

DEVELOPMENT OF EUROPEAN STANDARDS: NON-ELECTRICAL EQUIPMENT FOR USE IN EXPLOSIVE ATMOSPHERES

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The European standards body, CEN, has a mandate to produce standards in support of Directive ATEX 100 which specifies requirements for both electrical and no-electrical equipment for use in potentially explosive atmospheres. This work is being carried out in the technical committee CEN/TC 305 with working group WG2 being responsible for standards for non-electrical equipment. The paper describes the development and current status of the standards being produced and the reasons for the differences between the standards for electrical and non-electrical equipment. In particular the requirements contained in the European standard EN 13463 part 1 "Non-electrical equipment for potentially explosive atmospheres -Part 1: Basic method and requirements" with its specification that manufacturers must carry out an ignition hazard assessment for the classification of equipment are elaborated.

Explosive atmospheres, Standards, ATEX, Non-electrical equipment

INTRODUCTION

In order to help manufacturers of equipment and protective systems intended for use in potentially explosive atmospheres meet the Essential Safety Requirements relating to EU Directives 89/392/EC [1] (machinery directive) and 94/9/EC [2] (ATEX 100A) mandated standards for non-electrical equipment are being prepared by CEN/TC305 Working Group 2. *EN 1127 – 1 Explosive atmospheres – Explosion prevention and protection Part 1: Basic concepts and methodology* [3] is a type A standard and sets out the overall philosophy of explosion prevention and protection. The standards currently being prepared by WG2 are type B standards and set out the requirements for specific means of prevention and protection which can be used for different types of equipment.

The first of these standards provides the basic method and requirements and is the core document which sets out the philosophy, concepts and requirements for all the standards in this series while parts 2 to 8 give the requirements for the specific 'types of ignition protection' which may be used.

TYPES OF 'IGNITION PROTECTION MEASURES'

STATUS OF THE STANDARDS

Table 1 lists the current standards in the EN13463 series and their current status. In addition a subgroup of WG2 is preparing a type C product standard on the construction and specifications for fans working in potentially explosive atmospheres.

Although there appears at first sight to be a degree of similarity between the standards being developed for non-electrical equipment and those currently available for electrical equipment, there are in fact major differences. These arise because in normal operation the majority of non-electrical equipment does not constitute an ignition source whereas the converse is often true for electrical equipment.

Table 1. Status of the EN 13463 Standards as of September 2002

EN 13463 Part No:	Title	Status
1	Basic method and requirements	Published Jan 2002
2	Protection by flow restricting enclosure (fr)	Public Enquiry (ends 22.03.03)
3	Protection by flameproof enclosure (d)	Public Enquiry (ends 22.02.03)
4	Protection by inherent safety (g)	Draft
5	Protection by constructional safety (c)	Vote (ends 08.10.02)
6	Protection by control of ignition sources (b)	Public Enquiry (ends 22.02.03)
7	Protection by pressurisation (p)	Draft
8	Protection by liquid immersion (k)	Vote
	Safety requirements for ignition protected fans	Public Enquiry

EN 13463-1 PART 1 BASIC METHOD AND REQUIREMENTS

EN 13463-1 "Non-electrical equipment for potentially explosive atmospheres Part 1: Basic method and requirements" was finally published in January 2002. The standard provides a methodology for classifying equipment into the different Categories of Group I and Group II. The standard requires the manufacture to carry out a formal documented hazard analysis that identifies and lists all of the potential sources of ignition by the equipment and the measures to be applied to prevent them becoming effective. Examples of such sources include hot surfaces, naked flames, hot gases/liquids, mechanically generated sparks, adiabatic compression, shock waves, exothermic chemical reaction, thermite reactions, self ignition of dust, electrical arcing and static electricity discharges.

If equipment is designed and constructed according to good engineering practice and the ignition hazard assessment ensures that the equipment does not contain any effective ignition sources in normal operation, the equipment can be classified as category 3 equipment. Similarly where the ignition hazard assessment ensures that the equipment does not contain any effective ignition sources during foreseeable malfunctions or rare malfunctions, the equipment can be classified as category 2 or category 1 equipment respectively.

SCOPE OF EN 13463-1

Part 1 of the standards for non-electrical equipment for potentially explosive atmospheres specifies the basic method and requirements for design, construction, testing and marking of non-electrical equipment intended for use in potentially explosive atmospheres of gas, vapour, mist and dusts. It is valid for atmospheres having pressures ranging from 0,8 bar to 1,1 bar and temperatures ranging from –20 °C to + 60 °C. It also includes atmospheres that can exist inside the equipment if, for example, the external atmosphere can be drawn inside the equipment by natural breathing produced as a result of fluctuations in the equipment's internal operating pressure, and/or temperature.

The standard may also be used for the design, construction, testing and marking of equipment intended for use in atmospheres outside the validity range stated above, but in this case, the ignition risk assessment, ignition protection provided, additional testing (if necessary), manufacturer's technical documentation and instructions to the user, shall clearly demonstrate and indicate the equipment's suitability for the conditions it may encounter.

METHODOLOGY FOR CLASSIFYING EQUIPMENT INTO DIFFERENT CATEGORIES

The standard contains a methodology which will enable equipment manufacturers to classify non-electrical equipment into the different categories. This is shown diagrammatically in figure 1.

Equipment Intended for use in a Potentially Explosive Atmosphere

All equipment is intended for use in a potentially explosive atmosphere needs to be assessed to determine if there are effective ignition sources present in normal operation, or if there are sources that might become effective if faults occur. In performing this assessment, account has to be taken, not only of the equipment's moving parts, but also the equipment's enclosure. This is because some enclosure materials pose an effective ignition risk in normal operation irrespective of their contents . For example, enclosures made of light alloys or plastics, which can give rise to either thermite ignition when struck by rusty steel, or by electrostatic discharge when rubbed by other materials or contacted by flowing liquids. It is for this reason that even relatively innocuous mechanical mechanisms have to be assessed. The requirements of this standard do not apply to a piece of equipment with no potential ignition sources.

Ignition Hazard Assessment

The ignition hazard assessment, described in Section 5.2 of the standard, and explained below, is used both to identify potential sources of ignition in a piece of equipment and also to determine whether any applied protective measures render these non-effective.

Eliminate the Ignition Source(s)/prevent them becoming Active/or Apply Protective Measures

These include measures to ensure that the ignition source does not arise, measures to ensure that the ignition source cannot become active, measures to prevent the explosive atmosphere reaching the ignition source or measures to contain the explosion and prevent flame propagation. The various protective measures and the corresponding different types of ignition protection are applied in addition to the measures described in this standard.

The application of a protective measures is designed to make the ignition source non-effective. The ignition source may or may not be eliminated depending on the protective measure or type of ignition protection applied.

Whether a protective measures has to be applied and how many depends on the result of the ignition hazard assessment and the desired final classification of the equipment. For example:

- No protective measures are required and a piece of equipment may be classified as Category 3, 2 or 1 if the ignition hazard assessment shows that it has no effective ignition source during normal operation, expected malfunctions or rare malfunctions respectively, provided that the requirements of this standard are applied.

- A single appropriate protective measures will be required for a piece of equipment which in normal operation has no effective ignition source but has an effective ignition source during expected malfunctions in order for it to be classified as Category 2. The requirements of this standard and of the chosen ignition protection standard have to be applied.
- Two appropriate protective measures will be required for a piece of equipment which has an ignition source both in normal operation and during expected malfunctions in order for it to be classified as Category 2. The requirements of this standard and of both the chosen ignition protection standards have to be applied.

A similar logic applies for the classification of Category 1 equipment. The use and limitations of the types of ignition protection are given in the individual ignition protection standards.

Is the Equipment Capable of Igniting the Explosive Atmosphere during Normal Operation/Expected Malfunctions /Rare Malfunctions?
The classification of a piece of equipment into Category 3, 2 or 1 depends on the result of the ignition hazard assessment of the equipment together with any protective measures that are applied. Potential ignition sources may have been rendered non-effective, by means of one or more appropriate types of ignition protection. This depends on the category of equipment that is required and whether effective ignition sources occur in normal operation or during expected malfunctions or rare malfunctions.

IGNITION HAZARD ASSESSMENT

The standard requires that all equipment and all parts of it shall be subjected to a formal documented hazard analysis that identifies and lists all of the potential sources of ignition by the equipment and the measures to be applied to prevent them becoming effective. Examples of such sources include hot surfaces, naked flames, hot gases/liquids, mechanically generated sparks, adiabatic compression, shock waves, exothermic chemical reaction, thermite reactions, self ignition of dust, electrical arcing and static electricity discharge.

Consistent with the requirements of the ATEX 100a Directive the standard specifies that protective measures/types of protection shall be considered and/or applied in the following order:

- ensure that ignition sources cannot arise
- ensure that ignition sources cannot become effective
- prevent explosive atmosphere reaching the ignition source
- contain the explosion and prevent flame propagation

The ignition hazard assessment document will differ according to the different equipment groups and categories of equipment in a particular group. The standard requires that the results of the ignition hazard assessment shall include as a minimum, information on all potential ignition sources, the measures which have been applied to prevent the sources becoming effective, and the ignition protection used.

The manufacturer has to record the results a defined tabular format and the hazard assessment report must be included with the required technical documentation which demonstrates compliance with the standard. An example of the form for recording the results for equipment group II is shown in table 2.

Two examples of completed ignition hazard assessments are included in the standard to help manufacturers and users of the standard.

Table 2. Defined format for recording the Ignition Hazard Assessment (given in EN13463-1)

Potential ignition source				
Normal operation (Cat. 3)	Foreseeable malfunction (Cat. 2)	Rare malfunction (Cat. 1)	Measures applied to prevent the source becoming effective	Ignition protection used

MAXIMUM SURFACE TEMPERATURE

To maintain consistency with standards for electrical equipment, the temperature classes T1 to T6 are used to classify the maximum surface temperature for Group IIG equipment. The safety margin to the minimum ignition temperature of the potentially explosive atmosphere as required by EN1127-1 has been included in the defined maximum surface temperature of the equipment so that the temperatures are directly comparable with those for electrical equipment.

ELECTROSTATIC HAZARDS

The standard includes requirements to prevent the occurrence of electrostatic hazards. These apply to any non-conductive parts of the equipment exposed to the explosive atmospheres and susceptible to electrostatic charging. The requirements are based on the recommendations in the CENELEC report [4]

Occurrence of Highly Efficient Charge Generating Mechanisms (Propagating Brush Discharges)

Where propagating brush discharges can arise following highly efficient charging of non-conductive layers and coatings on metal surfaces the standard requires that they shall be prevented in both Group I and Group II equipment from occurring by ensuring that the breakdown voltage across the layers is less than 4 kV.

For Group IID equipment to be used only in the presence of dust atmospheres with a minimum ignition energy of greater than 3 mJ propagating brush discharges can also be prevented by ensuring that the thickness of the non-conducting layer is greater than 10 mm.

Occurrence of Brush Discharges

The occurrence of brush discharges are prevented by the requirement that the projected surface areas conductive materials shall be so designed that under normal conditions of use, maintenance and cleaning, danger of ignition due to electrostatic charges is avoided.

For Group I equipment of both Category M1and M2 this requirement applies when the surface area projected in any direction of more than 100 cm^2.

For Group II equipment the standard requires that it shall be so designed that under conditions of use, maintenance and cleaning, danger of ignition due to electrostatic charges is avoided. Three means are provided for satisfying this requirement:

- by suitable selection of the material so that the insulation resistance of the enclosure does not exceed 1 GΩ at (23 ± 2) °C and (50 ± 5)% relative humidity,
- or by virtue of the size, shape and lay-out, or other protective methods, such that dangerous electrostatic charges are not likely to occur. For category 2G equipment this requirement can be satisfied by using the test provided in Annex C of the standard.
- or by limitation of the surface area projected in any direction of non-conductive parts of equipment liable to become electrostatically charged as shown in the table 3:

To prevent incendive brush discharges, the thickness of layers or coatings of plastic (non-conductive) solids on earthed metal (conducting) surfaces which can become charged in Group IIG equipment shall not exceed 2 mm in the case of gases and vapours of Group IIA and IIB or 0.2 mm in the case of gases and vapours of Group IIC.

There is no need to prevent brush discharges and hence no restriction on the thickness of layers or coatings of plastic (non-conductive) solids on earthed metal (conducting) surfaces which can become charged in Group II equipment intended for use on potentially explosive dust atmospheres with a minimum ignition energy of greater than 3 mJ.

Table 3. Permitted maximum projected areas for non-conductive parts of equipment liable to become electrostatically charged

Category	Permitted area cm²			
	Dusts (MIE < 3 mJ)	IIA	IIB	IIC
1	250	50	25	4
2	500	100	100	20
3	No limit *	No limit*	No limit*	No limit*

*unless the intended use of the equipment can result in frequent incendive discharges occurring in normal operation, in which case the criteria for Category 2 equipment shall apply.

These values may be multiplied by 4 if the exposed flat areas of plastics are surrounded by conductive earthed frames.

CONTENTS OF THE ‘IGNITION PROTECTION MEASURES STANDARDS

PART 2: PROTECTION BY FLOW RESTRICTING ENCLOSURE (fr)

Protection by flow restricting enclosure is “... a type of ignition protection which, by sealing of the means of an enclosure, reduces the probability of ingress of a surrounding explosive atmosphere into the enclosure to an acceptably low level so that the concentration inside the enclosure is below the lower explosive limit. ” (Definition from prEN 13463-2).

Experience has shown that even simple enclosures can prevent a surrounding explosive atmosphere from reaching ignition sources inside them. flow restricting enclosures are such simple enclosures, which will prevent, with adequate probability, the atmosphere inside the enclosures becoming explosive if the atmosphere outside the enclosure becomes explosive rarely and for a short duration only. For this reason their use is restricted to the fulfilment of the requirements of Group II - Category 3 equipment.

An explosive atmosphere surrounding an enclosure can penetrate it mainly due to the influence of three mechanisms, namely: ventilation, equalisation of pressure differences between the inside and outside (breathing), and diffusion.

If such an enclosure is effectively sealed, but not necessarily gas-tight, it can be assumed that ventilation and diffusion will not cause a significant short-time exchange of atmosphere. Under these conditions, an exchange of the external and internal atmospheres through the seals will only take place if there is a pressure difference across them. Such pressure differences may be caused by changes in temperature and will result in the enclosure "breathing" but will not cause a significant flow of atmosphere into or through the enclosure

PART 3: PROTECTION BY FLAMEPROOF ENCLOSURE(d)

Since its conception, protection by flameproof enclosure has been developed to allow many kinds of continuously sparking equipment to be used safely in places where a potentially explosive atmosphere exists. For electrical equipment, this type of protection is well known for protecting power arcing components and is defined and described in EN 50018. As the electrical equipment standard contains the generic testing, verification and marking requirements, unnecessary duplication of the requirements in this non-electrical equipment standard is avoided by cross reference to the electrical standard. In this standard, only those differences necessary for the purpose of providing protection for non-electrical equipment are written in full.

The basic principle of ignition protection by the use of a flameproof enclosure, is that gases, or vapour, may enter the enclosure through the cover joints/flanges and if an explosive atmosphere inside the enclosure ignites, neither the enclosure will be deformed significantly, nor flame transmitted through the joints/flanges to the explosive atmosphere outside. For this reason the enclosure has to be both robust and have dimensionally controlled cover joints/flanges with maximum allowable safe gaps appropriate for the types of explosive gas/vapour likely to occur inside the equipment

EN 50018 does not consider explosive atmospheres formed by dusts, except for Group I, category M2 electrical equipment, where its associated General Requirements document - EN 50014, states that flameproof equipment designed, constructed and tested for use in explosive atmospheres of firedamp (explosive mine gas consisting mainly of methane) needs no alteration, or further testing to allow it to be used where a coal dust cloud is present.

The flame proof enclosures standard for non-electrical equipment has been extended to allow the concept to be used in potentially explosive dust atmospheres. The concept used for protecting equipment against dust cloud ignition in this standard for both Group I, Category M2 mining equipment, and Group II, Category 2G and 2D non-mining equipment is the testing of an enclosure in a gas/air mixture. This is because it introduces an acceptable safety factor against ignition and it allows a much more simple method of testing and verifying its explosion protection properties.

Examples of non-electrical types of equipment that can be protected by flameproof enclosure include equipment with potentially hot rubbing surfaces exceeding the ignition temperature of the atmosphere surrounding them, e.g. friction clutches and brake linings.

PART 4: PROTECTION BY INHERENT SAFETY (g)

The concept of this standard is to define limits for energy and relative speed between movable components of equipment below which it is impossible to form ignition sources. Two methods to realise this are:

- Definition of limits for energy and relative speed preventing the formation of ignitable sparks or hot surfaces in any potentially explosive atmosphere. Mechanical equipment which is small enough or designed to make it impossible to exceed these limits may be used in any potentially explosive atmosphere without additional hazard assessment.
- Definition of acceptable limits for energy and relative speed in dependence on the probability of occurrence and type of explosive atmosphere. The higher the impact energy and the relative speed between movable parts the higher is the probability of generating ignitable sparks or hot surfaces. The idea of defining limits is that the increase of the probability of generating ignitable sparks or hot surfaces has to be related to the decrease in the probability of occurrence of explosive atmospheres and their ignition energy. This then provides a relationship between the category of the equipment and its use. Mechanical equipment which is designed to make it impossible to exceed limits defined for a given zone may be used as equipment of the respective category in this type of explosive atmosphere without additional hazard assessment.

This concept is being developed into a draft standard in the working group.

PART 5: PROTECTION BY CONSTRUCTIONAL SAFETY (c)

The type of protection "constructional safety" is defined as a "type of ignition protection in which constructional measures are applied so as to protect against the possibility of ignition from hot surfaces, sparks and adiabatic compression generated by moving parts.", (Definition from prEN 13463-5)

Mechanical (non-electrical) equipment has been used for decades in potentially explosive atmospheres. Effective ignition sources were most frequently avoided by application of sound engineering principles so that the probability of creating high temperatures or mechanical sparks which could act as an ignition source was reduced to an appropriate level. These measures are part of the safe construction of the equipment based on sound engineering principles and provide ignition protection without additional protection measures thus, this equipment is "constructionally safe".

The standard provides requirements relating to materials for external enclosures and exposed equipment parts, ingress protection, gaskets and sealing arrangements, lubricants/coolants/fluids, moving parts, bearings, power transmission systems, clutches and couplings, brakes and braking systems; springs and absorbing elements and conveyor belts.

PART 6: PROTECTION BY CONTROL OF IGNITION SOURCES (b)

The type of protection "control of ignition sources" is defined as "a type of ignition protection applied to one or more potential ignition sources in non-electrical equipment, whereby integral sensors detect impending operation likely to cause an ignition and initiate control measures before a potential ignition source becomes an effective ignition source. The control measures applied may be either automatic, or manual." (Definition from prEN 13463-5)

Many types of non-electrical equipment intended for use in potentially explosive atmospheres of gas, vapour, mist and/or combustible dust, do not contain an effective ignition source in normal operation. However, there is a risk that an ignition source might arise in such equipment if the moving parts suffer a malfunction or an abnormal operation occurs.

An example of this is turbine, having high speed rotating blades fixed to a shaft, supported on rolling element bearings, inside a stator. In normal operation no ignition capable frictional ignition sources should be present. However, because the clearances between the rotor and stator are very small, malfunctions such as the collapse of a shaft bearing, distortion of a rotating blade, build up of foreign material on a rotating blade, etc. could cause the clearance to be reduced and frictional sparking, or hot surfaces, to occur.

To prevent potential ignition sources from becoming effective during normal operation, malfunction and rare malfunction, it is possible to incorporate sensors into the equipment to detect impending dangerous conditions and initiate control measures at an early stage of deterioration before the potential sources are converted into effective sources. The control measures applied, may be initiated automatically, via direct connections between the sensors and the ignition control actuators, or manually, by providing a warning to the equipment operator (With the intention of the operator applying the ignition control measures e.g. by stopping the equipment).

In this standard, the incorporation of such sensors and their associated automatic/manual ignition control measures, to prevent potential ignition sources becoming effective ignition sources, is known as protection by "Control of ignition source 'b' ".

This type of ignition protection, and the devices used to achieve it, can take many forms. In practice, they may be mechanical, electrical, optical, visual or a combination of all of these. Some examples of simple mechanical sensor/actuator devices are fusible plugs centrifugal speed governors, thermostatic valves, pressure relief valves (using springs or weights), etc.. Although this standard deals with the ignition protection of non-electrical equipment, it nevertheless has to take account of the fact that an increasing amount of non-electrical equipment makes use of electrical sensors to detect and initiate the ignition control measures. It is therefore impossible to produce a non-electrical equipment protection standard without making reference to the use of electrical sensors and their associated ignition control actuator circuits.

Some examples of combined electro-mechanical sensor/actuator devices are temperature, flow and level monitoring/control devices, optical pulse counters, that sense abnormal rotational speeds, vibration sensors, that detect abnormal vibration, from e.g. rolling element bearings, before they fail, conveyor belt alignment devices, power transmission belt tension devices, wear detectors on clutches, that detect unacceptable wear likely to cause frictional heating by incorrect engagement of the clutch.

Such sensor/actuator control devices may be either, continuously active in normal operation of the equipment (e.g. to control the temperature of category 3 equipment), or be arranged so that they only to detect abnormal operation (e.g. to detect impending dangerous over-temperature in category 2 equipment).

Integrity of the Protection System – Functional Failure Rates (FFR)

As malfunction of any of the above sensors/actuator control devices, may result in failure to apply the appropriate ignition control measure, they must be considered to be safety related parts of the equipment. This ignition protection standard therefore calls for them to be assessed and suggests a minimum quality for such devices in the form of a Functional Failure Rate (FFR) that the equipment manufacturer must attempt to achieve.

Thus, to meet the requirements of this standard, the non-electrical equipment manufacturer has to perform both the ignition hazard assessment (Required by EN 13463-1), and additionally, a risk evaluation, to determine the Functional Failure Rate (FFR) necessary to ensure that the sensors/ignition control actuators function when they are called upon to contain the ignition risk within tolerable limits.

The Functional Failure Rate (FFR) is defined as a level of risk reduction to be aimed for by the equipment manufacturer as a result of an evaluation of the ignition risk, caused by the failure of a sensor or ignition control actuator to perform its intended function, at the same time as a potential ignition source in the equipment converts into an effective ignition source in the presence of an explosive atmosphere. Three classes of FFR are defined depending on the probability of occurrence of the above three events occurring simultaneously, i.e. the occurrence of the ignition source, the failure of the control system and the presence of an explosive atmosphere, the latter being defined by the category of the equipment. FFR1 is defined as a low probability of all three events occurring simultaneously; FFR2 has a foreseeable probability and FFR3 has a high probability.

Criteria used in the Different Functional Failure Rate Levels

One of the main difficulties facing a manufacturer in using control of ignition sources as a means of protection is the selection and classification of integrity of the control system to be used as there are currently no defined criteria for non-electrical control systems. The standard therefore specifies criteria which have been based on the concepts used in various European Standard. Thus *EN 954-1 "Safety of Machinery – Safety related parts of control systems : Part1: General principles for design."* written by CEN/TC/114 to assist machinery manufacturers, describes 5 categories (B, 1, 2, 3 and 4) that can be applied to assess the quality of the safety related parts of machinery control systems. Although not specifically written for the purpose of assessing ignition control devices, some of the principles described in that standard have been used in the development of the criteria used in prEN 13463-6.

In the case of electrical control systems, the International Electrotechnical Commission Standard IEC 61508 "Functional safety of electrical/electronic/ programmable electronic safety-related systems", was written by IEC/65A to assist manufacturers of safety related systems. It contains the requirements for four Safety Integrity Levels (SIL 1, 2, 3 and 4) that can be applied to describe the quality of the safety related parts of a control system. Following the recent publication of the seven parts of IEC 61508, some member state test authorities have announced their intention to offer a service for checking such safety related components and protective systems and provide manufacturers with an attestation of its Safety Integrity Level (SIL) rating. In addition IEC/TC/44 Committee has recently started work on a document that is the equivalent of EN 954-1 for electrical/electronic and programmable controlled machine safety. This is based on IEC 61508 and was circulated in September 2000 as IEC draft 44/292/CD. When published this latter document will give more definitive guidance on the SILs of safety related parts of machines.

At the present time however, most sensors and ignition control actuators used for the purpose of this standard will not have been assessed or given a SIL rating, and in addition these are not applicable to non-electrical control systems. Thus in order to provide a common classification of the control systems to be used for ignition protected equipment and in order to easily link these to the 3 categories of equipment the standard specifies three "Functional Failure Rate " levels.

Application of a Functional Failure Rate (FFR) to Different Categories of Equipment

The likelihood that a hazard will occur increases from Function Failure Rate class 1 to 3 and this is reflected in more stringent requirements for the control system for FFR1 to FFR3, i.e. control systems of class FFR3 have therefore a higher reliability. Thus suitable sensors and/or ignition control actuators for use with a FFR of 1 are characterised by well tried components, having a proven history of reliability, assembled and installed in accordance with any relevant standards, adopting well tried safety principles, able to withstand expected influences during operation of the equipment and checked for failure to perform their intended functions at each periodic maintenance check on the equipment, while FFR3 systems have to be so arranged that a single fault on a sensor, or ignition control actuator, does not cause loss of the ignition protection and any such fault is immediately detected at the time it arises. The following table shows the link between the likelihood of occurrence of an ignition source (identified by the manufacturer during the ignition hazard assessment described in EN13463 Part-1), the desired category of the equipment and the resulting Functional Failure Rate class.

For Category 3 Non-electrical Equipment

This equipment, by definition, does not contain sources of ignition in normal operation. To meet this basic requirement, it will not therefore usually be necessary to apply additional Control of Ignition Source 'b' protection to cater for abnormal operation of the equipment. The exception to this, is equipment that has to be controlled by some device as part of its normal operation. For example, a speed control device fitted to ensure that a rotating part of a machine maintains the correct speed in normal operation. In this case, the speed control device can be interpreted as an "Ignition control actuator" as described in this standard.

Table 4. Minimum FFR requirements for a single sensor/ignition control actuator used to protect Group II equipment

Ignition source	Category 3	Category 2	Category 1
Foreseeable in normal operation	FFR 1	FFR 2	FFR 3
Foreseeable during malfunction	Not relevant for category 3	FFR 1	FFR 2
Foreseeable during rare malfunction	Not relevant for category 3	Not relevant for category 2	FFR 1

It is also be possible to fit a Control of Ignition Source 'b' device to normal industrial equipment, thereby convert it from equipment that is not intended for use in a potentially explosive atmosphere to a type that meets the definition of category 3 equipment.

In the above cases, the probability of the control actuator failing at the same time as an explosive atmosphere occurs will be rare and consequently FFR1 has therefore been assigned by this standard to those ignition control sensors/actuators used to protect category 3 equipment.

For Category 2 Non-electrical Equipment

This category of equipment needs to be protected against ignition sources occurring in normal operation and also with foreseeable faults on the equipment. In this case, the probability of an ignition source developing in the equipment at the same time as its associated ignition control actuator is faulty and an explosive atmosphere is present is higher than for category 3 equipment. Nevertheless, the mid-range functional failure rate will suffice. FFR 2 is therefore been assigned by this standard to those ignition control sensors/actuators used to protect category 2 equipment.

For Category M2 Non-electrical Equipment

Category M2 equipment needs to be ignition protected and suitable for the severe operating conditions of use found in gassy mines, but it is intended to be de-energised if an explosive atmosphere occurs. The probability of an ignition source developing in the equipment at the same time as its associated ignition control actuator is faulty and an explosive atmosphere is present is therefore higher than category 3, but not as high as category 2 because of its intended short time exposure to an explosive atmosphere. A mid-range functional failure rate will however suffice. FFR 2 has therefore been assigned by this standard to those ignition control sensors/actuators used to protect category M2 equipment.

For Category 1 and Category M1 Non-electrical Equipment

Category 1 equipment needs to be ignition protected in normal operation, also with foreseeable faults and rare faults applied to the equipment. Category M1 equipment needs to be ignition protected to a very high level, also be suitable for the changing conditions in mines and continued use in an explosive gassy mine atmosphere.

The definitions and requirements for both categories of equipment also include reference to such equipment being either safe with more than one fault applied, or double ignition protected. Thus a commensurate high functional failure rate class is needed. FFR 3 is therefore been assigned by this standard to those ignition control sensors/actuators used to protect category 1 and category M1 equipment.

A flow diagram shown in figure 2 is provided which illustrates this procedure.

PART 7: PROTECTION BY PRESSURISATION (p)

As with the standard on flameproof enclosures, the electrical standard on pressurisation is being extended to cover the situation of equipment for use in potentially explosive dust atmospheres. A draft is in preparation.

PART 8: PROTECTION BY LIQUID IMMERSION (k)

The type of protection "liquid immersion" is defined as is a "type of protection in which potential ignition sources are made ineffective or separated from the flammable atmosphere by either totally immersing them in a protective liquid, or by partially immersing and continuously coating their active surfaces with a protective liquid in such a way that an explosive atmosphere which may be above the liquid, or outside the equipment enclosure cannot be ignited." (Definition prEN13463-8).

Certain types of non-electrical equipment, intended for use in potentially explosive atmospheres of gas, vapour and/or dust, have their potential ignition sources rendered ineffective by either submersing them in a protective liquid, or by continuously coating them with a flowing film of protective liquid. In some equipment, the protective liquid is provided solely for the purpose of preventing the potential ignition sources from becoming effective. In other equipment, the protective liquid serves additional purposes, such as lubricating and/or cooling moving parts, or as in the case of hydraulic systems, for transmitting energy. In some equipment, the protective liquid may be the actual process liquid itself.

Examples of the kinds of equipment utilising this type of ignition protection are oil immersed disc brakes, diaphragm and other submersible pumps used for delivering flammable liquids, oil filled gearboxes, fluid couplings etc. In all of the above, ignition protection is achieved by the fact that protective liquid prevents the surrounding explosive atmosphere from coming into contact with the ignition source(s) by continuously coating, and/or lubricating and cooling the moving parts.

A similar type of ignition protection, known as oil immersion "o", has been used for many years for electrical equipment, where, in addition to the above, the liquid also acts as an electrical insulating medium. It is for this latter reason that this standard cannot be applied to electrical equipment, because it allows the use of liquids that conduct electricity.

SAFETY REQUIREMENTS FOR IGNITION PROTECTED FANS

This draft standard specifies the basic methods and requirements for design, construction, testing and marking of complete fan units intended for use in potentially explosive atmospheres in air containing gas, vapour, mist and/or dusts. Such atmospheres may exist inside, outside or inside and outside of the fan. A draft standard is available.

CONCLUSIONS

The development of standards for non-electrical equipment for use in potentially explosive atmospheres is progressing satisfactorily with the important first standard on Basic method and requirements now published. The standard includes many novel aspects when compared with the equivalent standard for electrical equipment and requires that the manufacturer carries out an ignition hazard assessment. Requirements are given for both equipment groups I and II and for the different categories of equipment. In addition specific requirements are given for non-conductive parts of equipment to protect against the hazards of electrostatic charging.

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REFERENCES

1. Machinery Directive 98/37/EC
2. ATEX100a (Equipment for use in potentially explosive atmospheres) Directive 94/9/EC
3. EN 1127 – 1 Explosive atmospheres – Explosion prevention and protection Part 1: Basic concepts and methodology
4. CENELEC report R044-001 Safety of machinery – Guidance and recommendations for the avoidance of hazards due to static electricity

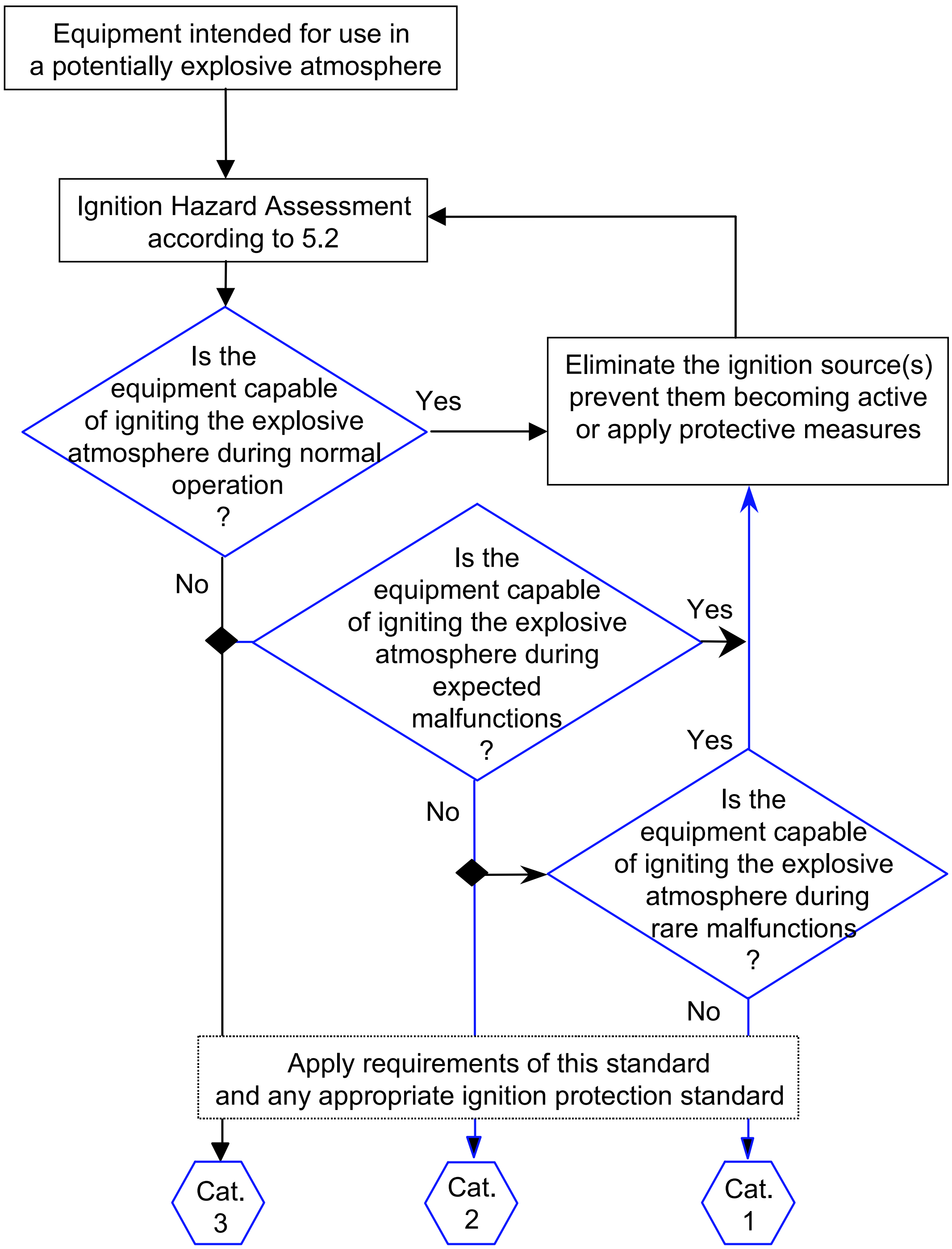

Figure 1. Methodology for classifying equipment into the different categories of group II

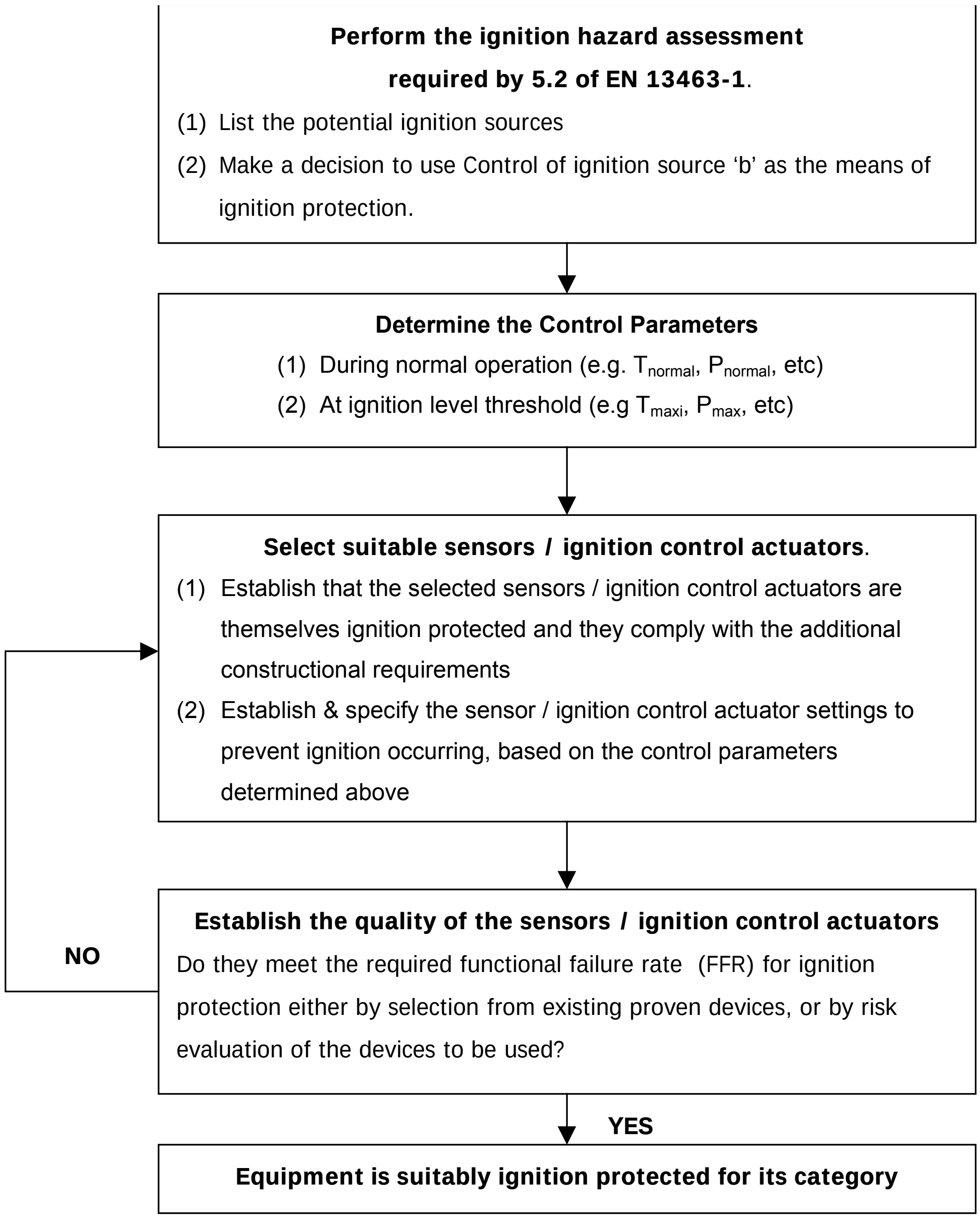

Figure 2. Flow diagram showing steps in the design of control of ignition sources protection