ATEX Reviewed

ATEX FOCUS

Ron Sinclair, Managing Director, Baseefa Rockhead Business Park, Staden Lane,
Buxton SK17 9RZ United Kingdom. Website: www.baseefa.com

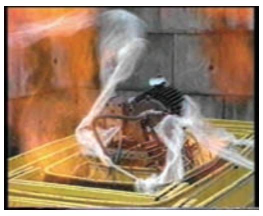
As this article is being published, we will have just completed the interim application of the ATEX Directives. By 1 July 2006, all plants within Europe should be able to demonstrate full compliance with the requirements of 1999/92/EC as adopted in each member state. In the UK this is the Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

Beginners Start Here

Explosive atmospheres can occur either deliberately or accidentally in many activities in the environmental field. Although everyone should now be well aware of the existence of both the ATEX Directives, it is sometimes desirable to go back to first principles to make sure our acquired knowledge has a firm foundation. I know from reading various articles which have been published over the years that it is all too easy to make fundamental mistakes if the origins of requirements are not fully understood. In this short article, I will attempt to cover the foundation work necessary to understand the technical basis for the directives and how they are operated in practice.

What is an Explosive Atmosphere ?

In leading training courses, I have come to realise that it is important to explore this fundamental question before proceeding with the detail. Most of us handle an explosive atmosphere on a daily basis in our own kitchens. But the atmosphere is under careful control and is burned by a process of "stable combustion" at the burner on our gas cooker.



There is only a problem when we move from the controlled to the uncontrolled state. In this case, instead of the flamefront being in a fixed position, it moves through the unburnt mixture and - as the "burnt" gasses behind the flame are hotter than the unburned gasses in front of it - the process is accompanied by a rise in pressure. Depending on the relative speeds of the flamefront and the pressure wave we may have stable combustion, unstable deflagration or, in extreme cases, detonation.

Provided that we do not move too far towards detonation, the actual pressure rises and pressure rise times are reasonably predictable for given gas- or vapour-air mixtures. The pressure rise time depends on the natural speed of the flamefront in an unconfined situation, which can vary considerably; typically 3.5 m/sec for methane-air and 28 m/sec for hydrogen-air mixtures.

Although the results may be reasonably predictable in simple geometry, it is a different matter for explosions occurring in real situations, where obstructions lead to increased turbulence and early onset of the high pressures associated with detonation. For this reason, the standard for flameproof equipment requires that the actual pressures are measured for representative gasses of the equipment group that will be marked on the label. Pressures of 6 to 8 bar are typical of all gasses in simple enclosures, but pressures over 20 bar are not uncommon as soon as content (printed wiring boards, motor stators and rotors, etc.) is introduced which may prevent a smooth development of the flamefront.

The minimum ignition energy of a gas-air mixture is also variable, and related to flame speed. We can all recognise the situation where an unreliable domestic gas burner blows out the pilot light (or match) rather than catch light. A minimum amount of energy needs to be transferred to the explosive mixture before the flame front will "expand" rather than collapse in on itself. It is keeping this balance of energy on the right side that is so important in ensuring that electrical or mechanical equipment does not become an ignition source.

What is an Ignition Source?

Many things, some obvious, some not so obvious, can ignite an explosive atmosphere. A full consideration is given in EN 1127-1, which is a generic standard covering many aspects of explosive atmospheres and ignition prevention (and should be on the reading list for all involved with explosive atmospheres). An abbreviated list would include:

Flames
Electric arcs and sparks
Impact energy
Thermite chemical reactions on impact of light metals
Frictional energy
Hot surfaces
Compression ignition (as in the diesel engine)
Electrostatic discharges

Other than flames, which are clearly a separate issue, the standards for protection of electrical and non-electrical equipment for use in explosive atmospheres address all of these and provide for methods of controlling or mitigating against such potential ignition sources.

Safety and Consequences

It has to be recognised that there is no such thing as absolute safety. The "hazard" is the potential for something to go wrong. The "risk" is the likelihood that it will go wrong. And when it does go wrong, there is a likely "consequence".

In considering explosive atmospheres, there are two separate risk factors: the probability of the explosive atmosphere being present in sufficient quantity that it will, if ignited, create an explosion with measurably-undesirable consequences; and the probability that a source of ignition will be active at that time.

Although we are now encouraged to consider consequences (how many people will get killed or injured, what will the financial cost be in loss of production or destruction of inventory?), the traditional view of hazardous atmospheres did not give these factors due weight.

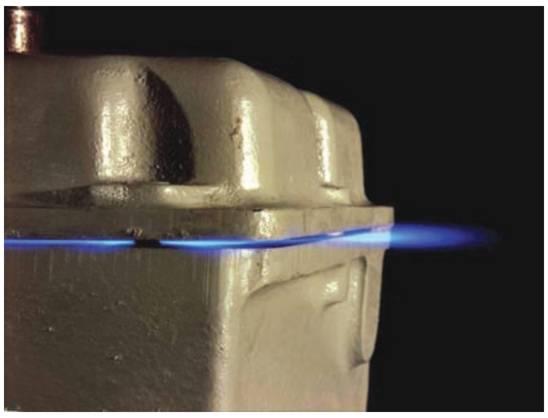
Risk 1 – The explosive atmosphere

The probability of the explosive atmosphere being present is represented by defining three Zones:

- In Zone 0, the hazard is likely to be present for protracted periods, or even continuously.
- In Zone 1, the hazard may be present from time to time as part of normal operation, but not for protracted periods.
- In Zone 2, the hazard is not present in normal operation and, if it is present as a result of mal-operation, will only be so for a short period and very infrequently.

Similar definitions are applied to Zones 20, 21 and 22 for dust-air atmospheres, although there are additional complications from dust layers.

We call everything else the "Safe Area" but, as we



learned from the incident at the oil tank farm at Buncefield, it is not always safe. It is not practical to base the zoning system on the very occasional extreme circumstance such as at Buncefield where, according to the HSE's interim reports, it seems likely that two independent control systems failed and allowed petrol to flow uncontrolled from the top of a storage tank for nearly an hour. The vapour spread well beyond the zoned areas and it was inevitable that it would be ignited eventually. In this case, the source of ignition was really irrelevant to the fundamental problem: how did the overflow continue undetected for so long? Although the risk from an oil tank farm is obvious, we should remember 22 years ago when we had the salutary warning in the water supply industry. Methane collected in the water transfer tunnel at Abbeystead before coming unexpectedly into the valve house (notionally a safe area). The source of ignition was never identified but sixteen people died in that safe area.

Risk 2 – The Ignition Source

We can reduce the inherent level of risk, for example by using anti-static plastic materials, avoiding combinations of light metals, and by ensuring that potential mechanical friction sources are well lubricated. Electrical sparks can be reduced to non-incendive levels, using protection techniques such as intrinsic safety, or avoided altogether using increased safety. If we cannot guarantee to avoid ignition capable arcs or sparks, we can put them in a flameproof enclosure, or keep the gas away using purging and pressurisation techniques. In all cases, we are also concerned with the hottest surface that the explosive atmosphere can access.

The different statistical probability of ensuring that an ignition source cannot be active is represented by the "Category" of the equipment according to the ATEX Product Directive 94/9/EC:

- Category 1 Equipment is "safest", with no ignition sources in normal operation or in the event of very severe conditions, or with two faults within the equipment.
- Category 2 Equipment is safe in normal operation and with expected faults.
- Category 3 Equipment is safe in normal operation.

The Categories are awarded a suffix "G", "D", or "GD" according to applicability in gas and/or dust atmospheres.

Based on historical evidence, the various traditional protection techniques are assigned to the categories, or have different levels appropriate to more than one category. The protection techniques are also generally varied according to the minimum ignition energy for which the equipment is designed, resulting in marking IIA, IIB or IIC. The maximum surface temperature is marked according to Temperature Classification, T6 through to T1.

Europeans have become used to the ATEX categories. Internationally we are about to introduce "Equipment Protection Levels" which will have total equivalence but will use lower case a, b and c rather than the numeric 1, 2 and 3 of the categories.

Zones plus Categories

It is the ATEX "User" Directive 1999/92/EC which brings the Zones and Categories together to give an overall risk. The plant owner is allowed to allocate Categories to Zones based on an analysis of possible consequences, but the very strong recommendation is that the Categories are used in the Zones indicated in the table. From this it can be concluded that the risk factor from Category 1 Equipment in Zone 0 (or 20) is similar to the risk factor from Category 3 Equipment in Zone 2 (or 22). This is a simplification since, generally, many more items of equipment are installed in each Zone 2 than in each Zone 0, so the risk has to be multiplied by this factor.

The majority of plant owners seem to follow the correspondence in the table, rather than trying to justify alternatives in their overall risk assessment. It is perhaps in some of the environmental fields, with plant in remote locations operating without personnel being present, that scope can be found to vary the direct correspondence in the table. Expert help from bodies such as Baseefa can build the evidence for a modified risk assessment and possibly lead to justification of a satisfactory, but more economical, installation.

The Legal Requirements

Since July 2003, it has been mandatory that all equipment with a potential source of ignition which is being sold on the European market for the first time is accompanied by a Declaration of Conformity to the ATEX Product Directive (94/9/EC). Even though there was a seven-year lead in, a number of manufacturers, particularly those of non-electrical equipment, missed the deadline.

Since July 2003, it has been mandatory that all new installations (and modifications to existing installations) should meet the requirements of the ATEX User Directive (1999/92/EC), implemented in the UK as DSEAR.

From 1 July 2006, it has been mandatory that all existing plants and installations meet the requirements of 1999/92/EC (DSEAR).

These requirements are not particularly onerous, and many plant owners will already have been complying with most of the requirements as a result of the work done to satisfy the requirements of PUWER (the Provision and Use of Work Equipment Regulations). However, the main plank of the legislation is to formalise the need to classify the plant into Zones, and the need to carry out a risk assessment on all equipment within the Zones.

This risk assessment is easy for new plants where all equipment is fully compliant with 94/9/EC. Where existing plants have older equipment, it is not too difficult for electrical equipment that has reasonably identifiable certification to previous standards (although getting hold of the actual certificates may sometimes be a problem).

The problems occur with the mechanical equipment which may be being assessed for the first time. A technical basis for the assessment must have a firm foundation, and there is a requirement to demonstrate the competence of anyone performing such an assessment.

ATEX Notified Bodies, such as Baseefa, have experience in doing that type of assessment and their competence is underwritten by their appointment as a Notified Body. The final legal responsibility for the risk assessment must rest with the plant owner, but the actual work can be given to someone else with proven competence.

Just as July 2003 was the peak of interest from manufacturers of equipment as they finally awoke to the deadlines of 94/9/EC, we have seen a major panic as plant owners suddenly realised that July 2006 and mandatory application of DSEAR was upon them.

Gas Group		Flammability Limits (%v/v)		Autoignition Temperature	Minimum Ignition Energy	Flame Speed	Relative Density
		Lower		Upper	(deg C)	(microJ)	(m/s)
I	Methane	5	15	595	290	3.5	0.55
IIA	Propane	2	9.5	470	250	4.0	1.56
IIB	Ethylene	2.7	34	425	120	6.5	0.97
IIC	Acetylene	1.5	100	305	20	14	0.9
IIC	Hydrogen	4	75	560	20	28	0.07

Representative Gasses and their basic properties

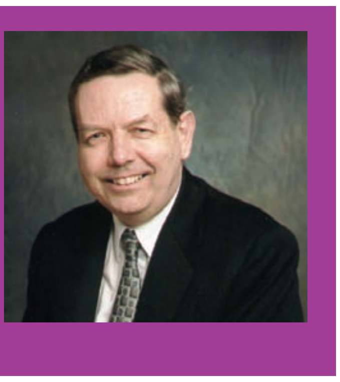
Zone 0	Category 1G or 1GD
Zone 1	Category 1G, 2G, 1GD or 2GD
Zone 2	Category 1G, 2G, 3G, 1GD, 2GD or 3GD
Zone 20	Category 1D or 1GD
Zone 21	Category 1D, 2D, 1GD or 2GD
Zone 22	Category 1D, 2D, 3D, 1GD, 2GD or 3GD

Allocation of Equipment by Category to Zones

Author Details

Ron Sinclair has been active in the certification of equipment for use in explosive atmospheres for over 30 years. Previously a designer of large electrical machines, he has developed expertise in all types of Ex protection while working for the UK Health and Safety Executive's Baseefa and EECS. When HSE decided to terminate the certification activity in 2001, Ron led the staff into the creation of a re-formed Baseefa as a private company. Baseefa boasts over 300 years collective experience of hazardous area certification, while finding new ways to serve its customers and develop its services in the private sector.

Ron is active in standards development for hazardous area equipment: he is Chairman of BSI Committee GEL/31; Chairman of Cenelec Committee TC31; and a major contributor to the development of IEC standards as well as the CEN standards for non-electrical equipment. He attends the European Commission's ATEX Standing Committee, and is well placed to interpret the latest thinking from the legislators.



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