WEIGHING IN HAZARDOUS AREAS

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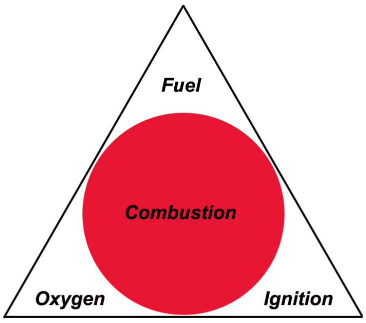
Although health and safety regulations have moved a long way since canaries were used down mines to detect unwanted levels of methane, explosions due to the ignition of accumulations of dusts, gases and vapours in industrial environments are still regularly occurring, often resulting in serious injuries and loss of life.

To help prevent such explosions occurring, equipment and products operating in so-called hazardous areas are required to meet stringent criteria. Hazardous areas are essentially designated places where, under well defined conditions, the presence of certain materials (such as gases, dusts or fibres) makes an explosion probable.

Three elements, often referred to as the explosion triangle are required for an explosion to take place:



- Dust, gas or mist in sufficient proportions
- Sufficient supply of air or oxygen
- Source of ignition

Weighing systems are essential operational parts of many animal feed processes where designated hazardous areas can exist, and therefore they must be designed, certified and installed accordingly. Although evidence indicates that most industrial explosions are not caused by problems with weighing systems, each probable cause must be eliminated. The applications for the weighing equipment are extremely diverse and may include weighbridges, bag fillers, crane scales, storage silos, hopper scales, grain elevators, belt scales and conventional floor and bench scales. (It is worth remembering that there may be a potential risk if non-certified weighing equipment is, albeit unwittingly, moved into a hazardous area.)

The technical and operational requirements for weighing equipment and systems installed in hazardous areas are governed by international legislation. The two most recognised sets of legislation are the European ATEX regulations and those in the US based around regulations defined in the National Electrical Code (NEC) governed by the National Fire Protection Agency (NFPA). (The main certifying body in the US is FM global and common parlance sometimes refers to *'FM approved systems for hazardous areas')*. Traditionally there have been differences between the two systems, but there is growing cooperation and standardisation. The required regulations that need to be implemented will depend on where you are in the world but outside Europe and the US most countries adopt one of these two systems.

THE ATEX DIRECTIVES

The **ATEX** Directives (**AT**mosphere **EX**plosive) have harmonised the regulations used throughout Europe which historically have been based around an individual blend of local, national and international regulations.

There are in fact two ATEX Directives, one of which places the burden of responsibility on suppliers and the other on end-users. Hazardous areas are classified according to their location, type of hazardous material and potential risk factor. The ATEX Directives now cover hazards relating to both gas and dust environments. In the past, the applications for dust were less well defined but now equipment must be certified and marked accordingly. Products only certified for use in gaseous hazardous areas cannot be used in dust environments and vice versa.

The ATEX Directive 94/9/EC (also known as Article 100a and Article 95) outlines the requirements suppliers must meet to achieve compliance for their equipment and protective systems for use in hazardous areas. It applies to both electrical and mechanical equipment and covers potentially explosive areas below ground, on the surface and on offshore fixed facilities. Guidance on the detailed technical requirements are given in the associated European Harmonised Standards (EN)

The directive applies to both electrical and mechanical equipment, and protective systems intended for use in potentially explosive atmospheres. These include:

- equipment and protective systems for use within potentially explosive atmospheres
- devices for use outside potentially explosive atmospheres, but which are required for, or contribute to the safe functioning of equipment and protective systems located inside such atmospheres; and components relating to the above

An explosive atmosphere is defined as a "mixture with air, under atmospheric conditions, of flammable substances in the form of gases, vapours, mists or dusts in which, after ignition has occurred, combustion spreads to the entire unburned mixture".

The directive specifically does not define atmospheric conditions. However, guidance from the European Commission indicates that *"a surrounding temperature range of -20°C to 60°C and a range of pressure between 0.8 bar and 1.1 bar may be appropriate as a basis for design and intended use of products"*.

As with all new style EU directives, individual member states adopt the fundamental aspects of the directives under their own national legislation.

94/9/EC was originally implemented in the UK by *The Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres Regulations (SI 1996 No.192)* which came into force on 1 March 1996. These Regulations have been amended by the *Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres (Amendment) Regulations 2001 (SI 2001 No.3766)* which came into force on 21 December 2001. The amendment principally covers the concept of "putting into service".

The ATEX Workplace Directive 1999/92/EC (also known as Article137) covers the health and safety aspects of workers potentially at risk from exposure to explosive atmospheres. The Directive places the onus on the end user to ensure measures are taken to ensure the safety of employees. This directive is implemented in the UK by the *Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).* Employers have an obligation under law to complete a formal risk assessment of all hazardous areas within their company by 30th June 2006.

ATEX HAZARDOUS AREA CLASSIFICATION

Under the ATEX regulations, hazardous areas are divided in 'Zones' relating to the likelihood of an explosive atmosphere existing. Apparatus is divided into Equipment groups (I for mining and II non-mining) and into Categories 1,2 and 3. The Categories provide respectively, very high, high and normal levels of protection against ignition. For non-mining applications the following table gives an overview of this:

Hazard	*Hazard continuously present (>1000 hrs per year)*	*Hazard present under normal operation (10-1000 hrs per year)*	*Hazard only present infrequently (<10 hrs per year)*
Gases	ZONE 0	ZONE 1	ZONE 2
Dusts	ZONE 20	ZONE 21	ZONE 22
Equipment category	1	2	3
ATEX Annexes	III and IV or V	III and IV or V	VIII
Group	II	II	II

An EC type examination by a notified body is required for Category 1 and 2 equipment but not for Category 3. However manufacturers may opt for examination of category 3 equipment to endorse the quality of their products.

TEMPERATURE CLASSIFICATION

Temperature classification is an important part of hazardous area equipment designation and gives the maximum surface temperature that any part of the equipment can reach under operational or fault conditions, assuming an ambient temperature of 40°C. *Note that products certified to T6 meet the most stringent temperature requirements.*

T Code	*T1*	*T2*	*T3*	*T4*	*T5*	*T6*
Max surface temperature	450°C	300°C	200°C	135°C	100°C	85°C

WEIGHING SYSTEMS

Typical weighing systems are comprised of load cells, junction boxes, cabling, weight controllers together with ancillary displays and controls. Depending on the application, these may be situated in the hazardous area or designated safe area. Essentially each piece of equipment and interconnecting cable or lead is considered as a potential source of ignition which needs 'protection'. Examples of applications are shown in the accompanying diagrams.

Historically strain gauge load cells were often treated as non-energy storing devices or 'simple apparatus' and as a result some manufacturers did not gain certification for their products. Use of such products in some hazardous area applications was accepted provided they were used with recognised zener barrier systems. This satisfied some users but this was very much a grey area and today, with new legislation and a growing focus on liability and accountability, users of weighing systems in hazardous areas insist on ATEX certified load cells. These products not only undergo stringent testing by an independent 'Notified Body' but also individually during manufacture.

MIX AND MATCH

Just because a particular load cell, weighing instrument and zener barrier set is individually certified, it does not automatically mean that a system based on the combination of the components meets the ATEX requirements. All components must be 'compatible' when put together and many suppliers of hazardous area weighing equipment put together technical files documenting the compatibility of components in combination with instrumentation.

INTRINSIC SAFETY

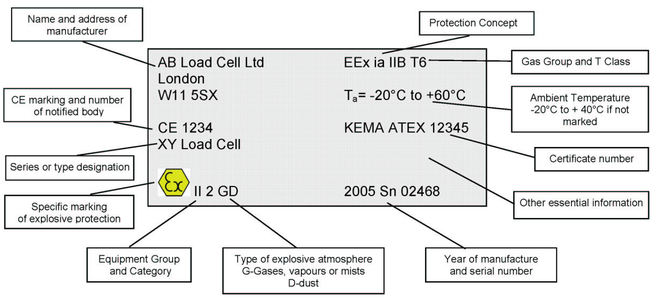
Intrinsic safety (IS) is one of several techniques for preventing explosions in hazardous areas and is the most popular, efficient and cost effective, especially for weighing systems. This technique was first developed during the first world war for use in coal mines. Intrinsic safety operates by limiting the electrical and thermal energy in circuits and equipment to levels that are too low to ignite the type of gas or dust that is ever likely to be present.

Safety is usually accomplished by inserting an energy limiting interface such as a "shunt diode" safety barrier in the wiring between the safe area and the hazardous area. This barrier is typically a passive network device that uses Zener diodes, resistors and fuses to safely divert excess electrical energy to ground and thus prevent sparking in or overheating of equipment in hazardous areas. Their key benefits are low cost and the ability to operate with data in analogue D.C. or high-speed digital forms. All other methods of protection such as oil immersion, encapsulation, flameproof or explosion proof protection, and pressurisation (purged) rely on the continual maintenance of a physical barrier between the explosive atmosphere and the equipment. Any breach of such barriers renders the protection inoperative. By contrast Intrinsic Safety provides inherent protection by restricting the energy at its source and therefore has both commercial and technical advantages.

Circuits and equipment are designed so that safety is maintained both in normal use and under possible fault conditions. (ia certified equipment - ignition should not occur as a result of two faults; ib certified equipment - ignition should not occur as the result of one fault). Certification can be given for individual components such as load cells (entity approval) and complete systems.

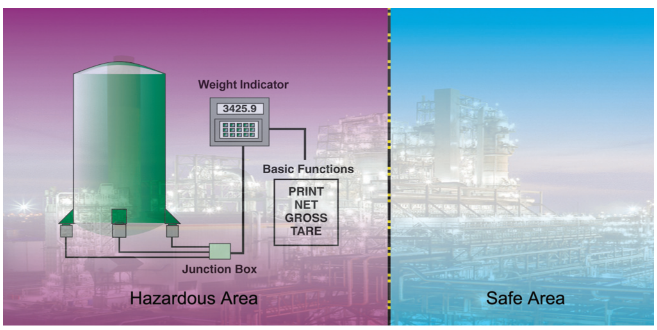
EQUIPMENT MARKING AND ATEX COMPLIANCE

Mandatory product labelling for a typical certified load cell is shown below:



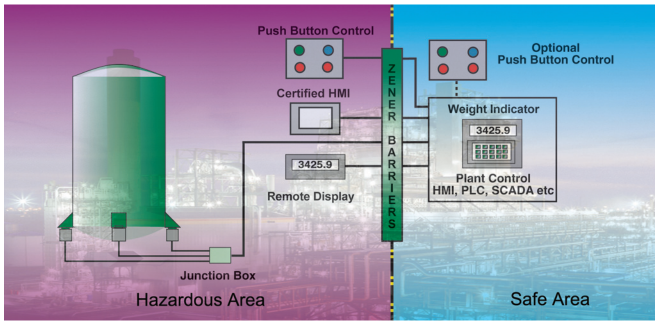
The overall requirements in hazardous areas cover all the equipment. For instance, many FIBCs are filled and discharged in dusty environments and equipment used must meet the statutory health and safety regulations including ATEX. The bags themselves must also meet strict requirements to avoid them being the source of any potential sources of ignition through build up of static.

ATEX1



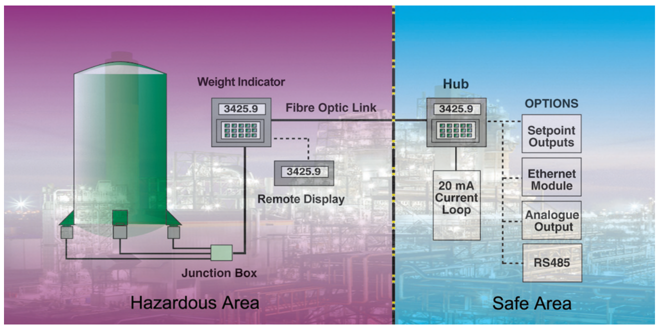
In this example, the complete weighing system is situated in the hazardous area with no link back to the safe area. Power is usually provided from appropriately certified battery packs or mains. Typical applications can range from simple vessel storage systems to bag filling stations.

ATEX2



In this conventional hazardous area weighing application, the system integrity is maintained via Zener Barriers. Optional ATEX certified equipment such as remote weight displays or HMIs can be located in the hazardous area, powered from the safe area via the Zener Barriers. Control functions are typically carried out from the designated safe area.

ATEX3



This third example shows a fibre optic link between the hazardous area and the safe area. Full functionality of the ATEX certified Weight Indicator is available through the Hub Terminal in the safe area and an extensive range of communication options complete this flexible and versatile installation. Power to the instrumentation in the hazardous area may come from certified batteries or mains supplies.

CONCLUSION

Users must ensure that any hazardous areas in their plant are suitably identified and classified. Weighing equipment for use in these areas must be selected and installed in strict accordance with statutory legislation. This can be a complex process and expert advice should always be sought. There is no room for error especially when lives are at risk.