WHITE PAPER

Safeguarding your team from the dangers of explosive gases

Being fully aware of the environment your team is working within, and safeguarding all involved from explosive gases, has never been more important. This paper will explore what constitutes an explosive atmosphere, the gases which come into this category, and the ways in which they can be measured and risk assessed.

Ensuring businesses, their personnel and customers are properly equipped, educated and protected from the dangers of explosive gases is Crowcon's mission, and we hope the following information raises awareness about the best ways to do this.

CROWCON
Detecting Gas Saving Lives

“It is important to note that not all gases are explosive... However, if they are present in any environment in high enough concentrations then they can reduce oxygen levels and cause injury or death.”

What are explosive gases?

A great place to start is to define the characteristics of flammable gases and explore which gases are explosive. It is important to note that not all gases are explosive. Gases such as argon, helium, neon and nitrogen are inert and do not burn or explode as they are non-reactive to many materials. However, if they are present in any environment in high enough concentrations then they can reduce oxygen levels and cause injury or death.

Explosive gases are formed when flammable liquids reach the ‘flash point’ temperature, in which vapour is given off at a sufficient rate to form an explosive mixture with air. Liquids with flash points below normal ambient temperatures automatically release vapour in sufficient volume to provide an explosive mixture. Therefore any leakage of such liquids is potentially as dangerous as a flammable gas leak.

Fuels like Diesel or Jet Fuels have quite high flash points, at >30oC, and so vapour accumulations can only be detected when ambient temperatures exceed this level.

When the gas or vapour and air has developed to form an explosive mixture of gas or vapour, it can be ignited via a spark of energy or simply by being at a sufficiently high temperature. The lowest temperature which will cause a mixture to burn or explode is called the ignition temperature (sometimes referred to as auto-ignition temperature).

Knowing the molecular weight of a substance allows professionals to decide whether a gas or vapour will accumulate at high or low level upon release, and therefore fully comprehend the risks involved. Knowing these details also enables conversion from the mass concentration (mg/m3) to volumetric measures (ppm).

In practice, the molecular weight of a compound is the sum of the atomic weights of the species as given in the molecular formula. In practice the terms, molecular mass, molecular weight, formula mass and formula weight are used interchangeably by chemists.

Another important characteristic to understand that can contribute to the risks in explosive atmospheres is the density and vapour pressure. Vapour density, or relative density, is a measure of the density of a gas or vapour relative to air. It is calculated by dividing the Molecular Weight of the gas by that of air (28.80).

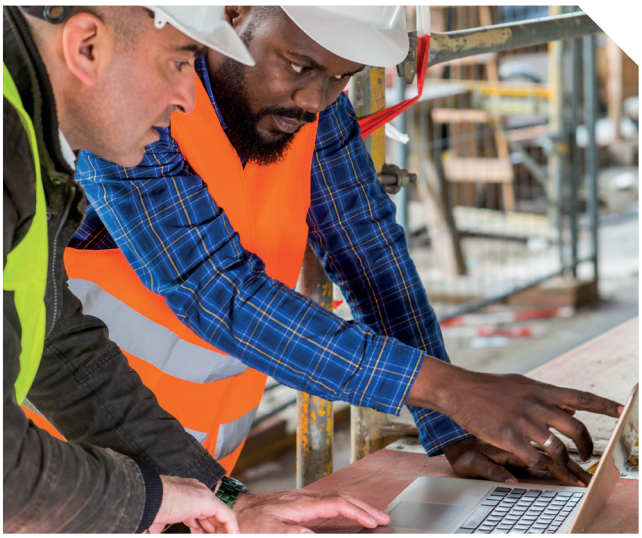
Gases or vapours with a vapour density of less than one are lighter than air and they tend to rise from the point of escape and can be readily dispersed. Gases or vapours with a vapour density of greater than one are heavier than air and tend to sink to lower levels. Heavy gases can remain trapped for a long time in ducts and inspection pits ready to explode as soon as a source of ignition is introduced.

By measuring and fully understanding the vapour pressure of the substance within an environment it is possible to calculate whether sufficient vapour may be emitted to create an explosion hazard in which the substance is used.

"The Health and Safety Executive speaks at length about the dangers of fire and explosion from dangerous substances on their website."

The risk of explosive gases

The risks posed by explosive gases are wide-ranging. The Health and Safety Executive speaks at length about the dangers of fire and explosion from dangerous substances on their website. They detail how each year individuals are injured by accidental fires or explosions due to flammable materials and warn those working in environments in which chemicals, vapours, liquids, gases, solids or dusts are used or created, of these hazards.



It is not just the initial explosion and injuries, or possibly fatalities, from the incident that workplaces have to be aware of. The knock on effect from these traumatic events also can include significant and costly damage to property and the environment, as well as to the business community. This then impacts the capacity to staff and risk assess other explosive environments that require ongoing measurement and presence.

As most fires are preventable, if teams are properly educated and equipped, there has never been a better time for line managers to reassess their workplace health and safety processes and to ensure each worker, as well as the business as a whole, remains accountable and responsible.

What are LEL's and how do they keep people and working areas safe?

The LEL, or lower explosive limit, is of paramount importance in terms of explosive atmospheres and flammable gases, because it measures the lowest concentration of a gas or vapour that could cause a high risk of explosion. The LEL is the lowest concentration of a gas or vapour that will burn in air and although it varies from gas to gas, it tends to be less than 5% by volume for most flammable gases.

As we know, three things must be present for an explosion to occur. These are combustible gas to act as the fuel, air, and a source of ignition. An explosion also relies on the fuel being present at the right concentration.

Measuring the lower explosive limit using gas detection systems and portable monitors safeguards individuals and working areas through the use of alarms and alerts, which go off before gases reach critical and explosive levels. By detecting flammable gas before it reaches an explosive concentration those in industrial sectors can ensure all on site remain safe and out of danger.

Specific thresholds vary according to the application, but the first alarm is typically set at 20% LEL and further alarms are commonly set to 40% LEL.

LEL levels are defined in the following standards: ISO10156 (also referenced in EN50054, which has since been superseded) and IEC60079. Many LELs are slightly different in the two standards, because the 'original' ISO standard lists LELs obtained when the gas is in a static state, while the LELs listed in the EN and IEC standards were obtained with a stirred gas mixture; this resulted in lower LELs in some cases (i.e. some gases proved to be more flammable when in motion). In the case of methane, for example, IEC60079 sets 100% LEL at 4.4% by volume, whereas the ISO standard sets it at 5%.

UEL (upper exposure limit)

As well as the lower explosive limit (LEL), below which the gas and air mixture is too lean to burn, there is also an Upper Explosive Limit (UEL), above which it will not be able to burn as the mixture is too rich.

The range between the LEL and UEL is referred to as the explosive range. Within this explosive range, a gas or vapour will readily ignite. Using gas detection equipment to continually monitor and measure both the LEL and the UEL is important because it gives teams parameters to understand the safe levels of gas in their environment, and most importantly to take action if the ratios lie within these defined margins.

If anything is detected near or within that range, the personnel on site will be able to take the right action to prevent damage.

“Certifications and standards are incredibly important to safeguard against one of the most significant concerns in industrial workplaces – the potential risk of fire and explosion.”

Equipment safety approvals, standards and certifications

Any equipment used in hazardous areas, or spaces in which there is the possibility of the presence of an explosive mixture of flammable gas, vapour, or dust and air, must be properly tested and certified. This is so that when in use, even under a fault condition, it cannot initiate an explosion.

All equipment produced by Crowcon meets European, American and other international Standards and Directives for electrical equipment used in hazardous areas.

The CENELEC standard is officially recognised by the European Organisation in its field, the European Commission through Directive 83/189 EEC. CENELEC uses International Electrotechnical Commission standards as a reference and ensures harmony across all European Community countries.

Certifications and standards are incredibly important to safeguard against one of the most significant concerns in industrial workplaces - the potential risk of fire and explosion. Alongside the ATEX Directive (discussed further below) there is the International Electrotechnical Commission for Explosive Atmospheres (IECEX), which is the certification that all electrical devices are required to go through by the International Electrotechnical Commission to ensure that they meet a minimum safety standard, that will determine whether they can be used in hazardous or explosive environments.

In the US, Underwriters Limited (UL) is a safety organisation that provides products that are to be sold into the marketplace with authentication that are safe for use. Similarly, the Canadian National Standards (CSA) provide products placed in the market, or put into service with a safety certification, displaying that they are fit for use.

However, The Safety Integrity Level (SIL) is the level of risk-reduction provided by a safety function, or to specify a target level of risk reduction. The certificates provided by both ATEX and SIL are what operators rely on in order to prevent fires and explosions but also to keep all those in industrial workplaces safe.

The logos located on equipment identify who or what association has tested and assessed the equipment, ensuring its safety based on set standards. Many associations will certify equipment as being explosion proof, clarifying that any ignition will be contained within the device and will not pose a threat to the outside environment. This action is intrinsically safe, thereby stopping the device from creating a spark that may lead to an explosion in a hazardous environment.

Although it is hard to identify all classification, to ensure that equipment has been certified safe, it is essential to look for familiar logos as a primary sign the equipment is safe and won’t pose a threat to the environment. Certificates allow for an easy visual for the operator to not only ensure that the devices work correctly but also protect all those in the hazardous environment it’s set to measure.

ATEX

The European ATEX Directive governs equipment for flammable atmospheres and details that equipment manufacturers and users comply with the EN61779 guidelines, which is the companion to IEC60079.

The standard's name is derived from Atmosphere Explosif and offers guidelines to control explosive atmospheres, as well as to govern the quality of the equipment and protective systems used within them. ATEX consists of Directives and is a continuance of CENELEC standards. It addresses issues that were not dealt with in the original EN standards, such as dust hazards. They were created in the hope that common standards across the continent should completely remove trade barriers within the community.

ATEX is based on the requirements of two European Directives. The first of which is the Directive 99/92/EC, and focuses on the requirements for improving the health and safety protection of workers potentially at risk from explosive atmospheres. The second is the Directive 2014/34/EU, which comprises an approximation of the laws of Members States concerning equipment and protective systems intended for use in potentially explosive atmospheres.

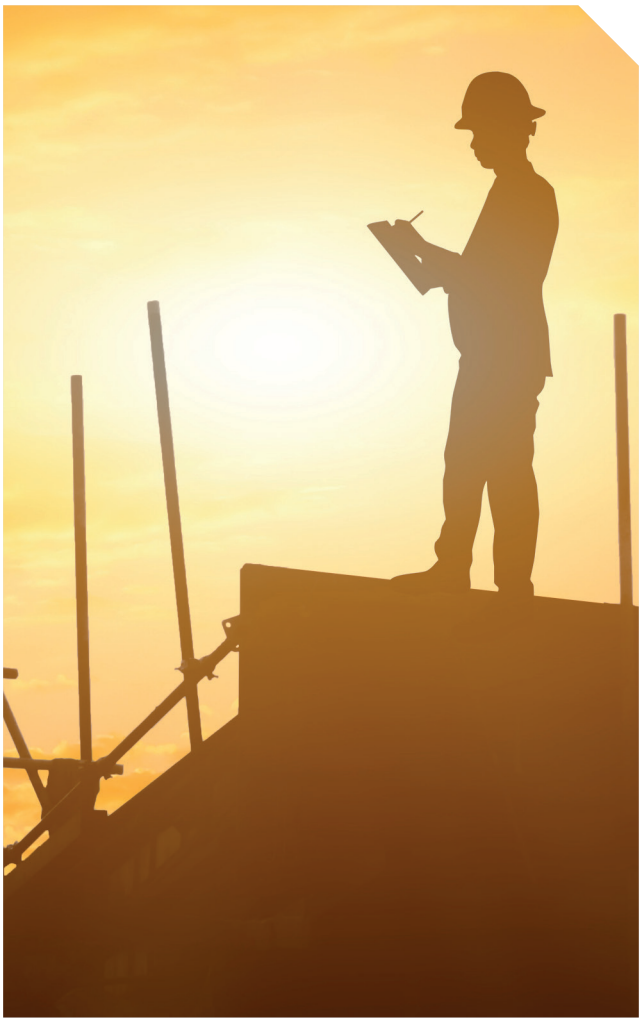
Directive 2014/34/EU divides the equipment and protective systems it covers into equipment groups and categories, providing a classification by the employer of the places where explosive atmospheres may occur in terms of Zones, as well as determining which equipment and protective systems groups and categories should be used in each Zone.

In line with ATEX stipulations, Crowcon applies the lower values of LEL in territories that adhere to European Standards. Since the ISO standard is still used in the US and some other markets, we continue to calibrate to ISO 10156 in these territories.

This means that all those utilising Crowcon products can be sure of their compliance and reliability, irrespective of their geographical location.

ATEX standards expect employers to eliminate or control the risks from dangerous substances. In line with these requirements, site operators must ensure that plant, equipment, protective systems and any associated connecting devices are only brought into service if the explosion protection document indicates that they can be safely used in an explosive atmosphere.

Within the directives, dangerous areas are classified in terms of zones of hazard. This is based upon the frequency and duration of the occurrence of an explosive atmosphere. Areas subject to flammable gas hazards are classified as either Zone 0, Zone 1 or Zone 2. Areas subject to flammable dust hazards are classified as either Zone 20, Zone 21 or Zone 22.



“Explosive atmospheres can be found in pharmaceutical, power generation, and food and wood processing sectors,”

Key industries and applications where explosive gas is present

The risk of explosion or fire is present in most industrial environments because the flammable gases or vapours means a mixture of compounds are likely to be encountered. For example, if we focus briefly on the petrochemical industry, here the raw materials used are a mixture of chemicals, which decompose naturally or are changed by the processes.

It isn’t just the petrochemical industry in which explosive gases pose a risk. Explosive atmospheres can be found in pharmaceutical, power generation, and food and wood processing sectors, to name a few. As there are many different substances that are flammable when mixed with air it is no surprise that a variety of industrial sectors will have risks from flammable gases somewhere in their process. As a result, companies in these sectors need to be aware of the explosive atmosphere their staff are working within, and fully equip their team to safeguard from explosions, injury or fatalities in the workplace.

In order to prevent explosions during shutdown and maintenance operations many industrial processes employ an inerting procedure. Here, for example, nitrogen may be used to purge a vessel of hydrocarbons before carrying out maintenance or repair work. Before entry by personnel, the vessel is then purged with air. As nitrogen is not flammable this cleanses the fuel tanker, for example, and safeguards the environment.

Products manufactured and designed to ensure safety

The ATEX Directive identifies two groups of equipment. Group 1 equipment is expected to be used in mining applications, and divided into categories M1 and M2. M1 identifies equipment that must continue to operate when a potentially explosive atmosphere is present, M2 identifies equipment that does not operate in this case.

Group 2 is intended for all other situations above ground and includes Surface Industries. It is similarly divided into categories 1, 2 and 3 for clarity. Category 1 equipment is intended for use in Zone 0 environments. Category 2 equipment is intended for use in Zone 1 environments. Category 3 equipment is intended for use in Zone 2 environments.

It is mandatory for manufacturers to obtain an EC Type Examination Certificate from a notified body if they are manufacturing electrical equipment in Categories 1 and 2 and M1 and M2.

It is important in equipment design that various protection techniques are employed to prevent explosions, and to adhere to the standards set internationally.

Another element of equipment design, to ensure safety, is that of temperature Classification. To ensure that there is no risk of ignition due to hot surfaces, equipment is classified with regard to the maximum surface temperature of any part of the equipment while in operation or due to a fault based on the ambient temperature of 40oC. Known as the “T” rating equipment must be selected with a suitable temperature classification such that it’s maximum surface temperature does not exceed the ignition temperature of the gases and vapours present where the equipment is to be installed.

Another grouping to detail and define which equipment can be used for which purpose, is that of gas and apparatus grouping and temperature rating. Gases are grouped together based on the amount of energy required to ignite the explosive mixture of gases with air. Equipment is classified into groups according to the gases and vapours for which it is suitable.

All Crowcon products provide you with reliable and robust equipment to excel safety standards and certifications.

Our sampling systems for gas safety are a reliable solution for detecting gas in extreme environments. These systems resolve bespoke, challenging gas detection requirements for companies worldwide. They can be tailored and custom built to meet individual businesses’ needs, no matter how complex these might be. They can be positioned away from the sample environment to ensure easy, safe access and can have several lines running from one system to allow for the monitoring of single or multiple gases, from various locations.

Theycan be installed and commissioned for you on site by our trusted partners and ongoing support, maintenance and servicing is provided by the specialist Crowcon sample systems team.

Engineered Fixed Systems, such as Xgard and Gas Pro Portables, are bespoke gas detection systems which are engineered to your needs. Due to their bespoke nature EFS solutions solve problems that lie beyond the scope of off-the-shelf gas detectors. They also solve gas detection problems that cannot be solved by standard products. As the design process is highly customer-centric, we are led by your voice and vision to provide you the solution that you had in mind. As the risks of explosive gases span many industries, all EFS systems can be installed across industries and sectors as required to ensure safety in wide ranging and diverse environments.

Final Thoughts

Equipping teams and environments with the correct equipment is incredibly valuable as it empowers workforces to take preventative action. Safeguarding workers from the dangers of explosive gases can only be done with the correct education, and the proper equipment.

This equipment and preventative action, not only safeguards workforces but also provides security and accountability for those responsible for workplaces and other non domestic premises to which the public have access. Taking responsibility for and adopting fire safe behaviours and procedures within an explosive environment is imperative to ensure safety.

For more information on the products Crowcon provides to measure and risk assess dangerous environments, as well as to gain expertise on gas detections procedures and best practice please contact a member of our knowledgeable and friendly team.

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