Guidance Note

Fire Industry Association

Leading Excellence in Fire Since 1916

FIA Guide on equipment for use in explosive atmospheres (ATEX)

1. INTRODUCTION

This Guide is intended to give background information on the use of electrical equipment in areas where there is a risk of explosion from flammable materials. It explains the principles used in the classification of the hazard and the equipment for use in specific hazards. It also gives information on the concepts available for protecting hazardous area equipment (henceforth referred to as Ex equipment, Ex apparatus or Ex systems).

The Guide aims to provide awareness to product designers and manufacturers, as well as those involved in the installation and maintenance of Ex equipment and Ex systems. It isn't meant to replace comprehensive training, technical advice from suitably qualified experts or acquired knowledge of applicable standards.

2. BACKGROUND

FD&A systems are sometimes installed in areas in which the atmosphere may contain flammable gases, vapours, dusts or fibres which could cause explosions or fires. The condition required for an explosion is the same as that for a fire. This is represented by the "combustion triangle", i.e.: the correct mix in the air of FUEL and OXYGEN together with the availability of a suitable IGNITION SOURCE. Fires generally develop slowly, giving sufficient time for corrective actions, while explosions happen extremely quickly, in a matter of microseconds. Explosions are often responsible for large-scale devastation and loss of life. Hence, it is essential that all possible conditions that could result in an explosion are removed, or significantly reduced, within the hazardous area. For this it is necessary to understand the characteristic of the fuels which may be involved and to limit the energy available to below the level required to ignite the flammable fuel-air mixture. Methods of classification of the degree of hazard, the combustible materials and the equipment protection methods have been established over the years, often following major incidents such as Flixborough (1974) and Buncefield (2005) in the UK. Such incidents have led to the development of better technical standards and the introduction of stronger national Regulations.

Ex environments are separated into three groups: **I**, **II** & **III**. **Group I** (for equipment used in mining and subterranean environments) is not covered in this document while **Groups II** & **Group III** (for equipment used in surface industrial environments) are covered. More specifically, **Group II** deals with the risk of explosions due to flammable gas and vapours while **Group III** deals with combustible dust <500 µm and fibres >500 µm.

Typical applications for **Group II** and **Group III** include oil and gas offshore platforms, refineries, chemical plants, flammable liquid storage facilities, car/aircraft refuelling facilities, paint factories and spraying shops, paper production plants, distilleries and bonded stores, grain storage facilities (silos), wood mills, and plants processing metals and plastics. This list is not exhaustive, and many new areas may be re-designated as hazardous following a change in usage.

It is the duty of employers and plant operators, to ensure that hazardous areas are correctly identified and classified. However, organisations supplying equipment to the end users for installation in hazardous areas are responsible for obtaining knowledge of the area's classification and to ensure that the equipment and systems they supply are designed to minimise the risk of explosion.

3. REGULATORY FRAMEWORK

3.1. European Regulations

There have been regulations in Europe since 1976 identifying the testing, certification and approval of electrical equipment for use in potentially explosive atmospheres. Compliance by manufacturers in the early days was voluntary.

In 1989 the Council of the European Community issued “Framework Directive” 89/391/EEC, setting the basic principle for the introduction of measures to encourage improvements in the safety and health of workers at work. In 1999 Directive 99/92/EC, known as **ATEX 137** (or the “**ATEX Workplace Directive**”) obligated employers to ensure the safety of workers. It was replaced in April 2016 by Directive 2014/34/EU, known as **ATEX 114** (or the "**ATEX Equipment Directive**"). The ATEX Equipment Directive obligates manufacturers and importers to place only fully compliant products, with CE and appropriate Ex markings, on the EU market.

3.2. UK Regulations

In March 1996, the UK Parliament introduced the **E**quipment and **P**rotective **S**ystems Regulations intended for use in potentially explosive atmospheres (**EPS**). The EPS Regulations effectively transposed the **ATEX 137** Directive in the UK Legislature. In December 2002, the UK introduced the **D**angerous **S**ubstances and **E**xplosive **A**tmospheres **R**egulations (**DSEAR**). **DSEAR** applies to workplaces where a potentially explosive atmosphere may occur and places a legal duty on employers to eliminate or control the risks from dangerous substances. **EPS** and **DSEAR** Regulations complement each other.

In December 2016, the UK Parliament enacted **SI** No. 1107, transposing into UK Legislature, **ATEX 114**, the ATEX Equipment Directive. On 31 December 2021 the **E**uropean **U**nion **W**ithdrawal **A**greement (**EUWA**) Act came into force. In accordance with the provision of the **EUWA** for the retention of some EU laws, the ATEX European Directive was transposed to the UK ‘independent’ Legislature as from January 2022. Thus, equipment used in classified hazardous areas must also comply fully with the ATEX Directive.

The Health and Safety Executive (HSE) has been given the enforcement role for the DSEAR and ESP Regulations and the EU ATEX Directive.

3.3. Other economic regions

Outside Europe, regulations regarding potentially Explosive Atmospheres vary from country to country. Some countries have adopted technical standards and enforce similar regulations as prevalent within a larger economic area like North American. It is necessary to be aware of the requirements and regulations which are in place when exporting equipment to specific markets.

In North America, equipment and systems for Hazardous Location (HAZLOC) must comply with the requirements of the Occupational Health and Safety (OHS) Regulations. In the US this will be the National Electrical Code (NEC) NFPA70 whilst in Canada, compliance must be to the Canadian Electrical Code (CEC, CSA C2.21). The rest of the world tends to apply IEC international standards and requires equipment to be approved under the IECEx Certification scheme.

4. HAZARD CLASSIFICATION

IEC 60079-10-1, for gases and vapours, and IEC 60079-10-2, for dust and fibres, specify the requirements for identifying hazards and classifying equipment for explosive atmospheres. The key principles for classification are explained in this section.

4.1. Hazardous Area Zone concept

The likelihood of a hazard being present in a concentration high enough to cause an ignition will vary from location to location. The probability of an explosion depends on how long the mixture of ignitable fuel and oxygen mixture is present. To classify this probability, installations are divided into Zones: **Zones 0**, **1** and **2** for flammable gases and vapours, and **Zones 20**, **21** and **22** for combustible dusts and fibres. The probability of an explosion is defined as:

Zones 0/20: An area in which an explosive gas atmosphere is present continuously or for long periods, i.e. for periods exceeding 1000 hours per year.

Zones 1/21: An area in which an explosive gas atmosphere is likely to occur in normal operation, i.e. for periods exceeding 10 hours but not exceeding 1000 hours per year.

Zones 2/22: An area in which an explosive gas atmosphere is not likely to occur in normal operation and, if it occurs, will only exist for a short time, i.e. not exceeding 10 hours per year.

The higher the probability of an explosion occurring in a specific area, the more stringent the protection measures for the equipment will need to be.

4.2. ATEX categories and IEC protection levels (EPLs)

In Europe, the ATEX Directive introduced the concept of **categories**, sub-dividing equipment for gas and dust groups into three categories: c**ategory 1**, **category 2** and **category 3**, depending on where the equipment is to be used and whether a potentially explosive atmosphere is always present, or is likely to occur for a long or short period of time. **Table 1** shows ATEX **categories** and their permitted **Zone** of use.

Table 1: Relationship between ATEX Zones and required equipment category

ATEX Zone			**Equipment**			
In which an *explosive* atmosphere is:	**Gas**	**Dust**	**Assured level of protection in:**	**Category**	**Marking**	
					Gas	**Dust**
Continuously present	0	20	The event of two faults	1	II 1G	II 1D
Likely to occur occasionally	1	21	The event of one fault	2	II 2G	Ex II 2D
Of very short duration and unlikely to occur	2	22	Normal operation	3	II 3G	II 3D

In 2006 the IEC introduced the concept of **E**quipment **P**rotection **L**evels (**EPLs**) whereby equipment for hazardous areas is allocated an uppercase letter (**G** for gases and **D** for dusts) and a lowercase letter (**a**, **b** or **c**) in line with the level of protection it affords, with **a** giving the highest protection and **c** the lowest. The relationship between **EPLs** and **Zones** is shown in **Table 2**.

In practice, the ATEX **categories** and the IEC **EPLs** achieve the same purpose and give the same results.

Table 2: EPL to Zone correspondence

Zone	EPL
0	Ga
1	Ga or Gb
2	Ga, Gb or Gc
20	Da
21	Da or Db
22	Da, Db or Dc

4.3. Hazardous substances spark energy grouping

Group II, gases, and **Group III**, dusts, are further sub-divided into **A**, **B** and **C** depending upon the type of hazardous substances present in the atmosphere. Gases are grouped together based upon the amount of energy required to ignite the most explosive gas to air mixture. Dusts are sub-divided according to the nature of the type of substance and electrical conductivity. These sub-divisions are used when determining the type and degree of protection required for the equipment to be used in explosive atmospheres with **C** requiring the highest degree of protection and **A** the lowest. **Table 3** lists the different groups for gases and dusts.

Table 3: Grouping of hazardous substances

Group II		**Group III**	
Electrical equipment for places with an explosive gas or vapour atmosphere		**Electrical equipment for places with an explosive dust or fibre atmosphere**	
Sub-division	**Max ignition energy**	**Sub-division**	**Explosive atmosphere**
IIA	260 microjoules	**IIIA**	Combustible fibres
IIB	95 microjoules	**IIIB**	Non-conductive dusts
IIC	18 microjoules	**IIIC**	Conductive dusts

Examples of gases and dusts atmospheres which can be found in **Group I** and **III** sub-divisions are given in **Annex A**, **Table 1** & **Table 2**, respectively.

4.4. Auto-ignition temperature and "T" Class rating

Flammable materials have a temperature at which ignition will take place, even in the absence of an external source. This **auto-ignition temperature** is the lowest temperature on the surface at which an explosive atmosphere will ignite. Apparatus in hazardous areas must not expose an explosive mixture to a temperature exceeding its auto-ignition temperature. Approved Ex apparatus are given a **T Class** rating. Six classes are defined from **T1** for flammable materials with the highest auto-ignition temperature to **T6** for those with the lowest auto-ignition temperature. **Table 4** shows the temperature range for each of the six temperature classes.

Table 4: Temperature Classes

T Class	Maximum surface temperature of equipment	Auto-ignition temperature
T1	450°C	>450°C
T2	300°C	>300°C ≤450°C
T3	200°C	>200°C ≤300°C
T4	130°C	>130°C ≤200°C
T5	100°C	>100°C ≤135°C
T6	85°C	>85°C ≤100°C

Flammable gases and vapours

The auto-ignition temperature of gases and vapours varies with their chemical composition. Only equipment which has a surface temperature not exceeding the mixture auto-ignition temperature can be installed.

Ignitable dusts and fibres

Dust and fibres can also ignite when subjected to elevated temperatures. It is important that the surfaces of any electrical equipment remain below the declared ignition temperature of the combustible materials present. These temperatures are determined by laboratory tests replicating realistic conditions of the dust or fibre hazards. Auto-Ignition temperatures for dusts and fibres depend on the type of substances present, their electrical conductivity and whether they are in the form of a cloud in the atmosphere or deposited in layers on a surface.

Explosive mixtures

Explosive mixtures combine the hazard from the presence of flammable gas or vapour, and ignitable dust or fibres. The maximum surface temperature for such a mixture will be that of the lowest temperature applicable.

4.5. Hazard Groups and T Classes for Common Gases and Dusts

The explosive substance Group and T Class do not follow each other, a substance may ignite when exposed to a high spark energy or to a low surface temperature (Ethyl Nitrate) or vice versa (Hydrogen).

Annex A gives a list of typical flammable gases and dusts which may be encountered in each hazard sub-division of **Group II** and **Group III**.

5. EXPLOSION PROTECTION CONCEPTS

There are varying types of equipment protection which can be used within hazardous area to ensure that the potential for an explosion is removed or greatly reduced. The apparatus must be designed and manufactured in accordance with parameters known as **protection concepts**. There are four main protection concepts and one 'special' concept within the scope of IEC 60079-0. The four main concepts are:

a) to prevent a potential ignition arising,

b) to limit the ignition energy of the equipment,

c) to prevent the explosive atmosphere contacting the ignition source and,

d) to prevent an internal ignition from escaping outside the equipment.

Annex B lists the available protection concepts and provide more information about those which are most likely to be used for FD&A devices and systems.

There are practical considerations which influence the design of fire detection and fire alarm devices for use in hazardous areas. Fire detectors need to be able to sense the environment into which they are installed to provide their detection function and alarm devices, such as sounders operate by emitting pressure waves directly into the surrounding air. **Annex B** addresses the protection concepts commonly used when protecting FD&A and devices. They include protection by 'intrinsically safe circuits', 'flameproof enclosures, 'encapsulation', 'increased safety', 'ingress-proof enclosures' (i.e. complying to IEC 60529).

6. INSTALLATION AND MAINTENANCE

IEC 60079-14 specifies the requirements for the design, selection, erection and initial inspection of electrical installations in hazardous areas. Because of the additional complexity and cost of ATEX compliance, it is recommended that electrical equipment are installed, as far as is reasonably practicable, in non-hazardous areas. Where this is not possible, then it must be located, as certificated Ex equipment, in an area where an explosive atmosphere is least likely to occur. The appropriate requirements for electrical installations in non-hazardous areas, particularly the recommendations in the different parts of BS 5839 for FD&A systems, must be applied.

The principal installation requirements of IEC 60079-14 are listed in this section.

6.1. Competence of personnel

The design of the system, the selection of equipment and the installation must be carried out by persons trained in the principles of hazard classification, the various types of protection and installation practices. The competency of the person must be relevant to the type of work to be undertaken and the person must undertake appropriate continuing education.

6.2. Access and work on-site

Safe work permit

During site visits it may be necessary for personnel to access and work in classified hazardous areas. In this event, it will be necessary to obtain a **safe work permit** valid for the duration of the work. This permit ensures that the fuel mixture is not expected to be present, in quantities which may give rise to flammable concentrations, during a specified period. The permit may prescribe continuous or periodic gas monitoring and/or detailed actions to be taken in the event of a release.

Personal equipment

Items of personal equipment which are battery or solar operated are sometimes carried by personnel and inadvertently taken into a hazardous area. A basic electronic wristwatch is an example of a low voltage, electronic device which has been independently evaluated and found to be acceptable for taking in a hazardous area. All other personal battery or solar operated equipment must be the subject of a safe work permit procedure.

Employers and their staff must be aware of the potential risk created by static electricity which may be generated by certain kind of fabrics and take appropriate measures before entering the hazardous area.

6.3. Assurance of conformity of equipment

All electrical apparatus in hazardous areas, have to be certificated, with exception of ‘simple apparatus’, by a government appointed Notified Body. They must carry mandatory Ex Markings (see **Fig 1** and **Fig 2**). Apparatus intended for the UK market must have the UKEX as well as the CE Marks if trading in the EU. Third-party approval to a recognised IECEx scheme is sufficient in most countries in the rest of the world except North America.

Fig. 1: Example of Marking for gas atmospheres

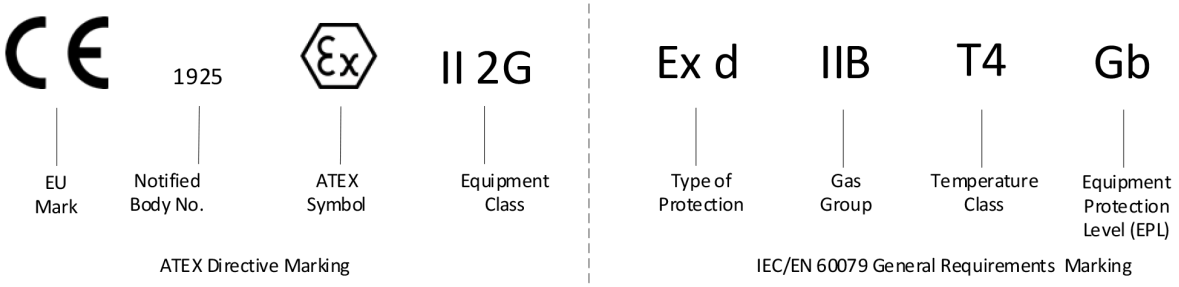
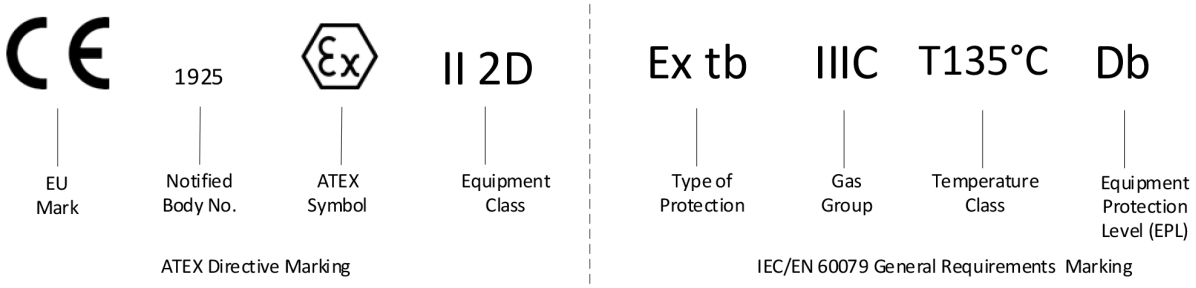


Fig. 2: Example of Marking for dust atmospheres



In the UK, Notified Bodies (NBs) are appointed by UKAS. Appointed organisations and their scope of operation can be found at *https://www.gov.uk/uk-market-conformity-assessment-bodies*. Most NBs can offer UKEX, ATEX and IECEx certification services and, as international organisations, may often be able to offer certification services in other parts of the world such as the USA, Canada or Brazil. In many instances, having products certificated to the IECEx scheme can simplify the testing and certification to local national schemes.

Installation of equipment that does not have a certificate is possible when certificated equipment cannot be sourced if this has been formally verified and documented in the installation verification dossier.

6.4. Selection of equipment

The selection of electrical equipment for hazardous areas must be based on information given in the documentation provided, including:

– Zone classification and, where given, the EPL required;

– Group/sub-Group and ignition temperature of the gas or dust which may be present;

– External influences and ambient temperature;

– Intended application of the equipment.

When the EPL is specified in the area classification documentation, its requirements for selecting the equipment must be followed.

6.5. Installation

Installation of electrical equipment and systems must comply with IEC 60079-14 as well as any other requirements specified for the plant and given in the documentation provided.

Cables and wiring systems

Cables and wiring systems accessories recommended in the BS 5839 series for the installation of FD&A systems are generally suitable for wiring fixed systems in hazardous areas. For other types of systems, the requirements of IEC 60079-14:2014, Clause **9** apply.

Openings in walls for cables and conduits between different hazardous areas and between hazardous and non-hazardous areas must be adequately sealed, for example by means of sand seals or mortar to prevent the flow of hazardous gases.

When it is necessary to connect the screen of a cable to electrical earth, for example to protect sensitive circuits from undue electrical interference, the screen must be connected to earth at one point only. This would normally be at the non-hazardous area end of the circuit to avoid the possibility of the screen carrying circulating current caused by differences in earth potential.

Control and indicating equipment (CIE)

The CIE used in FD&A systems monitors and controls devices installed in both hazardous and non-hazardous areas. Hence, CIE is normally installed in non-hazardous areas. Electrical circuits connecting Ex apparatus must conform to the protection method used, (e.g. Ex d, Ex i, etc.).

Power supply equipment (PSE)

PSE for apparatus in hazardous areas which derive power from the Main's supply or from heavy-duty batteries, are normally installed in a non-hazardous area. PSE conforming to EN 54-4 and having double-insulated transformers are suitable for powering Ex equipment.

Electromagnetic radiation

Equipment capable of receiving radio signals can be installed in hazardous areas if it complies with IEC 60079-14:2014, sub-clause **6.7**, and if adequate protection for the hazard in that area is provided. The standard covers radio frequencies in the range from 6 KHz to 60 GHz and imposes power limits for each equipment group.

6.6. Protection against static electricity

Build-up of static electricity in hazardous areas can be a potential source of igniting sparks. The risk is higher for the lower **Zone** numbers and '**a**' ranking EPLs (see **Table 1**). Requirements for dealing with static electricity can be found in IEC 60079-14:2014, sub-clause **6.5**. The hazardous area would have been designed so that, under normal conditions of use and maintenance, the danger of ignition due to electrostatic charges is avoided. It is important that the installation of FD&A equipment do not add to the risk of electrostatic discharge. This may be achieved by bonding to earth conductive metals and by fixing warning labels on plastic surfaces.

6.7. Specific considerations for IS circuits

IEC 60079-14:2014, clause **16**, specifies additional requirements for intrinsically safe systems. The notable ones are listed below:

Cable parameters

The parameters of cable connecting intrinsically safe apparatus must be less than the value of capacitance (C_C) and inductance (L_C) or (L_C/R_C) for the **Zone** where the apparatus is installed. These parameters depend on the safety barrier used and are specified in the ATEX system certificate.

The connection of IS cable must be protected against ingress to at least a rating of IP20. Cables and associated wiring systems of IS circuits must be identifiable by suitable markings.

Earthing of screens

If a screened cable is used, the screen for that circuit must be earthed at the same point as the intrinsically safe circuit which it is screening, e.g. the safety barrier. If an intrinsically safe circuit or sub-circuit which is isolated from earth is run in a screened cable, the screen shall be connected to the equipotential bonding system at one point.

Simple apparatus

Intrinsically safe circuits can incorporate uncertificated devices without the need for additional protection. These 'simple apparatuses are components or a combination of components which are within the energy-limited safety of the circuit in which they are used. Simple apparatus may include:

a) passive components, e.g. switches, junction boxes, resistors and simple semi-conductors,

b) sources of stored energy consisting of single components with well-defined parameters, e.g. capacitors or inductors, whose values are acceptable for the IS circuit considered,

c) sources of energy which do not generate more than 1,5 V, 100 mA and 25 mW, such as thermocouples.

Simple apparatuses are independent of the equipment protection level. They, and any associated circuits, must be clearly marked as simple apparatus.

6.8. Specific considerations for Flameproof circuits

IEC 60079-14:2014, clause 14, specifies additional requirements for Flameproof systems. The notable ones are listed below.

Certification

Only Ex d equipment having a full Ex certificate (usually marked 'X') and carries a full Ex marking including a T rating must be installed in a hazardous area. Enclosures and components having only a component certificate, marked 'U', cannot be installed.

Solid obstacles

The flameproof flange of Ex d equipment must not be closer to any solid obstacles than the distances specified in IEC 60079-14 sub-clause 14.2, Table 13, unless certificated otherwise.

Protection of flameproof joints

Only protection method specified in the manufacturer's documentation must be used. Flameproof joints shall not be painted and, although painting of Ex d enclosures is permitted, care must be taken that paint doesn't penetrate any gap in the flameproof joints. In the absence of manufacturer's instructions, only corrosion inhibiting grease, such as petroleum jelly or soap-thickened mineral oils, may be used on joint surfaces.

Conduit systems

Explosive gases must not enter conduit systems used for the electrical connection of Ex d equipment. This is normally achieved by ensuring that conduit junctions and conduit connections are gas tight. Requirements for conduit systems used for flameproof equipment are specified in IEC 60079-14 sub-clause **14.4**.

6.9. Initial inspection and verification

On completion of the installation and prior to first use, it is necessary to carry out an initial detailed inspection of the equipment and the installation to verify compliance to all the requirements. Equipment-specific inspection schedules can be found in **Annex C** of IEC 60079-14.

Verification dossier

It is necessary to prepare a verification dossier for each installation. This dossier must show compliance with the relevant equipment certificates as well as with the relevant requirements of IEC 60079-14 and any documentation provided for other requirements specific to the plant. It must be either kept on the premises or stored in another location. In the latter case, a document must be left on the premises indicating who the owner or owners are and where the dossier is kept.

6.10. Maintenance

Like for FD&A systems, regular maintenance of electrical systems in hazardous areas is paramount to their continuing safety during their operational life. Maintenance requirements for Ex equipment, including work schedules, can be found in IEC 60079-17.

7. APPLICABLE STANDARDS

Hazardous area standards

In recent years, an international common standard language has been developed that unifies and regulates the use of equipment and systems in potentially explosive atmosphere. The relevant standards have been adopted by CEN and implemented by the EU as hEN standards for the ATEX Directive. Although there is a plethora of standards addressing different equipment types and installation situations, the standards most relevant to this Guide are:

IEC number	Title	hEN number
IEC 60050-426	International Electrotechnical Vocabulary (IEV) – Part 426: Explosive atmospheres	
IEC 60079-0	Explosive atmospheres – Part 0: General Requirements	EN 60079-0
IEC 60079-1	Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"	EN 60079-1
IEC 60079-5	Explosive atmospheres – Part 5: Equipment protection by powder filling "q"	EN 60079-5
IEC 60079-6	Explosive atmospheres – Part 6: Equipment protection by oil immersion "o"	EN 60079-6
IEC 60079-7	Explosive atmospheres – Part 7: Equipment protection by increased safety "e"	EN 60079-7
IEC 60079-10-1	Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres	EN 60079-10-1
IEC 60079-10-2	Explosive atmospheres – Part 10-2: Classification of areas – Explosive dust atmospheres	EN 60079-10-2
IEC 60079-11	Explosive atmospheres – Part 11: Equipment protection by intrinsic safety "i"	EN 60079-11
IEC 60079-13	Explosive atmospheres – Part 13: Equipment protection by pressurised room "p"	EN 60079-13
IEC 60079-14	Explosive atmospheres – Part 14: Electrical installations design, selection and erection	EN 60079-14
IEC 60079-15	Explosive atmospheres – Part 15: Equipment protection by type of protection "N"	EN 60079-15
IEC/TR 60079-16	Electrical apparatus for explosive gas – Part 16: Artificial ventilation for the protection of analyzer(s) houses	No hEN
IEC 60079-17	Explosive atmospheres – Part 17: Electrical installations inspection and maintenance	EN 60079-17
IEC 60079-18	Explosive atmospheres – Part 18: Equipment protection by encapsulation "m"	EN 60079-18
IEC 60079-31	Explosive atmospheres – Part 31: Equipment protection by enclosure "t"	EN 60079-31
IEC 60529	Degrees of protection provided by enclosures (IP Code)	EN 60529

Fire detection and alarm standards

The BS EN 54 series of product standards for FD&A systems applies to the installation of Ex equipment. They include:

– inputs devices: parts 5, 7, 10, 11, 12, 17, 18, 20, 22, 24, 26, 28, 29, 30 and 31

– output devices: parts 3, 18 and 23

– control equipment: parts 2, 4, 16, and 25

The BS 5839 series of codes of practice for the design, installation, commissioning and maintenance also applies. They include:

– BS 5839-1 for commercial and industrial buildings:

– BS 5839-6 for domestic premises:

– BS 5839-8 for voice alarm systems:

The BS 7273 series of codes of practice deals with the operation of protective measures in case of fire. Five parts of the series addresses recommendations for systems operating electrical devices which could be installed in classified areas. The relevant standards are BS 7273 parts 1, 3, 4, 5 and 6.

ANNEX A

ATEX Apparatus Groups and Temperature Classes for common Flammable Gases and Dusts

A1. Common Flammable Gases and vapours – Group II

Table A1 below lists flammable gases and vapours in for each sub-division: A, B and C together with the Temperature Class required for equipment in the hazardous area.

Table A1: Ignition Temperatures for Common Flammable Gases and Vapours

Gas Group	Temperature Class					
	T1	T2	T3	T4	T5	T6
IIA	Acetone	Ethanol	Diesel	Acetaldehyde		Ethyl Nitrate
	Methane	Cyclohexane	Aircraft Fuel	Ethyl Ether		
	Ethane	Propanol 2	Fuel Oil			
	Benzene	Butyl Alcohol	N-Hexane			
	Methanol	N-butane	Heptane			
	Toluene		Kerosene			
	Propane					
	Ammonia					
	Acetic Acid					
IIB		Ethylene				
		Ethyl Oxide				
			Hydrogen sulphide			
IIC	Hydrogen	Acetylene				Carbon Disulphide

A large percentage of applications require a 'T3' rating. Equipment rated 'T4, T5 or T6' would therefore be suitable for 'T3' applications. However, equipment rated T1 or T2 would not be suitable.

A2. Common flammable dusts and fibres – Group III

Table A2 lists flammable dusts and fibres for each sub-division: A, B and C together with the Temperature Class required for equipment in the hazardous area.

Equipment must not be installed where the surface temperature of the equipment is greater than the ignition temperature of the given hazard. **The temperatures listed must not be exceeded by any equipment installed in the hazardous area**.

Table A2: Ignition Temperatures for Common Flammable Dusts and Fibres

Material	Ignition Temperature	
	Cloud	Layer
Coal Dust	380°C	225°C
Polythene	420°C	320°C
Starch	460°C	435°C
Lead	460°C	240°C
Cellulose	490°C	430°C
Flour	490°C	340°C
Sugar	490°C	460°C
Cocoa	500°C	200°C
Grain Dust	510°C	300°C
Phenolic Resin	530°C	450°C
Polyacrylonitrate	540°C	400°C
Soya Meal	540°C	340°C
Zinc	570°C	440°C
Aluminium	590°C	450°C
PVC	100°C	450°C
Soot	810°C	570°C

ANNEX B

ATEX Apparatus Protection Concepts

Table B1 lists the different protection concepts available to product designers for ensuring equipment are safe in the Zone for which it is intended. Equipment with a protection suitable for Zone 0 can also be used in Zones 1 and 2, products suitable for Zone 1 can also be used in Zone 2, but products designed for use in Zone 2 only cannot be used for lower Zone numbers.

Table B1: Types and applications of equipment protection concepts

Type of Explosion Protection Method	Protection Code	Description	International Standard	Zone Suitability
To prevent a potential ignition arising	Ex e	Increased Safety	IEC 60079-7	1, 2
	Ex -nA	Type "N" protection	IEC 60079-15	2
To limit the ignition energy of the equipment	Ex ia	Intrinsic Safety 'ia'	IEC 60079-11	0, 1, 2
	Ex ib	Intrinsic Safety 'ib'	IEC 60079-11	1, 2
	Ex ic	Intrinsic Safety 'ic'	IEC 60079-11	2
	Ex -nL	Type "N" protection	IEC 60079-15	2
To prevent the explosive atmosphere contacting the ignition source	Ex p	Purge/pressurized protection	IEC 60079-2	1, 2
	Ex px	Purge/pressurized protection "px"	IEC 60079-2	1, 2
	Ex py	Purge/pressurized protection "py"	IEC 60079-2	1, 2
	Ex pz	Purge/pressurized protection "pz"	IEC 60079-2	2
	Ex ma	Encapsulation "ma"	IEC 60079-18	0, 1, 2
	Ex mb	Encapsulation 'mb'	IEC 60079-18	1, 2
	Ex o	Oil immersion 'o'	IEC 60079-18	1, 2
	Ex -nR	Type 'N' protection	IEC 60079-15	2
	Ex ta	Type 'ta' protection	IEC 60079-31	0, 1, 2
	Ex tb	Type 'tb' protection	IEC 60079-31	1, 2
	Ex tc	Type 'tc' protection	IEC 60079-31	2
To prevent the explosive atmosphere contacting the ignition source	Ex d	Flameproof 'd'	IEC 60079-1	1, 2
	Ex q	Sand/powder (quartz) filling	IEC 60079-5	1, 2
	Ex -nc	Type 'N' protection	IEC 60079-15	2
Special	Ex s	Special protection	(see) IEC 60079-0	0, 1, 2

Protection concepts applicable to FD&A devices

Intrinsic Safety – "Ex I"

"Ex i" is an explosion protection concept whereby the electrical energy within the equipment is restricted to a level below that which may cause an ignition. There are three types of intrinsic safety protection: **ia**, **ib** and **ic**. **Type ia** allows for the occurrence of two faults and can be used to protect apparatus in **Zone 0**, **Zone 1** or **Zone 2**. Type **ib** allows for the occurrence of one single fault and can be used to protect apparatus in **Zone 1** or **Zone 2**. Type ic doesn't take into consideration the occurrence of faults and can only be used to protect apparatus in **Zone 2**.

IS protection is achieved by means of Safety Barriers limiting the energy which is transmitted by the IS circuit from the Safe Area to the Hazardous Area. The certified system configuration allows for three types of safety barrier. A brief outline of their characteristics, advantages and disadvantages is given below:

Single Channel Zener Barriers whereby the electrical energy is limited by a network of resistors and shunt Zener diodes. These have minimum restrictions on the operation of fire detectors, but one side must be connected to a high-integrity (safety) earth. Single Channel Zener Barriers are available with either positive or negative polarity. The earthing of the barrier may not always be compatible with the operation of the system CIE. In such cases, an isolating safety barrier should be considered.

Dual-Channel Zener Barriers are similar to single channel barriers but have networks of limiting and shunting Zener diodes in both lines of the IS circuit. They have similar advantages but present a high impedance between the IS circuit and the high-integrity (safety) earth. They are more appropriate for use with partially floating voltage detection circuits.

Galvanically Isolated Barriers (also known as transformer isolated barriers) differ from conventional shunt Zener barriers in that they provide electrical isolation between the input (safe area) and the output (hazardous area). This is achieved by the use of a dc converter on the input side which is connected to the hazardous area through a voltage-and power-limiting resistor/zener combination similar to a conventional barrier. This galvanic isolation technique means that the circuit does not need a high integrity safety earth and that the intrinsically safe circuit is fully floating. Earth leakage problems for control and indicating equipment are therefore eliminated if this type of barrier is used. It is permissible to earth the screen of the associated IS cable if required by other system considerations.

Typically, the intrinsic safety protection concept is used in smoke detectors and heat detectors which require the sensing element or elements to be in direct contact with the environment.

Flameproof enclosure – "Ex d"

"Ex d" is an explosion protection concept in which the equipment that may cause an explosion is contained within an enclosure which can withstand the force of an internal explosion and prevent transmission of explosive energy to the outside. "Ex d" protection also prevents the hazardous atmosphere from entering the enclosure. It imposes specific requirements on the mechanical and electrical construction of apparatus and can only be used in **Zone 1** or **Zone 2**.

A typical application of the flameproof protection method for FD&A devices is its use in light receiving or emitting radiation devices such as flame detectors or visual alarm devices.

Encapsulation – "Ex m"

Ex m is an explosion protection concept whereby the component or circuit that could potentially cause an ignition is encapsulated to prevent contact with the explosive atmosphere. This concept also limits the surface temperature of the equipment under normal operating conditions. It can only be used in the protection of electrical equipment in **Zone 1** or **Zone 2** classified areas.

Encapsulation is unlikely to be used as the main means of protection in FD&A devices. It may, however, be employed to protect specific components or group of components that have sparking characteristics.

Increased safety – "Ex e"

"Ex e" is an explosion concept applied to the hazardous area installation to ensure increased security against the possibility of excessive temperatures and sparks from electrical equipment. "Ex e" can only be used for the protection of electrical equipment in **Zone 1** or **Zone 2** classified areas. Devices that normally cause sparks are excluded from use in this method of protection.

Non-Sparking – "Ex N"

"Ex N" is an explosion protection concept like Ex e whereby precautions are taken to ensure that hazardous area electrical equipment is secured against the possibility of excessive temperatures and igniting sparks. It uses enclosures constructed and certified as 'explosion protected' according to IEC 60079-7. It is only suitable for use in **Zone 2** classified areas.

Requirements for 'explosion protected' enclosures include air and creepage gaps between conductors, minimum cross-section for winding wire, impregnation of coils, protective measures for uninsulated live parts and ingress protection (IP).

Typical applications of Ex N for FD&A equipment and systems include junction boxes, connection racks, batteries and transformers enclosures, and end-of-line devices.

Non-Sparking – "Ex t"

"Ex t" is an explosion protection concept whereby an enclosure is used to restrict dust ingress and to provide means to limit surface temperatures. It is split into 3 protection levels: "Ex ta", "Ex tb" and "Ex tc", for **Zones 0**, **1** and **2** respectively.

DISCLAIMER

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