Introduction

Gas monitoring is widely used to detect the presence of a gas, which may cause a hazard, or the absence of a desirable gas. Gas monitoring is broadly split into three categories.

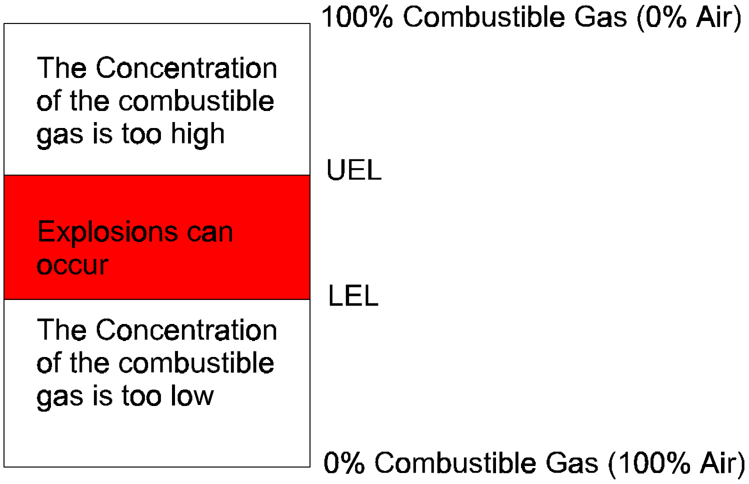
- Combustible gases and vapours.
- Toxic gases
- Oxygen deficiency or excess

Combustible gases and vapours.

A wide range of gases can form a combustible mixture with air. Modern combustible gas detectors are designed to detect for the presence of a build up of a combustible gas long before it presents a hazard to personnel or plant and equipment. Combustible gases can be normally present due to a range of industrial or domestic processes.

- Petrochemical process industries
- Gas pipelines
- Gas pumping stations
- Gas processing
- Gas Storage
- Gas Bottling
- Heating plant
- Battery charging stations
- Boiler plant
- Engine plant
- Power generation
- Gas turbines
- Landfill sites
- Bio gas generators

For a gas to burn in air its concentration in air must fall within certain well-defined limits. If the concentration is too small then it cannot sustain a flame and will not ignite. This low limit for combustion is termed the **L**ower **E**xplosive **L**imit. Similarly if the concentration is too high then there will be insufficient oxygen for the gas to combine with for combustion. This upper limit is termed the **U**pper **E**xplosive **L**imit.



In each case over many years a wide range of gases have been characterised and their limits documented. Some of the more commonly encountered gases and vapours are indicated in the following table. Note that the concentrations are expressed as a percentage of volume of the flammable gas that must be present in air.

Gas	Formula	%LEL	%UEL	Ignition Temperature	Flash Point Deg C
Acetylene	C2H2	1.5	100	305	36
n-Butane	C4H10	1.5	8.5	365	152
Carbon Monoxide	CO	12.5	74		
Hydrogen	H2	4.5	75	560	-240
Methane	CH4	5	15	595	-82
Natural Gas		3.8-6.5	13-17		
Propane	C3H8	2.1	9.5	470	97
Ethylene	C2H4	2.7	24	425	10
Styrene	C8H8	1.1	8	490	32
n-Nonane	C6H20	0.7	5.6	205	31
i-Hexane	C6H14	1	7.4	265	-20

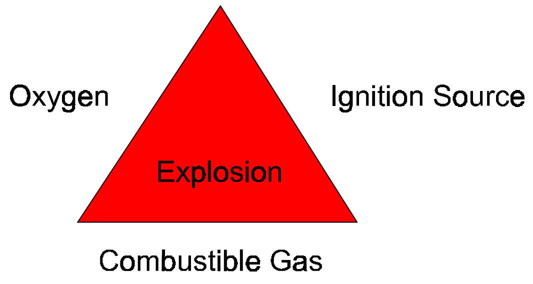
The flash point of a combustible liquid is that temperature at which point sufficient vapour is liberated to form an ignitable mixture with air near the liquid surface. The flash point gives some indication of how dangerous the liquid is with respect to heat.
The ignition temperature is the temperature required for the gas/air mixture to spontaneously combust whilst the mixture is between the LEL and UEL.

Vapour	%LEL	%UEL
Acetone	2.6	12.8
Benzene	1.2	8
Cyclohexane	1.3	8
Diethyl Ether	1.85	48
Ethyl Acetate	2.2	11.4
Ethyl Alcohol	3.3	19
Ethylene Oxide	3	100
Methyl Alcohol	7.3	86
n-Octane	1	3.2
White Spirit	1.1	6
p-Xylene	1.1	7

Looking through the tables above it will be noted that for a few gases and vapours the UEL is 100%. This indicates that the gas can under certain circumstances explode even if not mixed with air. This is possible either because the gas molecules contain oxygen which must be liberated to support combustion or because the molecular structure is unstable and may decompose explosively if for example it is stored under pressure or comes into contact with a triggering agent. Acetylene is an example of a gas in the latter category.

An explosion is only possible if the following three conditions are fulfilled

1. The concentration of the gas is between the LEL and UEL
2. A sufficient amount of Oxygen exists
3. There is a source of ignition



It should be noted from the previous tables that the ignition source need not be a naked flame or spark. Some gases have very low ignition temperatures so merely the presence of a hot surface can ignite the gas/air mixture.

Toxic Gas Monitoring.

A wide range of gases and some vapours are used in industrial processes may occur naturally or be produced as a by-product that are in some way hazardous to health. What level of gas can be normally tolerated and the harm that the gas can cause to the human body depend on the concentration and exposure time. Gases are given **T**hreshold **L**imit **V**alues for an eight-hour average exposure. The limits are set by Government regulations and are usually very low being measured in low **P**arts **P**er **M**illion values. Often gas concentrations may exceed the TLV for a short period of time. Tables are also published indicating the short **T**ime **W**eighted **A**verage to take account of this bearing in mind the toxicity of the gas.

Unlike flammable gas detection where the end result is always an explosion, toxic gases will have different effects on the human body due to the interaction with the gas.

In almost all cases the method of interaction for the gas with the body is from normal respiration. Lungs are highly efficient at the transfer of gases in and out of the body. They therefore provide an excellent opportunity for the transfer of airborne contaminants into the blood stream. The blood carries all foreign materials absorbed into the body at some stage. The following table indicates the toxicity of a number of common gases.

Gas	Formula	Threshold Limit	Hazardous Limit	Lethal Concentration
Hydrogen Cyanide	HCN	10 ppm	150ppm/1 Hour	300ppm
Hydrogen Sulphide	H2S	20 ppm	250ppm/1 Hour	600ppm
Sulphur Dioxide	SO2	5 ppm		1000ppm
Chlorine	CL2	1 ppm	4ppm/1 Hour	1000ppm
Carbon Monoxide	CO	50 ppm	400ppm/1 Hour	1000ppm
Carbon Dioxide	CO2	5000ppm	5%	10%

Threshold Limit.	This is the concentration to which it is believed you can be exposed continuously without adverse effect.
Hazardous Limit.	A Concentration that may cause death.
Lethal Concentration.	A concentration that will cause death for short-term exposure.

It must be noted that a person’s physiological make up can have a considerable influence. For instance in the case of H2S industrial studies have shown that persons previously exposed to H2S become hypersusceptible. Studies have also shown that persons who have consumed alcohol within 24 hours of exposure have succumbed at unusually low concentrations.

The following passages give some characteristics of common toxic gases.

Carbon Monoxide (CO)

There is no doubt that carbon monoxide which is odourless and colourless is the most abundant toxic gas. Different authorities put maximum safe exposure limits at 30 to 50 ppm and even lower levels have the effect of causing drowsiness. Having a similar density to air, it is readily inhaled and fixed detectors need to be mounted at head height.
Any process where there is incomplete combustion of carbon fuel leads to the production of carbon monoxide, eg petrol and diesel engines, coal, gas and oil boilers, even smoking. Its presence in mines is due to the slow combustion of coal.

Hydrogen Sulphide (H_2S)

Hydrogen sulphide is the most renowned toxic gas because of its bad egg odour which can be smelt down to less than 0.1 ppm. A maximum safe exposure limit is 10 ppm but high concentrations cannot be smelt and can lead to instant paralysis. It has almost the same density as air so detectors are mounted at head height or near potential sources of leaks. It is produced during the decay of organic materials, is extracted with oil (when the oil is said to be sour) and is often found underground during tunnelling and in sewers. It is a constituent of biogas.

Sulphur Dioxide (SO_2)

This gas is colourless and has a characteristic choking smell. It is formed on burning sulphur and materials containing sulphur such as oil and coal and it is highly acidic giving sulphurous acid in water. With the oxides of nitrogen it is a cause of acid rain and in the atmosphere, especially when it is foggy, it affects many people's respiratory systems. In industry its maximum safe level is 2 ppm. It is found in industrial areas and near power stations and it is a raw material for many processes. It is twice as heavy as air and it tends to fall to ground level.

Chlorine (Cl_2)

Chlorine is a pungent smelling, corrosive, green/yellow gas. Its most well known use is in water purification for domestic supplies and in swimming pools. Its properties rely mainly on its oxidising power. It is a very heavy gas and is readily absorbed by most materials. For this reason it is not available in cylinders or aerosol cans in dilute mixtures and it is a very difficult gas to detect (so difficult that even calibration requires special techniques). This is not because chlorine electrochemical sensors are not effective but is to do with getting the gas into the sensor.

Oxides of Nitrogen - Nitric Oxide (NO) and Nitrogen Dioxide (NO_2)

There are three nitrogen oxides. Nitrous oxide (N2O) (modern name dinitrogen oxide) is not poisonous, is used as an anaesthetic and is used as a propellant for whipped cream etc. Nitric oxide NO (modern name nitrogen monoxide) and nitrogen dioxide NO2 are the constituents of so called NOx which with sulphur dioxide causes acid rain. The main cause of these gases in the atmosphere is petrol and diesel engines, inside which a chemical combination of atmospheric nitrogen and oxygen takes place. Just out of an exhaust system, nitric oxide accounts for about 90% of NOx. However it reacts spontaneously with oxygen in the open atmosphere to give nitrogen dioxide. Nitric oxide is a colourless gas but nitrogen dioxide is an acid, pungent smelling, brown gas. The maximum safe level for nitric oxide is 25ppm and for nitrogen dioxide 3ppm. Both can be detected by electrochemical sensors. In the open environment it is best to monitor for nitrogen dioxide.

Carbon Dioxide (CO_2)

Despite the fact that we breathe out carbon dioxide and that it is present in the atmosphere to the extent of about 400ppm its maximum safe level is 5000ppm (0.5%). It is produced during combustion and in brewing and other fermentation processes, and is one of the main constituents, with methane, of landfill gas and sewage treatment digester gas. There are hazards in the brewing industry particularly as the gas is heavier than air and collects at low levels. There is some degree of risk in crowded, badly ventilated places, and this problem is often worsened by oxygen deficiency. One application is to increase plant growth by elevating normal levels in greenhouses etc. It is odourless and colourless and difficult to measure in ppm levels, infrared absorption being the usual technique.

Hydrogen Cyanide (HCN)

This well known poison is a colourless, sweet smelling gas with a 10 minute maximum safe level of 10ppm. It is easily detected and the main industrial application where it is found is in gold refining.

Hydrogen Chloride (HCl)

This pungent smelling gas is highly corrosive and dissolves readily in water to form hydrochloric acid. It is used in and produced by many chemical processes. There is a sensor for hydrogen chloride although care in its use is necessary because of its cross sensitivities.

Ammonia (NH_3)

Ammonia is the only common alkaline gas. Its density is about half that of air and it has a characteristic smell. Its maximum safe level is 25ppm but its alkalinity makes it highly reactive with acid gases and chlorine and its presence in atmospheres containing other gases is often masked by this. For instance, if ammonia and chlorine are present in equal concentrations, the result is a cloud of ammonium chloride and neither of the two gases. Ammonia is flammable with an LEL of 15%. It is produced in vast quantities all over the world to provide fertilisers, urea for resins, explosives and fibres such as nylon. It is also used as a refrigerant and this is increasing with the demise of CFCs. Another application is to maintain the sterility of water supplies after treatment with chlorine and sulphur dioxide. It can be detected in ppm levels electrochemically and in LEL concentrations by pellistor sensors.

Ozone (O_3)

Ozone is not a stable gas and is generated as it is required. Increasing use is being made of its sterilising properties in the treatment of water, instead of using chlorine. It can be detected at low ppm levels, electrochemically but the sensors also react to chlorine and nitrogen dioxide.

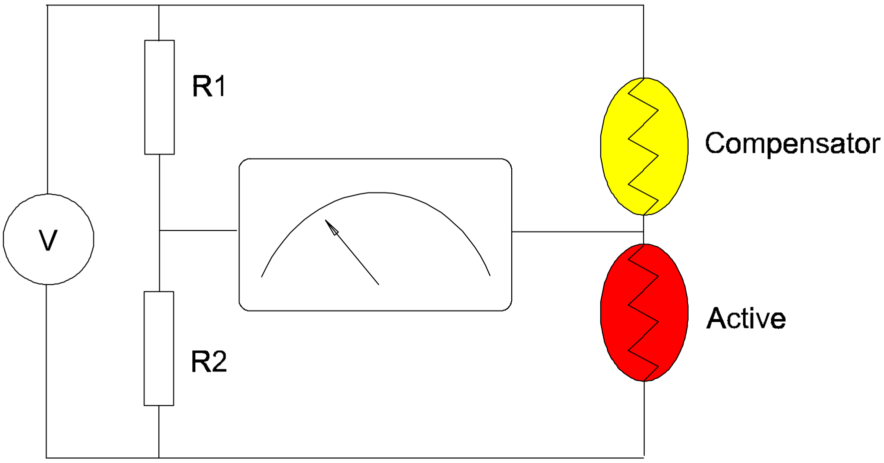
Monitoring Methods

Not all gases and vapours can be monitored using the same technique. Each gas has its own physical properties so what works well for detecting one gas may not work for another. The following paragraphs give brief details on some of the more common detection methods.

Flammable Gases

Pellistors

The pellistor is a well defined transducer commonly used for many years for the detection of flammable gases. The pellistor is based on the wheetstone bridge circuit principle. The following diagram shows the basic arrangement of the circuit.



Two coils of platinum wire are mounted into the detector assembly. One coil is coated with an active catalyst material, this is the active ‘bead’, the other coil is coated with an inactive refractory material, this is the compensator ‘bead’. The two beads form one half of a wheetstone bridge circuit. As power is applied the two beads heat up to their normal operating temperature. As a flammable gas diffuses into the detector head assembly it combusts on the active bead. The inactive bead does not react to the gas. The combustion on the surface of the active element increases its temperature and so changes the resistance of the wire. This change in resistance unbalances the bridge circuit resulting in a reading on the meter which directly corresponds to the gas concentration. The compensator bead only responds to changes in ambient temperature and so acts as a temperature compensation mechanism.

This technique has been employed for flammable gas detection for many years. The technology is well characterised and cheap to implement. Recent advances in catalyst materials has reduced the effect of poisoning of the catalyst due to contaminants. Oliver IGD offer two types, the MK3 sensor head and the Type B. Both use catalyst materials with exceptional resistance to poisoning and with long operational life.

The pellistor is not selective but will respond to any flammable gas.

Infra-Red

In recent years infra red transducers have been employed for flammable gas detection. The technique is based on the fact that certain types of gases absorb certain wavelengths of infra red energy. Gases which can be detected and measured by this technique are those which are termed heteroatomic gases. This means a gas which has a chemical bond such as CO (Carbon Monoxide), CO2 (Carbon Dioxide), CH4 (Methane). Gases that do not have such a chemical bond i.e N2 (Nitrogen), He (Helium) cannot be measured with this technique.

In practice a filament is used to generate the infra red energy. The Infra red light (energy) is focused into a beam usually using a convex mirror. The light beam passes through the gas to be measured and falls onto two detectors. The detectors are made selective to a particular gas by being used in conjunction with an optical light filter that only passes a narrow range of light frequencies. One detector is made selective to the target gas. The other detector is chosen to be in an area of the infra red spectrum that is not likely to have any of its energy absorbed. The difference between these two signals is related to the measured gas concentration. If the compensating channel filter is correctly chosen it should correct for any degradation in the light source or soiling of the optics.

The benefit of this technique is that it is so selective. This is a bonus for monitoring gases such as carbon dioxide, which is difficult to measure by any other technique. Its selectivity can be a handicap for flammable gas detection as the bandwidth of the detector must be a compromise to be narrow enough to exclude the detection of non flammable gases. This can inevitably mean that some flammable gases depending where they occur will be excluded. The device does not therefore act as detector for all flammable gases unless multiple detectors are employed which increases cost. Other problems can arise due to interference’s from water vapour which is a good infra red absorber and has multiple spectra.

Toxic Gases

Electrochemical Cells

An electrochemical cell is a type of air battery developed from fuel cell research. Such devices are self powered micro fuel cells. They use a capillary barrier to limit the amount of toxic gas to be detected reaching an assembly made up of electrodes immersed in an electrolyte solution. The electrodes are usually platinum or gold. There are usually three electrodes termed ‘reference’, ‘counter’ and ‘measuring’. An electric potential is applied between the measuring and reference electrode. An electro-chemical reaction takes place when the target gas meets the measuring electode. Electrons are liberated and migrate through the electrolyte to the counter electrode. The current that is generated by this action is directly proportional to the gas concentration. The cells are made selective to a gas by the choice of electrode material, electrolyte and sometimes by employing absorbing chemical layers in the diffusion membrane to remove interfering gases.

This technique works very well for a number of gases and has the benefit that it requires little power making it ideal for portable equipment. In some cases a sensor for a particular gas may also respond to other gases so care should be taken to understand the characteristics of the sensor to be employed. The Oliver IGD Tocsin 101 range of toxic gas sensors are based on electrochemical sensors with a typical in service life of 2-3 years. The sensors can be easily replaced in field.

Semiconductor Sensors

Semiconductor gas sensors are in essence a bridge circuit heated to 300 Degrees Centigrade. The measuring gas is absorbed onto the semiconductor and its resistance changes. The change in resistance is proportional to the gas concentration. Different types of semiconductor material are used for different gases.

In practice selectivity to the target gas can be poor and spurious readings can be obtained due to humidity effects. Care must be taken to apply this technology where good selectivity to the gas can be demonstrated along with environmental stability.

The Oliver-IGD Tocsin 101 Freon detector utilises semiconductor sensors for the detection of a range of refrigerant gases.

Thermal Conductivity

The principle of thermal conductivity is very similar to that of the pellistor. Two platinum coils are arranged in a wheetstone bridge circuit. One coil is in contact with the gas stream the other is sealed into a separate chamber and is used for temperature compensation. All gases have different thermal conductivity's and so will conduct heat away from the coil in the gas stream at differing rates. The change in temperature of the coil is directly proportional to the change in thermal conductivity of the gas mixture flowing past it.

This is a very old established technique and is well characterised. Its major draw back is that it is not at all selective and will respond to any change in gas composition. Generally the technique is used for measuring binary gas mixtures industrial processes for example controlling the mixing of two known gas streams. The technique is useful in that it can be used to monitor gases that are hard to measure using any other technique for example Nitrogen or Helium.

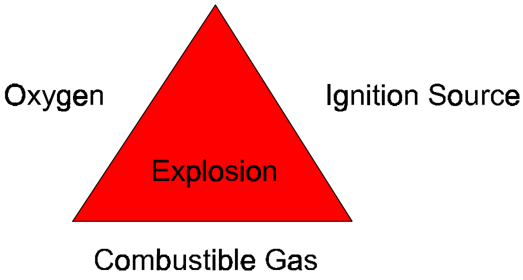
Hazardous Area Classifications.

In industry many locations may have the possibility that a hazard may exist due to the presence of a flammable gas for a significant duration of time. Examples of such places could be:

- Oil drilling platforms
- Oil storage
- Oil refineries
- Natural gas drilling platforms
- Natural gas processing and storage
- Oil tanker terminals
- Compressed bottled fuel gas filling plant
- Compressed bottled fuel gas storage
- Large boiler plant
- Gas turbing power generators
- Bio-gas generators
- Landfill sites
- Paint and varnish processing
- Battery charging stations
- Chemical plant

Such installations will need to be continuously monitored to detect for any build up of gas, which may become combustible and be a hazard. However as previously discussed for the gas to combust three conditions must be met.

4. The concentration of the gas is between the LEL and UEL
5. A sufficient amount of Oxygen exists
6. There is a source of ignition



In places where there is a significant risk that the combustible gas can or is present for a significant time due to the nature of the process then in these places any potential source of ignition must also be controlled.

The aim of area classification is to reduce, to an acceptable level, the possibility of a flammable atmosphere coinciding with an electrical source of ignition. Different countries will classify hazardous areas in different ways so it is important to understand local codes of practice however the underlying principles are the same. The following points are to be considered when an area is classified.

1. The nature of the hazard.

Gases are grouped together into classification groups either IIA, IIB or IIC dependant on their ignition energy. The lower the ignition energy the higher the alphabetic grouping.

For example

Hydrogen	(low ignition energy so easily ignited)	Gas Group IIC
Propane	(higher ignition energy so not so easily ignited)	Gas Group IIA

2. The ignition temperature of the hazard

Hazards are classified by their **A**uto **I**gnition **T**emperature. This is the temperature at which the gas will spontaneously combust in the presence of air. It does not necessarily follow that a gas falling into a severe gas group will have a low AIT. For example Hygrogen is group IIC but has a high AIT of 560 Degrees Centigrade.

The auto ignition temperature should not be confused with flash point. Flash point of a substance is that point at which sufficient gas or vapour is liberated that will ignite if a source of ignition is provided. The material automatically ignites once it reaches its AIT.

3. The probability of the hazard existing.

The ZONE defines how likely it is that a hazardous concentration will exist at the location. For gas and vapour hazards three zones are defined, 0,1 and 2. In general

Hazard present for more than 1000 hours/year = Zone 0
Hazard present for 10 to 1000 hours/year = Zone 1
Hazard present for less than 10 hours/year = Zone 2

This approximates to

Zone 0 : 10% or more of the time
Zone 2: less than 0.1% of the time

The zone number classification usually stems from the source of release. So if the source is continually releasing to atmosphere the classification will be Zone 0. If the release is a possibility then the Zone will normally be Zone . If the release is unlikely to occur or only occur under some fault condition then the Zone will normally be Zone 2.

All equipment, including gas detection equipment must be tested and certified for use in zoned areas.

Area Classifications USA and Europe

Europe		USA
Zone 0	An area where an explosive mixture is likely to be present at all times under normal operating conditions.	Division 1
Zone 1	An area where an explosive concentration is likely to occur in normal operation.	Division 1
Zone 2	An area where an explosive concentration is unlikely to occur or in the event that it should is only of short duration	Division 2

Areas that fall outside of these zones are usually termed ‘safe’ or ‘non-hazardous’.

Equipment that is certified for hazardous area use will be marked as such and usually falls into one of three categories.

Intrinsically Safe	Denoted as: EEx ia EEx ib	For use in Zone 0,1 or 2 Zone 1 or 2
Flameproof	EEX d	Zone 1 or 2
Increased Safety	EEx e	Zone 1 or 2

Intrinsically Safe Equipment

As the name implies the form of protection here is based on the circuit design of the equipment being such that it does not constitute a hazard. Generally this means that the electrical circuit of the equipment cannot store sufficient energy even under fault conditions that will cause a spark or generate sufficient heat to be a source of combustion. EEX ia equipment is tested with two coincident faults. EEX ib is tested under one fault condition.

If intrinsically safe equipment is to be selected for an application it is necessary to know the what the ignition temperature of the gas or vapour to be detected is and in which gas group it falls.

Flameproof and Increased Safety Equipment

These types of equipment gain approval by mechanically separating the electrical circuits of the equipment from the gas hazard. In the case of flameproof equipment the equipment enclosure must contain an explosion of the circuit within itself therefore preventing the equipment becoming an ignition source.

Before using or specifying equipment for a hazardous area the approval code marked on the product must be checked for its suitability.

For Example

EEx d IIA T3

E	Approved to European Norme
Ex	Explosion Proof
d	Flameproof for use in Zone 1 or 2
IIA	Suitable for gases or vapours in this group
T3	Suitable for gases or vapours with an ignition temperature greater than 200 Degrees Centigrade.

Temperature Classifications

Maximum Surface Temperature in Degrees Centigrade	EN61779-1:2000 BS5501 pt 1 BS4683 pt 1 IEC79-1	USA UL698
450	T1	
300	T2	
280		T2A
260		T2B
230		T2C
215		T2D
200	T3	T3
180		T3A
165		T3B
160		T3C
135	T4	T4
120		T4A
100	T5	T5
85	T6	T6

Gas Groups

Gas	Harmonised EC Standard Cenelec EN61779-1:2000 IEC79-1	USA Standard UL 698
Methane	I	D
Propane	IIA	D
Ethylene	IIB	C
Hydrogen	IIC	B
Acetylene	IIC	A

Complete tables of flammable gas data can be found in EN 61779-1:2000

Basic considerations for the installation of fixed systems.

A fixed gas detection system should be so installed that it is capable of monitoring those parts of a plant or other premises where combustible gas(es) may accidentally accumulate. The system should be capable of giving an early warning of both the presence and the general location of an accidental accumulation of combustible or toxic gas(es), in order to initiate one or more of the following actions, either automatically or under manual control :

a) safe evacuation of premises
b) appropriate fire fighting procedures
c) shut down of process or plant;
d) Ventilation control

Two main types of fixed systems are commonly used:

Fixed point systems.

Systems consisting of remote sensors connected to the control equipment by electrical cables. These systems are the most suitable for the majority of industrial applications. A system of this type should in general be installed so it is capable of continuous monitoring of every part of the plant or other premises where combustible or toxic gas(es) may accidentally accumulate. It should be capable of giving the earliest possible warning of an accidental release or accumulation of gas within practical limitations of the system e.g. as relating to the numbers and locations of sensors as may reasonably be provided. Remote sensors should be connected to their associated control equipment by means of appropriate cables as may be specified in the instruction manual.

Remote Sampling Systems

These systems consist of some kind of pumped sampling apparatus which sequentially draws a sample of the gas to be monitored from each monitoring area to the sensor via tubing. The system has advantages as there are no electrical components in the hazardous area so it is intrinsically safe. Also for some gases the monitoring technique may be expensive, this method only requires one detector. The shortcoming is that monitoring is not continuous if more than one area is to be monitored. Factors which must be considered are the length of sample tubing and pumping rate which determine the response time along with the detector response time. If more than one point is to be monitored these time lags must be considered when calculating the time period for one sweep of all the monitoring points. These considerations mean this type of system has limited applications. It does however have some good advantages where monitoring can be discontinuous and where the monitored environment is harsh. A good example of this would be bore hole monitoring where the sample can be particulate and or water laden.

Redundancy

In general a fixed system should be so installed that failure or maintenance of individual elements does not compromise the safety of the premises being monitored. Duplication of sensors in key areas is to be recommended.

Timing of Installation During Construction Operations

Sensors should be installed as late as possible in any program of construction so as to avoid damage to the sensors particularly from such activities as welding or painting. Our general recommendation is to install cable runs, junction boxes and control panels leaving sensors until the last possible phase. Oliver IGD personnel should be involved where practical during commissioning to undertake final cable termination and test.

Sensor Location

Sensors should be located in conjunction with specialist advice. Oliver IGD personnel are available to advise clients with specific applications.

Any agreement reached on sensor locations should be formally recorded.

Fixed sensors should be located so as to detect gas accumulations which could create a significant hazard. Factors to be taken into consideration are:

1. Indoor or outdoor site
2. Potential leak source
3. Nature of the gas or vapour to be detected
4. Nature of possible gas or vapour release (high pressure jet, evaporation, liquid leaks)
5. Presence or cavities, pits or cable channels
6. Topography of the site
7. Air movements: Temperature effects, Indoor natural ventilation, Indoor mechanical ventilation. Outdoors – wind speed and direction.
8. Local environment to plant
9. Population of plant and locations
10. Locations of potential sources of ignition.

Gas Behaviour.

The densities of gases and vapours with respect to air is given in EN 61779-1:2000. It should be noted that high pressure gas leaks can result in a drop in the gas temperature and subsequent temporary increase in density.

Sensors should be located in all areas where hazardous accumulations of gas may occur. Such places may not necessarily be close to the potential source of release. Heavier than air gases are particularly likely to accumulate in pits and trenches. Similarly lighter than air gases may accumulate in overhead cavities.

Sensors should be located close to any potential source of leakage but not so close that they respond to equipment which may produce inconsequential leakage. In general on open sites leaks may be dispersed without causing a hazard.

Where it is necessary only to detect the release of a gas or vapour from within a given area then sensors may be placed at intervals around the perimeter. This approach should not be adopted if a release of gas could cause a significant hazard to plant or personnel.

The hazards due to gas or vapour leaks are greater within buildings. A well designed ventilation system should result in a number of total air changes within a space per hour and thus limit the potential for a gas build up. However it is normal for there to exist dead pockets of gas/air that the ventilation system does not automatically limit. Detectors should be sited in these spaces. Smoke trace is useful in determining air flow within buildings and determining dead spaces. If a sensor is installed into a mechanical ventilation duct then its alarm point should be set as low as practical without inducing spurious alarms. Remember than the ventilation system may be drawing from a number of areas and so diluting a gas leak from any one area.

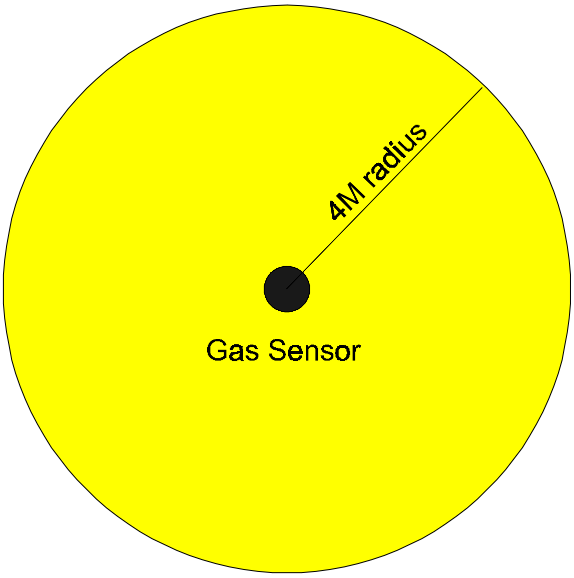
In general sensors should be sited above the level of ventilation openings and close to the ceilings for the detection of lighter than air gases.

Mount sensors below ventilation openings and close to the ground (or in pits, tunnels, cable troughs or under suspended floors) for heavier than air gases.

Where it is required to detect the ingress of gas to a building from an external source sensors should be sited adjacent to the ventilation openings. Just above the opening for lighter than air gases and just below for heavier than air gases. Again smoke trace can be useful to help to take into account prevailing winds and air currents.

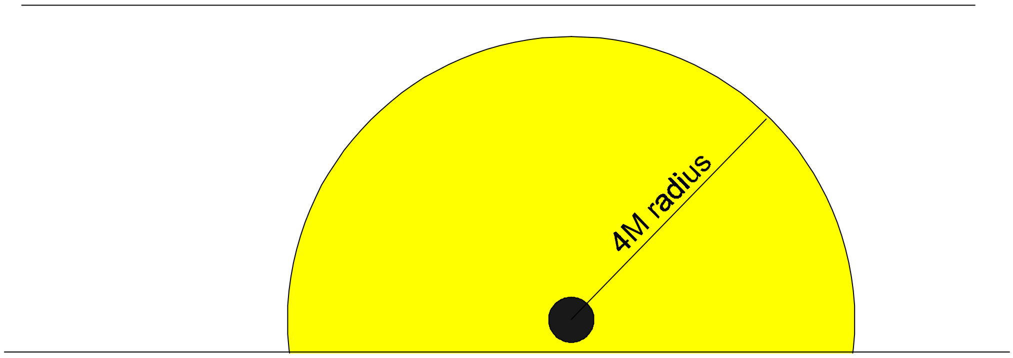
When siting sensors it is also necessary to consider the likely environmental conditions of temperature wind speed rain ice or snow all of which can have an adverse affect on the sensor. Oliver IGD provide a range of weather protection devices and should be consulted for advice on their applicability and use.

As a general rule a gas sensor can cover an area of around $50M^2$ this can be affected by the characteristic of the gas and by the nature of the hazard and is only intended for general guidance. All applications are different and require careful consideration before determining the number and location of sensors.



Perimeter representing 50 square meters
as the sensors capable sensing zone

It should also be considered that the general $50M^2$ rule equates to an approximate radius of 4M around the sensor. Wall mounting a sensor effectively halves its operational area. In some circumstances such as long corridors with good through flow ventilation the number of sensors can be reduced.



Sensor wall mounted in a corridoor showing limitation of sensing capability

Siting gas detectors is a specialised subject advice should always be sought for particular applications. Oliver IGD personnel are always available to give advice on particular applications.

Recommended Publications

EN 61779-1:2000	Electrical Apparatus for the detection of flammable gases
ISBN 0 9516848 2 5	Electrical Apparatus and Hazardous Areas
ISBN 0 7503 0074 4	Techniques and Mechanisms In Gas Sensing