search for new and more effective safety management tools.

The Worker Safety Scenario

Certainly, one of the main ongoing difficulties that the industry faces is that of the Health and Safety. Some of the more recent statistics support this statement and highlight that there are definitive improvements, but certainly scope to introduce further improvements:

Mining Industry Rate of fatalities in 2018

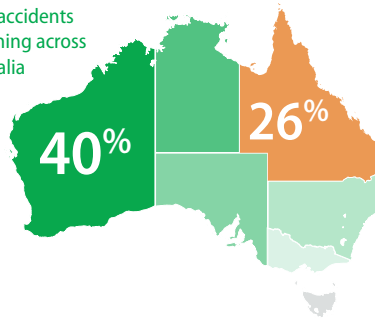


3rd Highest

per 100,000 workers

5th in workers fatalities
vs all industry groups across Australia

Fatal accidents
in mining across
Australia



Official Government statistics show that in 2018 mining was rated the 3rd highest industry for the rate of fatalities per 100 thousand workers (6), ranked fifth in worker fatalities vs all industry groups across Australia (5) with Western Australia being responsible for 40% of fatal accidents in mining followed by Queensland accounting for 26%. (7)

2019 - 2020



429

Lost Time Injuries



10,568

Rostered Days Lost

13,126

Rostered Days of Restricted Work

The number of serious LWT injuries are equally concerning. Over the 2019-20 period in Western Australia alone there were 429 Lost Time Injuries resulting in a total of 10,568 rostered days lost and a further 13,126 rostered days of restricted work. (8)

Based on a recent Safe Work Australia report, the number of fatalities occurring in the Australian mining sector fell considerably in 2020, but the ongoing management of health and safety in mining still faces ongoing and new challenges.

Management of Health and Safety in Mining is challenging.

Mining is an inherently high-risk activity that involves hazards such as:

- Interaction between people and plant/large mobile machines
 - Light and heavy vehicle interactions
 - The presence of dangerous gases.
- Confined space and working at height hazards
 - The risk of geotechnical failures (10)
- Operation remoteness and environmental/weather factors

The myriad of hazards present in mining are not the only challenges faced by safety professionals, managers and workers.



INEXPERIENCED WORKFORCE

With the drive for greater cost efficiencies, the number of temporary and contract workers employed in mining has increased significantly over recent years; in some instances, accounting for 60% of the workforce. Working in a mine is not a trivial job. With so many hazards endemic to a mining operation, a less experienced workforce would be more prone to unsafe behaviors, be unfamiliar with specific site risks and hazards, and influenced less by a positive safety culture instituted by the mining company.



THE AVAILABILITY OF SKILLED WORKERS IS DECREASING

With fewer young graduates entering the industry, this is forcing a diversification in recruitment strategies and campaigns encouraging newcomers by highlighting mining's focus on emerging technologies and digital transformation. (17)



DECENTRALISED INDUSTRY AND GOVERNMENT SAFETY ADMINISTRATION

Work Health and Safety (WHS) in the mining industry has always been decentralised in Australia, meaning that it is regulated by the States and each jurisdiction has a different legislative framework. Despite their being an overarching Federal Workplace Health and Safety Act, the fragmentation inflicted by State based Mining Regulations can be another challenge to teams in charge of safety, who have adapted to and follow to different regulations and compliance standards depending on the region.



Why Gas Safety in Mining?

Mines present a high risk of exposure to a range of toxic gases that lead to irrespirable and explosive atmospheres. This potential is well recognised in the industry, and there are considerable resources allocated to managing this risk. An atmosphere is considered to be irrespirable under conditions where there is an immediate threat to life or the potential for adverse health effects.

The toxic gas list for mining includes: (11, 14, 15)



FLAMMABLE GASES

Methane (CH₄), carbon monoxide (CO), hydrogen (H₂)

These gases pose many risks, including:



DANGER OF ASPHYXIATION DUE TO OXYGEN DEFICIENCY



POISONING BY NOXIOUS GASES



SUFFOCATING GASES

Carbon dioxide (CO₂), nitrogen (N₂), methane (CH₄)



EXPLOSION BY INADVERTENT IGNITION OF THE RESULTANT EXPLOSIVE MIXTURES



INJURY RESULTING FROM THE VIOLENT EJECTION OF COAL AND GAS



TOXIC GASES

CO, nitrogen (N) oxides, hydrogen sulphide (H₂S)



Getting to know the gases

Where they come from, the risks they impose and how to protect workers from them (15,16) is critical for a solid risk assessment and workplace safety.

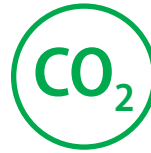


Methane

Methane is generated in a mine as a result of rotting of organic materials under high temperatures and pressure underground.



- Found in varying levels in most coal and shale deposits.
- Since it is lighter than air, it rises up displacing oxygen.
- Oxygen deficiency causes headaches, nausea, dizziness and is likely to result in death when the oxygen concentration falls below 6%.
- Methane gas is not toxic, but as a flammable gas it poses a high risk of explosion and fire at increased concentrations.

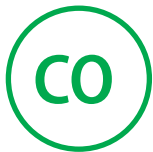


Carbon dioxide

53% higher density than that of dry air but at significantly-high concentrations has a sharp, acidic odour.



- Produced by all aerobic organisms when they metabolise organic compounds to produce energy. It is also produced by the decay and combustion of organic materials and the combustion of fossil fuels.
- The symptoms and consequences of inhalation vary accordingly to the concentration of the gas. It goes from difficulties to breath and headache through to suffocation with a risk death.



Carbon Monoxide

Gas with density relative to normal air of 0.97.



- It is formed during the incomplete combustion of any carbonaceous material, being an important component of the smoke emerging in the air. Always present in proximity to coal fires.
- Due to its general association with heat it is usually found in spaces tending toward roof level
- Carbon monoxide is recognised to be the most dangerous toxic gas found in coal mining. It poisons the body by being absorbed into the bloodstream faster than Oxygen, preventing the blood from taking up and transporting the necessary oxygen to the various cells and organs.
- Carbon monoxide poisoning is cumulative and acute carbon monoxide poisoning is a reversible process. Carbon monoxide is both flammable and explosive.



Hydrogen sulphide

Colourless, flammable, corrosive and extremely dangerous with sweet taste and pungent "rotten-egg" odour. It has density of 1.19 relative to normal air ventilated areas



- Produced by the decay of organic materials in the absence of oxygen gas and is a naturally occurring in seam gas in some coal and shale deposits. Because of its density, will tend to pool and stagnate in wells.
- Hydrogen sulphide is a highly toxic gas that irritates the mucous membranes and eyes and has narcotic effect on the nervous system.
- Massive acute exposures levels produce anoxia (absence of oxygen in arterial blood and tissues) resulting in death
- It forms flammable mixtures in air in the range of approximately 4.5 - 45%. At these concentrations there are significant risks to human life.



Nitrogen dioxide

In its physical state it appears as a reddish brown gas or yellow/ brown liquid with a pungent, acrid odour. With density relative to air of 1.6.



- Nitrogen dioxide is produced as a component of diesel equipment exhaust or as a result of the detonation or burning of explosive. Usually found in working areas immediately after shot firing.
- Nitrogen dioxide is extremely poisonous gas even in small concentration. It is highly irritating to the respiratory system.
- Concentrations of up to 200ppm are dangerous to life and health if breathed only for a few minutes.
- It is non-flammable and incombustible, but it will react violently with combustible materials. Produces Nitric acid when exposed to water.



Nitric Oxide

Appears as a colourless and odourless gas, the vapours of which are heavier than air.



- Nitric Oxide is generated as a result of the application of blasting explosives in the field. This process also produces NO2 and CO.
- Nitric oxide is a skin, eye and mucous membrane irritant, though it's most hazardous effects of nitric oxide are to the lungs. Inhalation causes symptoms of coughing and shortness of breath, along with a burning in the throat and chest. Patients may experience nausea and fatigue.
- Although the gas itself is non- flammable, it will accelerate combustion and increase the risk of fire and explosion in combustible and flammable materials.



Sulphur Dioxide

Sulphur dioxide is a colourless gas with a strong pungent odour that can be detected when the concentration reaches approximately 3ppm.



- Sulphur dioxide is produced by the combustion of sulphur compounds and is usually found in the vicinity of heating in coal containing sulphur.
- Sulphur dioxide is highly irritating to the mucous membranes of the eye and respiratory tract. In low concentrations the gas produces tearing, sneezing and coughing.
- Sulphur dioxide is extremely poisonous but poisoning rarely occurs because it is intolerable to breath for any length of time at high concentrations. Concentrations greater than 500ppm are dangerous to life and health after short exposures.
- Sulphur dioxide is non-flammable and incombustible.



Hydrogen Cyanide

HCN is a rapidly acting colourless gas. It is sometimes described as having a "bitter almond" smell but does not always give off an odour. Even then, the ability to detect the odour is genetically determined and cannot be smelt by everyone.



- Cyanide leaching is the predominant process of gold extraction in large scale mining. During this process hydrogen cyanide volatilised imposing risks for workers.
- Cyanide is a fast acting poison, causing severe breathing difficulties which develop very rapidly when cyanide is swallowed, inhaled or absorbed through the skin. Cyanide poisoning can be classed as short term (acute) or long term (chronic) and the symptoms and health effects are independent of the route of exposure.
- Cyanide gas is highly flammable and reacts violently in some situations generating high risk of explosion if exposed to heat or flames.



Anhydrous Ammonia

A colourless, highly irritating gas with a pungent, suffocating odour. "Anhydrous" refers to the Ammonia being in gas form (not dissolved in water).



- The use of hard coal exploitation technology in hazardous conditions with a high risk of spontaneous fire requires the selection of appropriate preventive measures. The most effective method for spontaneous fire risk prevention is the application of a fly ash and process water mixture. This method, though, causes the release of ammonia.
- Anhydrous Ammonia is a toxic gas. Exposure to 300 ppm is immediately dangerous to life and health, with effects starting with lung irritation through to severe respiratory damage with possible fatality at higher concentrations. Anhydrous Ammonia is also corrosive to the skin, eyes and lungs.
- Anhydrous ammonia is flammable.



Although gas exposure is a risk across the mining industry, some types of mining present a greater risk of gas hazards.

A key example is coal mining whereby the metamorphic conversion of plant materials to coal creates methane, carbon dioxide, and other gases, thus making coal both a source and a reservoir for these gases. Sudden releases of coal gas have been experienced in underground coal mines in many countries, including Australia.

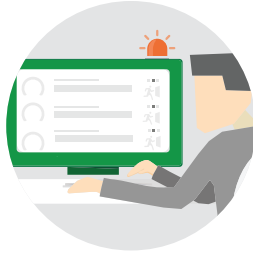
In Queensland particularly, underground coal operations are become deeper and as longwall production rates increase, the risk of methane in underground areas of the mine are becoming greater.

As part of the risk management process, the following measures are strongly recommended in building controls around gas hazards:

1. **Awareness:** Make sure that workers are aware of and understand the risks.
2. **Detection Equipment:** Personal Gas Monitors are the most common method used and is the recommended means of managing gas exposure.

For the most effective use of Gas Detection equipment there are four key areas that should be addressed:

- a. Identify the risk areas where the devices must be used.
- b. Have the right detector (with the right sensors), depending on the risks profile.
- c. Have devices calibrated and working properly.
- d. Have workers trained to use the devices properly

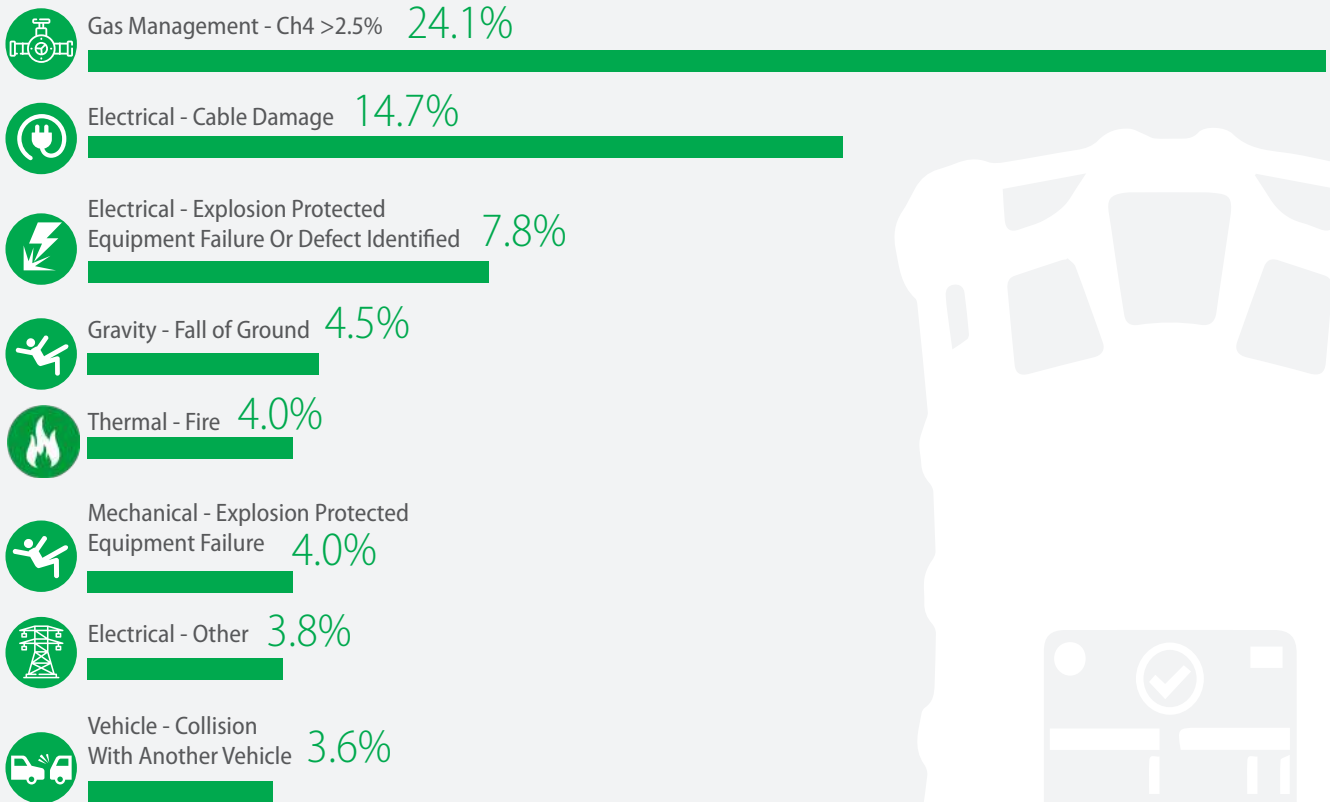


Your trustworthy Solution for gas safety in mining

Gas safety management is an important part of a mine site health and safety program.

As a prime example, when looking at regional statistics from 2017-20 for Underground Coal Mining in Queensland, Gas Management represents 23% of the hazards for under the High Potential Incidents index. Whilst in Western Australia, effects of chemicals or fumes are the second highest ranking "nature of injury", being responsible for 16% of recordable injuries based on a 2020 Department of Mines, Industry Regulation and Safety report. (8)

Top 8 HPI Hazard Types - UG Coal (Oct'19 to Sept'20)





Implementing a gas detection solution that can be trusted and a gas detection program that goes beyond compliance is necessary to have the peace of mind that workers and worksites are safeguarded. When developing gas safety programs and determining an equipment solution there are some points that must be considered.



ADVANCED TECHNOLOGY

The main job of gas detectors is to help keep workers and worksites safe. The faster a sensor responds, the safer the workers and worksite will be. Sensors should be able to accurately detect the presence of multiple gases simultaneously and within seconds do make a difference. Detectors should also be able to notify safety teams when they need to be replaced to prevent a lapse in protection and minimise downtime.



ROBUSTNESS AND RUGGEDNESS

Gas Detectors need to be trusted to work effectively even in the toughest conditions. That's why a detector's Ingress Protection (IP) rating matters. Detectors should have a long sensor life and be built to last.



DURABILITY

Look for equipment that has passed a 3 metre drop test and has an IP rating of IP68 for spray, dust and submersion. These tests are a great indication of durability, which has a direct impact on the total cost of ownership — an aspect that can't be ignored when it comes to budgeting.



LONG BATTERY LIFE

Battery capacity is key to a device's ability to be on duty for long hours without charging. The longer the field life of the battery, the less maintenance and attention is needed from the safety department, so you spend more time monitoring and less time and money maintaining.



FAST, EFFECTIVE MAINTENANCE

Automated test systems calibrate and bump-test gas detectors automatically. A test stand should be able to select a gas cylinder automatically and help you save gas volume.



SURFACE, UNDERGROUND AND QUARRIES

Whether used in surface or underground mining, the ideal product is designed to withstand the unique challenges of each environment and activity whilst maintaining compliance with local Standards and approvals.



SUBSTANTIAL WARRANTY

Gas detector suppliers that offer strong warranties stand behind their customer service and technical support. Substantial instrument and sensor warranties are a great indication of product quality and durability.



SOFTWARE AS A SERVICE

Software as a service consolidates all information from portables in one place. It should bring data from devices together in a user-friendly format so safety professionals can make the most of it. One of the most important benefits of software as a service is to allow safety managers to take a proactive approach to their portables by knowing in advance which devices need maintenance.



SEAMLESS CONNECTIVITY

Your solution should alert you at the detector and remotely via computer or mobile device, simplifying system setup and connectivity. The latest gas detectors can share information, including any alarms triggered. This offers an unparalleled opportunity to gather and analyse data to streamline processes and improve safety.



PERFORMANCE YOU CAN TRUST

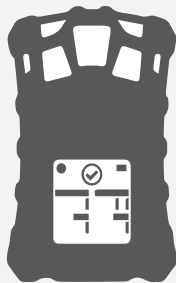
You should not only look for durable gas detectors that feature the latest and greatest technology, seamless connectivity and ease of use, but also partner with a manufacturer that can back up its offerings with an excellent track record of safety and support.



You want to find the right partner that will help you through this journey.

MSA is a market leader in gas detection with over 100 years of technical expertise in worker and worksite safety. MSA has been providing the market with gas detection solutions that make a significant, positive impact on safety programs, enabled by advances in unique, innovative technologies which add an additional layer of performance and protection. MSA has developed a suite of portable gas detection products which have been proven in the field over many years, thus providing a monitoring solution that you can trust.

MSA ALTAIR® DETECTOR



**RUGGED, RELIABLE
XCELL FAST-RESPONDING SENSORS**

SAFETY IO GRID SERVICES



**TRANSLATE DATA INTO TANGIBLE
INSIGHTS TO PLAN AHEAD**



**YOUR COMPLETE, TRUSTWORTHY GAS
DETECTION SOLUTION.**





Fleet Compliance and Transparency

Portable gas detectors help to protect workers and worksites from invisible dangers. However, managing gas detectors are critical, even when maintaining compliance across the fleet is a constant challenge. For effective use gas detectors require regular calibration, administration, record keeping, and more.

A study run by MSA Safety highlights some of the main “pains” when it comes to portable device management:



COMPLIANCE

Are my gas detectors compliant?
How do I know/confirm that they are compliant at any given time?
How do I monitor compliance?
Identifying GAPS in compliance – Detector fleet transparency



INCIDENT REPORTING

Time consuming process
collation of data and report formatting
Verifying accuracy of information
calibration and bump testing reports



STATISTICAL EVENT RECORDING

Statistical data mapping e.g. frequency of LEL alarms over specific period?
Locating, mapping and verifying trouble areas.



DOWNTIME

Fleet Management –out of service devices and fault mapping to understand systemic and environmental factors contributing to common issues
Preventative maintenance (Pre-empting breakdown)
Calibration Gas – expiration and inventory control.



SERVICE PROVIDER RELATIONSHIPS

Reliance on Service providers to maintain operational readiness.
Fleet health transparency – data ownership, tracking maintenance, service and repairs.
Process improvement – streamlining of fleet management processes

Safety teams can spend hours overseeing programs at different plants, including the writing of incident reports and manual record keeping of use and maintenance. Allowing teams in charge of safety to simultaneously navigate these multiple factors is paramount, so by providing them with innovative solutions, mining companies can enable their safety teams to lead improved safety outcomes. This is exactly when connectivity comes into play. Connectivity and cloud solutions streamline operational use and collate all information in one convenient and accessible location.

Using a central web-based location provides users with a single truth source whilst supporting proactive oversight and increasing worker productivity. Furthermore, an updated gas detector safety program ensures continued compliance with safety policies and Government Regulations.

Gas detection software services can help to reduce costs and create easy-to-understand reports. Safety managers rely on the Safety io Grid Fleet Manager and Grid Live Monitor for a variety of reasons, including:



DEVICE ALERT AWARENESS AND CONTROL

Get a real-time understanding of gas exposures and instrument readings while live monitoring employee location and movement with satellite and street views. You can also receive online alerts about man-down alarms, device concerns and panic button presses.



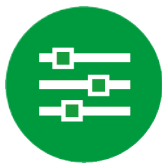
COMPREHENSIVE FIELD DEVICE MANAGER

From employee contact details to battery, compliance and sensor life alerts, the Grid Live Manager puts all the data at your fingertips. Plus, you can access employee contact details and current detector readings.



INFORMATION ACCESS:

Along with a daily e-mail about your fleet's status, you can access fleet information from anywhere with an internet connection. Easily share calibrations, detector records or alarm reports by downloading and sharing them at any time.



FLEET COMPLIANCE

Use your Grid Fleet Manager to determine what equipment is in use, who is using it, and which ones are available. You can also reduce downtime by decommissioning equipment requiring maintenance and ensure all gas detectors are bump tested, calibrated and that its sensors are functioning properly.



RISK ASSESSMENT

Identify hazards, understand root causes and drive accountability using Grid Fleet Manager. Having this information helps you create safer processes and find training opportunities based on equipment usage information.



ENSURING PROPER EQUIPMENT USE

Label devices to specific workers or departments and gain valuable insight into worker behaviours. Understand if workers are acknowledging alarms according to best practices or simply turning the devices off. Identify which users went to work without bump testing the instruments.

When it comes to gas safety in mining there are four main pillars you should consider:



AUTOMATED COMPLIANCE MANAGEMENT

The process of inspecting gas detection devices, calibrating them and bump testing is time-consuming and complex. By adding smart technologies, you can automate the compliance process and free up time to focus on higher-level objectives. Placing all information about your gas detectors in one spot in the cloud provides a broad overview of gas detector compliance data.



INCIDENT PREVENTION AND MANAGEMENT RESPONSE

The ultimate goal is to prevent every incident, but to best manage the risk you need to be able to access and analyse the data. Real-time connection to gas detectors provides more effective incident reporting and increased worksite visibility, making for a more thorough incident investigation and action plan to mitigate further risk. Using a comprehensive field device management system for current detector readings and alarm notifications to take action quickly.



WORKER HEALTH AND PRODUCTIVITY

Connected worker safety means figuring out how technologies, like connected gas detectors, can protect teams and safely boost productivity rates. Develop insights into worker safety by reviewing how and when devices are used. Use this information to identify training opportunities.



ACTIVE SAFETY MONITORING

By giving safety managers access to data from anywhere with an internet connection, they can stay on top of safety activities without walking through the facility daily. From afar, safety managers can see employees' locations using street and satellite views while getting real-time notifications of gas exposures and instrument readings.

Gas detection plays a big role in your workers' and worksites' safety. A great way to improve your safety program is by getting your gas detectors to do more for you. With trustworthy, industry-leading gas detectors, calibration stands and software as a service, companies can go beyond compliance and have peace of mind around their gas safety program.

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