# UL 60079-33

Explosive Atmospheres – Part 33: Equipment Protection by Special Protection “s”

UL Standard for Safety for Explosive Atmospheres – Part 33: Equipment Protection by Special Protection “s”, UL 60079-33

First Edition, Dated May 25, 2021

***Summary of Topics***

***This editorial revision of ANSI/UL 60079-33 dated June 18, 2021 corrects the itemization specification of g) – n) in Clause 8.2 to the correct itemization specification of a) – h) to match the IEC published standard.***

***UL 60079-33 is an Adoption of IEC 60079-33, Explosive Atmospheres – Part 33: Equipment Protection by Special Protection “s”, (first edition, issued by IEC September 2012). The National Difference document incorporates all of the U.S. National Differences for UL 60079-33.***

Text that has been changed in any manner or impacted by UL's electronic publishing system is marked with a vertical line in the margin.

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**ANSI/UL 60079-33-2021**



**UL 60079-33**

# Standard for Explosive Atmospheres – Part 33: Equipment Protection by Special Protection "s"

**First Edition**

**May 25, 2021**

This ANSI/UL Standard for Safety consists of the First Edition including revisions through June 18, 2021.

The most recent designation of ANSI/UL 60079-33 as an American National Standard (ANSI) occurred on May 25, 2021. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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# Preface (UL)

This UL Standard is based on IEC Publication 60079-33: First edition, Explosive Atmospheres – Part 33: Equipment Protection by Special Protection “s”. IEC publication 60079-33 is copyrighted by the IEC.

This edition has been issued to satisfy UL Standards policy.

This is the UL Standard for Safety for Explosive Atmospheres – Part 33: Equipment Protection by Special Protection “s”.



Note – Although the intended primary application of this Standard is stated in its Scope, it is important to note that it remains the responsibility of the users of the Standard to judge its suitability for their particular purpose.

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There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

**DR –** These are National Differences based on the **national regulatory requirements**.

**D1 –** These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

**D2 –** These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

**DC –** These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

**DE –** These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

> ***Addition / Add*** - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.
>
> ***Modification / Modify*** - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.
>
> ***Deletion / Delete*** - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.***Deletion / Delete*** - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

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# FOREWORD

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## EXPLOSIVE ATMOSPHERES – Part 33: Equipment protection by special protection “s”

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

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8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 60079-33 has been prepared by IEC technical committee 31: Equipment for explosive atmospheres.

The text of this standard is based on the following documents:

| FDIS | Report on voting |
|---|---|
| 31/997/FDIS | 31/1011/RVD |

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 60079 series, published under the general title *Explosive atmospheres*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

• reconfirmed,

• withdrawn,

• replaced by a revised edition, or

• amended.

# INTRODUCTION

**DV.1 DE** ***Modify the IEC Introduction to replace with the following:***

This standard was created to provide a set of requirements for a Type of Protection, involving any Equipment Protection Level (EPL), referred to as Special protection "s".

Special protection "s" allows for the design, assessment and testing of equipment

• that cannot be fully assessed in accordance with existing Types of Protection under the UL 60079 and UL 80079 series of standards because of functional or operational limitations;

• that achieves the desired Equipment Protection Level (EPL) by the use of this standard; and

• that is based on identification and mitigation of failure modes as part of an ignition hazard assessment.

Regarding the identification and mitigation of failure modes, the assessed safety of the assigned EPL of the equipment shall satisfy the EPL requirements and, where appropriate, be at least equivalent to the EPL provided by the defined levels for other existing Types of Protection.

It must be understood that this standard is not immediately applicable just because equipment does not comply with other existing Types of Protection. Manufacturers are to first consider the possibilities for design and re-design to other existing Types of Protection, or combinations of other existing Types of Protection, before proceeding to Special protection "s". This standard is only applicable when:

• it can be clearly demonstrated that compliance with other existing Types of Protection is not practicable; and

• additional measures have been applied to establish an equivalent EPL.

The responsibility of initially demonstrating the need to design for Special protection "s", and subsequently establishing the criteria for verification, lies with the manufacturer. This specification defines the safety concepts and shows how the essential safety requirements are to be achieved. It is likely this will be done in consultation with experts in the assessment of existing explosion protection techniques.

By its very nature, assessment and testing to Special protection "s" cannot be as prescriptive as for the other existing types of protection. It is anticipated that considerable dialogue is required between the manufacturer and one or more independent verifiers. Special assessment and testing will be identified by the independent verifier(s) to ensure the relevant EPL is achieved.

The need for a standard to address Special protection "s" can be justified on the basis that:

• Under the Division system, there is permission in 500.7(P) of the National Electrical Code (NEC), NFPA:2020 for other approaches to explosion protection. This permits the ability for new and innovative designs to be certified for Division 1 or 2 applications that are outside the Scope of existing US ANSI Division system protection techniques.

• While there is no such permission in the NEC under the Zone system, there is such permission under the IEC Zone system based on IEC 60079-33, Explosive atmospheres – Part 33: Equipment protection by special protection “s”.

• It is beneficial to have a US National approach that is consistent with this IEC approach and with the existing Division approach.

• There is an identified need, and has been a request, for this Special protection “s” standard from industry.

~~This part of IEC 60079 was created in response to a request from the IECEx certification system to provide a set of requirements to be used for certification within the IECEx product certification scheme when the standards for existing types of protection were not applicable.~~

~~The present standard refers to the use of one or more independent verifiers, in accordance with ISO/IEC rules on the writing of standards that mitigate against specifying particular forms of conformity assessment. The IECEx system will specify how the term "independent verifier" will be interpreted for the purposes of the scheme. For example, it may specify that in the case of three independent verifiers they shall all be certification body members of the scheme, each accepted specifically for the purpose of assessing special protection applications and each from a separate member country of the system.~~

~~The purpose of IEC 60079-33 special protection “s” for any equipment protection level (EPL) is to allow design, assessment and testing of equipment or parts of equipment that cannot be fully assessed within a recognized type of protection or combination of recognized types of protection because of functional or operational limitations and where the desired equipment protection level can be achieved by the use of this standard.~~

~~Special protection “s” allows a design concept that cannot comply in full with recognized types of protection, or where the design concept is not covered by recognized types of protection.~~

~~When specification for the equipment includes aspects as given above, additional information and data may be required from~~

~~• technical research,~~

~~• evaluation of existing data and information.~~

~~Manufacturers should first consider the possibilities for design to the recognized types of protection, or to combinations of recognized type of protection, before proceeding to special protection “s”.~~

~~This standard is intended to provide a framework to demonstrate how essential safety requirements can be met if not covered by established standards, thus allowing for innovation and dealing with unknowns.~~

~~When equipment intended to meet a recognized type of protection does not comply with all the provisions of the relevant standard, it is not to be considered under this standard unless:~~

~~• it can be clearly demonstrated that complete compliance with the type of protection is not practicable; and~~

~~• additional measures have been applied to establish an equivalent protection level.~~

~~Special protection "s" is based on identification of failure modes and ignition hazard assessment in the identified modes. In this regard, the assessed safety of the assigned EPL of the equipment will satisfy the EPL requirements and, where appropriate, be at least equivalent to the EPL provided by the defined levels for the recognized types of protection.~~

~~IEC 60079-26 [1][1] provides for requirements for equipment with EPL Ga and Ga/Gb but depends on combining types of protection already described in other parts of the IEC 60079 series.~~

[1] ~~Figures in square brackets refer to the Bibliography.~~

~~The responsibility of initially demonstrating the need to design for special protection "s" and establishing the criteria for verification lies with the manufacturer. The specification defines the safety concepts and shows how the essential safety requirements are to be achieved. It is likely this will be done in consultation with experts in the assessment of explosion protection techniques.~~

~~The requirements in this standard take into account:~~

~~• allowance for first, second or third party verification;~~

~~• the use of EPLs;~~

~~• the use of equipment groups for mining, gas and dust;~~

~~• alignment with existing temperature requirements;~~

~~• compatibility with the marking requirements given in IEC 60079-0.~~

~~Where requirements for a product/design concept are developed and intended for repeated use in subsequent designs, they should be reviewed and, provided the manufacturer is prepared to release the intellectual property, be included initially in an annex of this standard with the intention of being removed and relocated to an appropriate place at a later time, e.g. in an existing or new type of protection standard.~~

~~Unlike other recognized types of protection, special protection "s" may require the application of reliability engineering tools and procedures such as failure modes and effects analysis (FMEA), fault tree analysis (FTA) and failure modes, effects and criticality analysis (FMECA) to identify the failure modes of the equipment being tested. This type of analysis will ensure that the failure modes and corresponding mitigation designs are addressed by the most appropriate testing strategies, which simulate the environment in which the equipment will be operated, with appropriate factors of safety applied.~~

~~The probability of failure of the identified failure modes may need to be demonstrated to be of a similar likelihood as the failures expected in recognized types of protection.~~

~~Full life cycle conditions may need to be considered and any restrictions may form part of the mandatory directions for use of the equipment to ensure EPLs are maintained during the operational life of the equipment.~~

~~By its very nature, assessment and testing to special protection "s" cannot be as prescriptive as for the recognized types of protection. It is anticipated that considerable dialogue is required between the manufacturer and an independent verifier. Additional assessment and testing may be identified by the independent verifier to ensure the relevant EPL is achieved.~~

~~When undertaking verification, it is strongly recommended the guidance provided in this standard is followed including:~~

~~• applying different levels of verification to match the EPL (similar in concept to the approach given in the IEC 61508 series);~~

~~• always involving at least one independent person/organization (an independent verifier);~~

~~• not using personnel who have had any involvement in research or determining the criteria for establishing the essential safety requirements in conjunction with the manufacturer.~~

~~Where it is intended to apply the requirements of this standard within a certification system/scheme, the following recommendations are made:~~

~~• the requirements laid down in EN 50495 [2] for safety devices are observed;~~

~~• an assessment should be performed by independent certification bodies (as the independent verifier) according to the requirements in this standard before issuing a certificate of conformity;~~

~~• a certification body performing an assessment for equipment not covered by recognized types of protection should have demonstrated expertise in the field under question.~~

~~The need for a standard to address special protection "s" can be justified on the basis that:~~

~~• provision has been in IEC 60079-0 for many years with reference Ex "s" in a note in the marking requirements or elsewhere. This reference goes back to IEC standards that pre-date 1957;~~

~~• there have been standards used on a national basis for many years for certification to special protection "s". Examples are SFA 3009 in the UK and AS/NZS 1826 in Australia and New Zealand;~~

~~• it is necessary to have an international approach that is consistent;~~

~~• there is an identified need and has been a request for a special protection "s" standard from IECEx.~~

~~Support for the approach in the standard:~~

~~• the approach draws on the experience of the use of verifiers already in other IEC standards.~~

# EXPLOSIVE ATMOSPHERES – Part 33: Equipment protection by special protection “s”

## 1 Scope

1DV DR *DE Modification of Clause 1 to replace with the following:*

This ~~part of IEC 60079~~ standard gives the specific methodology for the assessment and testing, and requirements for marking of electrical equipment, parts of electrical equipment and Ex components with special protection “s”.

This ~~part of IEC 60079~~ standard applies to

• electrical equipment employing a method of protection not covered by any existing standard in the ~~IEC~~ UL 60079 series,

• electrical equipment employing one or more recognized types of protection where the design and construction is not fully compliant with the standard for the type of protection,

• electrical equipment where the intended use is outside the parameters of the scope of the standard for the type of protection.

• electrical equipment that may or may not also involve non-electrical ignition sources.

NOTE UL 80079-36 and UL 80079-37 apply to equipment that only involves non-electrical ignition sources.

This ~~part of IEC 60079~~ standard is not intended for equipment that is covered by the scope of other ~~IEC~~ UL 60079 equipment standards unless

• it is clearly demonstrated that compliance with the type of protection is not feasible, and

• additional measures are applied to establish an equivalent equipment protection level.

This ~~part of IEC 60079~~ standard for special protection “s” is applicable to Group I, Group II and Group III and for equipment protection levels Ma, Mb, Ga, Gb, Gc, Da, Db and Dc, as defined in ~~IEC~~ UL 60079-0.

Certain specific guidance for assessment and testing are provided in the annexes to this standard.

This standard supplements and modifies the general requirements of ~~IEC~~ UL 60079-0. Where a requirement of this standard conflicts with a requirement of ~~IEC~~ UL 60079-0, the requirement of this standard shall take precedence.

NOTE 1 This standard may be used where equipment requires a higher EPL than the underlying protection techniques provide. Additional control measures or additional design and test requirements would be applied.

NOTE 2 Parts of equipment that can be designed and tested to standardized techniques should be so designed. Only those parts where conformance with essential safety requirements is achieved through alternative controls should be considered for special protection “s”. Equipment similar in attributes and performance to other equipment within a particular type of protection should be reviewed first to that method of protection prior to being considered for the use of Ex ”s”. Some parts of ~~IEC~~ UL 60079 allow a degree of variance from the equipment

**requirements and where determined to be close enough by independent verifiers, then it is preferable to prescribe to the original type of protection.**

**Where references are made to IEC and ISO standards, the referenced requirements found in these standards shall apply as modified by any applicable US National Differences for the standard (see Clause 2).**

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

**2DV DR *Modification of Clause 2 references to replace with the following:***

**FM 60079-29-1, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases***

**FM 60079-29-2, *Explosive atmospheres – Part 29-2: Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen***

**UL 60079 (all parts), *Explosive atmospheres, specifically including:***

- **UL 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements***
- **UL 60079-29-1, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases***
- **UL 60079-29-2, *Explosive atmospheres – Part 29-2: Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen***

~~**IEC 60079 (all parts), *Explosive atmospheres***~~

~~**IEC 60079-0, *Explosive atmospheres – Part 0: Equipment – General requirements***~~

~~**IEC 60079-29-1, *Explosive atmospheres – Part 29-1: Gas detectors – Performance requirements of detectors for flammable gases***~~

~~**IEC 60079-29-2, *Explosive atmospheres – Part 29-2: Gas detectors – Selection, installation, use and maintenance of detectors for flammable gases and oxygen***~~

~~**IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems***~~

~~**IEC 61508-1, *Functional safety of electrical/electronic/programmable electronic safety-related systems – Part 1: General requirements***~~

~~**IEC 61511 (all parts), *Functional safety – Safety instrumented systems for the process industry sector***~~

~~**IEC 62061, *Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems***~~

~~**ISO 13849-1:2009, *Safety of machinery – Safety-related parts of control systems – Part 1: General principles for design***~~

~~**ISO 13849-2, *Safety of machinery – Safety-related parts of control systems – Part 2: Validation***~~

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60079-0, as well as the following, apply.

3.1
**hybrid mixture**
mixture of a flammable gas with a combustible dust

3.2
**special protection "s"**
concept to allow design, assessment and testing of equipment that cannot be fully assessed within a recognized type of protection or combination of recognized types of protection because of functional or operational limitations, but which can be demonstrated to provide the necessary equipment protection level (EPL)

3.3
**recognized type of protection**
type of protection, other than special protection "s", as listed in IEC 60079-0 and with defined design, construction, assessment and test requirements

3.4
**independent verifier**
person or organization, with the appropriate competency in the applied explosion protection methodology, responsible for the verification of design calculations, assessment and testing who are separate and distinct by management and other resources including financial, from the person or organizations responsible for all the activities associated with the design, manufacture or sales of the equipment

Note 1 to entry: This may be a second or third party assessor, a test laboratory, a certifying body, etc.

## 4 General

### 4.1 Application

Special protection "s" allows for the design of a product that cannot comply in full with recognized types of protection or where the standards for the recognized types of protection do not cover the required operating conditions such as:

• outside normal atmospheric pressure given in the IEC 60079 series;

• above normal oxygen content;

• outside the temperature ranges given in IEC 60079 series;

• hybrid mixtures (gas and dust).

NOTE Additional consideration and additional testing related specifically to the intended conditions of use could be necessary. This is particularly important when the types of protection “d” (flameproof enclosure – IEC 60079-1 [3]) and ‘”i” (intrinsic safety – IEC 60079-11 [4]) are applied. Such conditions might include hypobaric, hyperbaric and oxygen enriched atmospheres.

The IEC 60079 series for types of protection provide multiple methods to design products for use in explosive atmospheres and is recommended as a first consideration. Where equipment design contains innovative, unique or alternative explosion protection which does not align with the recognized types of protection, the equipment design may be evaluated as special protection “s”.

When equipment is designed with the intention of meeting a recognized type of protection, but does not or cannot comply with all the provisions of the relevant standard it shall not be considered under this standard unless:

• it is clearly demonstrated that compliance with the type of protection is not feasible; and

• additional measures are applied to establish an equivalent equipment protection level.

### 4.2 Equipment group and temperature classification

The equipment grouping and temperature classification defined in IEC 60079-0 for the use of equipment in explosive gas atmospheres apply to special protection ”s” equipment. The subdivisions A, B and C for equipment of Group II and Group III also apply.

For temperature classification, the limiting parameters, including external influences, shall be specified such that the maximum permissible temperature is not exceeded taking into account the relevant level of protection “sa”, “sb” or “sc” as required by Clause 7.

Equipment that comprises special protection “s” parts combined with parts with different protection techniques should generally be designed, tested and marked for the equipment grouping, temperature classification and EPL appropriate to the other techniques.

### 4.3 Level of protection (equipment protection level (EPL))

Electrical equipment with special protection “s” shall be either

• level of protection “sa” (EPL “Ma, Ga, Da”), or

• level of protection “sb” (EPL “Mb, Gb, Db”), or

• level of protection “sc” (EPL “Gc, Dc”).

The requirements of this standard shall apply to all levels of special protection “s” (EPLs) unless otherwise stated.

### 4.4 Manufacturer’s justification

The documented justification shall be prepared and provided to the independent verifier for the application of special protection “s” and shall include:

• the details of considerations given to the possibilities for design to the recognized types of protection, or to combinations of recognized types of protection, before proceeding to special protection “s”;

• aspects that are covered by the standards for any recognized type of protection applied; and

• those aspects that are not covered by verification to recognized types of protection.

The limiting parameters shall be specified, including all relevant ratings.

The documentation shall provide the evidence to support the claimed level of protection and shall include the proposed schedule of assessment and tests.

NOTE Documentation may take the form of a safety file defined in the IEC 61508 series and could include FMEA, HAZOPS, etc. As an example, in an FMEA, a fault may result from a failure of the component parts of the electrical equipment or from anticipated externally applied influences. Two independent malfunctions which may occur more frequently and which, separately, would not create an ignition hazard but which, in combination, could create a potential ignition hazard, should be regarded as occurring together to form a single fault.

### 4.5 Verification

Explosion protection of electrical equipment is generally achieved through one or more of the following methods of protection:

• containment of internal explosion;

• exclusion of explosive atmosphere;

• avoidance of ignition source;

• energy limitation, both sparking and thermal;

• dilution.

Special protection “s” uses one or a combination of these methods, and the verification shall identify the methods of protection used and how the implementation for each has been achieved.

The independent verifier/s (see Clause 5) shall ensure all applicable requirements of IEC 60079-0 and those other parts of the IEC 60079 series relating to the recognized types of protection identified for the equipment are met, except as varied in Clauses 8, 9, 10 and 11.

## 5 Independent verifier

### 5.1 General

By its very nature, testing and assessment to special protection “s” cannot be as prescriptive as for other techniques. It is anticipated that considerable dialogue is required between the manufacturer and an independent verifier. Additional tests may be required by an independent verifier to ensure the relevant level of safety is achieved.

NOTE An independent verifier may be an individual or an organization.

### 5.2 Competence

The process of verification is critical to the correct application of special protection “s” and this requires that the independent verifier shall be able to demonstrate the following knowledge and skills:

a) a broad knowledge of Ex philosophies including an understanding of

i) the ignition properties of flammable and combustible materials,

ii) the properties, mechanisms and control of ignition, and

iii) the full range of protection techniques in the IEC 60079 series;

b) access to or involvement in

i) IEC or national standards such that there is assured access to knowledge of all current activities related to the equipment being assessed, and

ii) research related to the proposed method of protection;

c) in-depth specific knowledge of the technique or method being assessed;

d) knowledge of and experience in the assessment of test facilities, equipment, procedures and personnel;

e) documentation and reporting skills.

### 5.3 Duties

The independent verifier shall

a) obtain a detailed knowledge of the technique or method being proposed,

b) review the proposed test specification and verification protocol,

c) assess the information presented against the appropriate standards and available data,

d) assess the test facilities, equipment, procedures and personnel,

e) document the findings in a report detailing how the equipment complies with the objective of this standard,

f) conduct other duties as assigned.

### 5.4 Acceptance

Within a certification scheme, the endorsement of the independent verifier shall be included in the scheme rules

Outside of certification, the applicant shall select an independent verifier (1) and, where required, the independent verifier (1), in conjunction with the applicant, shall select the independent verifier (2) and (3), taking into account the stated qualifications and summary of experience of the independent verifier(s).

NOTE An independent verifier can be an individual but more likely will be an organization such as a certification body with total ‘corporate’ knowledge. The IECEx Equipment Certification Scheme has a protocol to recognize the competence of ExCBs operating to this standard.

### 5.5 Independence

Independent verifiers shall be independent from the applicant and any organization that is involved in the design, manufacture or sale of the equipment. They shall be separate and distinct from those organizations by management and financial or other resources, so that any influence or pressure on the decision-making process, the assessment and the results can be excluded.

# 6 Design and construction

## 6.1 Principles of an integrated approach to explosion safety

Electrical equipment intended for use in explosive atmospheres shall be designed from the point of view of an integrated approach to explosion safety. In this connection, the design shall take into account in order of priority:

(1) avoidance of the formation of explosive atmospheres which may be produced or released by equipment;

(2) avoidance of the ignition of explosive atmospheres, taking into account the nature of every electrical source of ignition;

(3) effects of an explosion occurring which could directly or indirectly endanger persons and property

i) by halting the explosion, or

ii) by limiting the consequences of the explosion.

Equipment design shall be analysed for malfunctions in order to avoid, as far as possible, dangerous situations. Any misuse that can reasonably be anticipated shall be taken into account.

NOTE 1 Many of the essential requirements are contained in IEC 60079-0.

NOTE 2 Point 6.1 (3) is not covered in the scope of this standard.

## 6.2 Design and construction

It is intended that equipment be designed and constructed with due regard to the latest technological knowledge of explosion protection so that the EPL can be maintained throughout its anticipated lifetime.

Components to be incorporated into, or used as replacements in equipment, are to be designed and constructed in such a way that they fulfil their intended purpose of explosion protection when they are installed in accordance with the manufacturer's instructions.

## 6.3 Overloading of equipment

Where appropriate for the EPL, protection from overloading the equipment shall be provided and should be considered at the design stage.

NOTE This may be achieved by the use of over-current cut-off switches, temperature limiters, differential pressure switches, flow-meters, time-lag relays, over-speed monitors and/or similar types of monitoring devices.

## 6.4 Potential ignition sources

### 6.4.1 Hazards arising from different ignition sources

Protection from potential ignition sources such as sparks, flames, electrical arcs, high surface temperatures, acoustic energy, optical radiation, electromagnetic waves and other ignition sources shall be provided, see Figure A.1.

### 6.4.2 Hazards arising from overheating

Protection from overheating caused by friction or impacts occurring, for example, between materials and parts in contact with each other while rotating or through the intrusion of foreign bodies shall be provided.

### 6.4.3 Hazards arising from pressure compensation operations

Equipment fitted with integrated measuring, control and regulation devices shall be designed so that pressure compensations arising from them do not generate shock waves or compressions that may cause ignition.

## 6.5 Requirements in respect of safety-related devices

Safety devices shall function independently of any measurement or control devices required for operation, in addition

• for electrical circuits, the fail-safe principle shall be applied in general,

• in the event of a safety device failure, equipment and/or ignition capable components shall, wherever practicable, be secured,

• emergency stop controls of safety devices shall, as far as practicable, be fitted with restart lockouts. A new start command may take effect on normal operation only after the restart lockouts have been intentionally reset.

In the design of software-controlled equipment and safety devices, special account shall be taken of the hazards arising from malfunctions in the program.

Compliance with IEC 61508-1 or any related derivative may be considered to establish compliance with these requirements.

NOTE For further information see Annex A.

# 7 Application of equipment protection levels (EPL)

## 7.1 Equipment with EPL Ma

Equipment shall be designed and constructed so that sources of ignition do not become active, even in the event of rare malfunctions relating to equipment.

Equipment shall be equipped with means of protection such that

• either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection, or

• the requisite level of protection is ensured in the event of two expected malfunctions or a rare malfunction.

Equipment designed to be opened for short periods of time, e.g. during maintenance, shall also be designed so that

• it meets the requirements of EPL Mb when opened, or

• equipment shall be fitted with appropriate additional interlocking systems to reduce the likelihood of opening whilst energized, or

• where it is not possible to de-energize equipment, a warning label shall be fixed to the equipment to advise against opening with an explosive gas atmosphere present according to IEC 60079-0.

Where necessary, this equipment shall be equipped with additional special means of protection and remain functional with an explosive atmosphere present.

For equipment with EPL Ma, the proposed justification shall be provided by the manufacturer, according to 4.4, to the independent verifier (1) who is responsible for confirming the manufacturer's proposal. The resulting proposed schedule of assessment and test requirements shall be submitted by independent verifier (1) to independent verifier (2) and independent verifier (3) for agreement. Once agreement has been reached the independent verifier (1) shall perform the assessment and tests. Any variation to the original schedule of assessment and tests shall be submitted to the independent verifiers for further agreement.

Prior to issue, the final assessment and test report shall be submitted to the independent verifier (2) and independent verifier (3) for final confirmation.

### 7.2 Equipment with EPL Mb

Equipment shall be designed and constructed so as to prevent ignition sources arising, even in the event of frequently occurring disturbances or equipment operating malfunctions, which normally have to be taken into account.

Equipment shall be provided with means of protection ensuring that sources of ignition do not become active during normal operation, even under more severe operating conditions, in particular those arising from rough handling and changing environmental conditions. The equipment is intended to be de-energized in the event of an explosive atmosphere occurring.

Equipment designed such that it is intended to be opened for short periods of time, e.g. during maintenance, shall be such that

• equipment shall be fitted with appropriate additional interlocking systems to reduce the likelihood of opening whilst energized, or

• where it is not possible to de-energize equipment, a warning label shall be fixed to the equipment to advise against opening with an explosive gas atmosphere present.

For equipment with EPL Mb, the proposed justification shall be submitted by the manufacturer, according to 4.4, to the independent verifier (1) who is responsible for confirming the manufacturer's proposal. The resulting proposed schedule of assessment and test requirements shall be submitted by independent verifier (1) to independent verifier (2) for agreement. Once agreement has been reached the independent verifier (1) shall perform the assessment and tests. Any variation to the original schedule of assessment and tests shall be submitted to the independent verifier (2) for further agreement.

Prior to issue, the final test and assessment report shall be submitted to the independent verifier (2) for final confirmation.

### 7.3 Equipment with EPL Ga

Equipment shall be designed and constructed so that sources of ignition do not become active, even in event of rare malfunctions relating to equipment.

It shall be equipped with means of protection such that

• either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection, or

• the requisite level of protection is ensured in the event of two expected malfunctions or a rare malfunction.

Equipment designed to be opened for short periods of time, e.g. during maintenance, shall be designed such that the equipment is fitted with an appropriate additional interlocking system to reduce the likelihood of opening whilst energized.

Where it is not possible to de-energize equipment, a warning label shall be fixed to the equipment to advise against opening with an explosive gas atmosphere present.

For equipment with EPL Ga, the proposed justification shall be submitted by the manufacturer, according to 4.4, to the independent verifier (1) who is responsible for confirming the manufacturer's proposal. The resulting proposed schedule of assessment and test requirements shall be submitted by independent verifier (1) to independent verifier (2) and independent verifier (3) for agreement. Once agreement has been reached the independent verifier (1) shall perform the assessment and tests. Any variation to the original schedule of assessment and tests shall be submitted to the independent verifiers for further agreement.

Prior to issue, the final assessment and test report shall be submitted to the independent verifier (2) and independent verifier (3) for final confirmation.

### 7.4 Equipment with EPL Gb

Equipment shall be designed and constructed so as to prevent ignition sources arising, even in the event of frequently occurring disturbances or equipment operating malfunctions, which normally have to be taken into account.

Equipment designed to be opened for short periods of time, e.g. during maintenance, shall be such that

• equipment shall be fitted with appropriate additional interlocking systems to reduce the likelihood of opening whilst energized, or

• where it is not possible to de-energize equipment, a warning label shall be fixed to the equipment to advise against opening with an explosive gas atmosphere present.

For equipment with EPL Gb, the proposed justification shall be submitted by the manufacturer, according to 4.4, to the independent verifier (1) who is responsible for confirming the manufacturer's proposal. The resulting proposed schedule of assessment and test requirements shall be submitted by independent verifier (1) to independent verifier (2) for agreement. Once agreement has been reached, the independent verifier (1) shall perform the assessment and tests. Any variation to the original schedule of assessment and tests shall be submitted to the independent verifier (2) for further agreement.

Prior to issue, the final test and assessment report shall be submitted to the independent verifier (2) for final confirmation.

### 7.5 Equipment with EPL Gc

Equipment shall be designed and constructed so that it is not a source of ignition in normal operation and which may have some additional protection to ensure that it remains inactive as an ignition source in the case of regular expected occurrences.

For equipment with EPL Gc, the proposed justification shall be submitted by the manufacturer, according to 4.4, to the independent verifier who is responsible for confirming the manufacturer's proposal. Once agreement has been reached, the independent verifier shall perform the assessment and tests.

### 7.6 Equipment with EPL Da

Equipment shall be designed and constructed so that ignition of air/dust mixtures does not occur even in the event of rare malfunctions relating to equipment.

It shall be equipped with means of protection such that

• either, in the event of failure of one means of protection, at least an independent second means provides the requisite level of protection, or

• the requisite level of protection is ensured in the event of two expected malfunctions or a rare malfunction.

Equipment designed to be opened for short periods of time, e.g. during maintenance, shall be such that the equipment is fitted with an appropriate additional interlocking system to reduce the likelihood of opening whilst energized.

Where it is not possible to de-energize equipment, a warning label shall be fixed to the equipment to advise against opening with an explosive dust atmosphere present.

For equipment with EPL Da, the proposed justification shall be submitted by the manufacturer, according to 4.4, to the independent verifier (1) who shall be responsible for confirming the manufacturer's proposal. The resulting proposed schedule of assessment and test requirements shall be submitted by independent verifier (1) to independent verifier (2) and independent verifier (3) for agreement. Once agreement has been reached the independent verifier (1) shall perform the assessment and tests. Any variation to the original schedule of assessment and tests shall be submitted to the independent verifiers for further agreement.

Prior to issue, the final assessment and test report shall be submitted to the independent verifier (2) and independent verifier (3) for final confirmation.

### 7.7 Equipment with EPL Db

Equipment shall be designed and constructed so that ignition of air/dust mixtures is prevented, even in the event of frequently occurring disturbances or equipment operating malfunctions which normally have to be taken into account.

For equipment with surfaces that may heat up, measures shall be taken to ensure that the limiting temperature is not exceeded even in the most unfavourable circumstances. Temperature rises caused by heat build-ups and chemical reactions shall also be taken into account.

Equipment designed to be opened for short periods of time, e.g. during maintenance, shall be such that

• equipment shall be fitted with appropriate additional interlocking systems to reduce the likelihood of opening whilst energized, or

• where it is not possible to de-energize equipment, a warning label shall be fixed to the equipment to advise against opening with an explosive dust atmosphere present.

For equipment with EPL Db, the proposed justification shall be submitted by the manufacturer, according to 4.4, to the independent verifier (1) who shall be responsible for confirming the manufacturer's proposal. The resulting proposed schedule of assessment and test requirements shall be submitted by independent verifier (1) to independent verifier (2) for agreement. Once agreement has been reached the independent verifier (1) shall perform the assessment and tests. Any variation to the original schedule of assessment and tests shall be submitted to the independent verifier (2) for further agreement.

Prior to issue, the final test and assessment report shall be submitted to the independent verifier (2) for final confirmation.

### 7.8 Equipment with EPL Dc

Equipment shall be so designed and constructed that air/dust mixtures cannot be ignited by foreseeable ignition sources likely to exist during normal operation.

Equipment, including cable glands and connecting pieces, shall be so constructed that, taking into account the size of its particles, dust can neither develop explosive mixtures with air nor form dangerous accumulations inside the equipment.

For equipment with EPL Dc the proposed justification shall be submitted by the manufacturer, according to 4.4, to the independent verifier who is responsible for confirming the manufacturer's proposal. Once agreement has been reached the independent verifier shall perform the assessment and tests.

## 8 Preparation of assessment and test specification

### 8.1 General

All the appropriate requirements of the IEC 60079 series that affect the explosion protection integrity shall be applied.

### 8.2 Assessment and test specification

The assessment and test specification shall be prepared by the manufacturer and shall include:

a) assessments and tests from IEC 60079 series that are to be applied;

b) relevant requirements of the IEC 60079 series that are not being applied and are included in d);

c) justification for not applying the requirements of the IEC 60079 series identified in b);

d) replacement assessment or test details, including the acceptance criteria;

e) assessments and tests from other international, regional or national standards;

f) any new assessment or test procedure developed for this equipment related to the explosion protection;

g) any routine tests related to the explosion protection;

h) justification for use of assessments or tests in d), e), f) and g).

The preparation of this specification may be done in conjunction with the independent verifier(1).

Where replacement assessments and tests are taken from standards other than those within the IEC 60079 series, the standard, the edition or date and clause reference is to be included. These should be international standards but where they do not exist or are not suitable a regional or national standard may be used, or a new test or assessment procedure developed.

Prior to the implementation of the assessment and test specification, the independent verifier(s) shall confirm that the proposed assessment and test specification meets the requirements of this clause and the objectives of the standard.

### 8.3 Assessment and testing

The assessment and testing shall be carried out according to the specification of 8.2 in a suitable environment with appropriate test equipment.

NOTE This may be carried out by the manufacturer and witnessed by the independent verifier (1), or carried out by the independent verifier or carried out by a third party.

### 8.4 Reporting results of the assessment and test specification

The specification in accordance with 8.2, together with the results and conclusions, shall be included in the assessment and test report by the independent verifier (1).

## 9 Ignition hazard assessment

### 9.1 General

All electrical equipment and all parts of electrical equipment shall be subjected to a formal documented hazard assessment prepared by the manufacturer that identifies and lists the potential sources of ignition by the equipment and the protective measures to be applied.

Examples of such sources include hot surfaces, naked flames, hot gases/liquids, mechanically generated sparks, adiabatic compression, shock waves, exothermic chemical reaction, mechanical impacts resulting in thermite reactions, self-ignition of dust, electrical arcing and static electricity discharge.

### 9.2 Protective measures

Protective measures shall be considered and applied in the following order:

(1) ignition sources cannot arise;

Ignition sources such as arcs, sparks and hot surfaces do not occur;

(2) ignition sources cannot become effective;

Ignition from sources such as arcs sparks and hot surfaces do not occur due to the limitation of energy or temperature.

(3) exclusion of the explosive atmosphere;

The explosive atmosphere is excluded from reaching a source of ignition.

(4) explosion propagation avoidance;

If an explosion does occur within the enclosure it is not transmitted to the external explosive atmosphere.

### 9.3 Explanation of the ignition hazard assessment procedure

See Annex A.

NOTE These recommendations have been adapted as examples only from EN 13463-1:2009 Annex B [5]

### 9.4 Examples of ignition hazard assessment

See Annex B.

NOTE These recommendations have been adapted as examples only from EN 13463-1:2009, Annex C.

## 10 Application of special protection “s”

### 10.1 General

In the absence of an established construction, assessment and test specification in respect of the explosion protection for equipment with special protection “s”, it is not possible to provide detailed requirements to be applied for this type of protection.

Special protection “s” is a concept that may embrace an unspecified number of individual techniques that are not adequately described in standards for the recognized types of protection, and the protective measures, which in some cases need to be employed to ensure safety.

The acceptance of any implementation of special protection “s” is subject to the agreement of the manufacturer and the independent verifier(s).

### 10.2 Justification for the application of special protection “s”

#### 10.2.1 Application

The following scenarios or combination of scenarios are likely to apply:

• equipment that substantially meets one or more IEC recognized type of protection standards, but has an aspect that is not covered by the standard(s) that can be dealt with in some other way;

• equipment that aligns with a recognized type of protection but falls outside the parameters of the scope of the standard for that type of protection;

• equipment that uses an approach (technique) that is not covered by any of the existing standards in the IEC 60079 series;

• equipment that meets one or more protection standards but is required to have a higher EPL that would normally be the case for the technique(s).

The probability of failure of the identified failure modes may need to be demonstrated to be of a similar likelihood as the failures that occur in recognized types of protection.

### 10.2.2 Equipment substantially meeting the requirements for the recognized types of protection

For equipment that substantially meets one or more IEC recognized type of protection standards, but has an aspect that is not covered by the standard(s) that can be dealt with in some other way.

• example – flameproof joint of a type not covered by the standard;

• example – higher voltage than provided for in the compliance requirements or testing equipment in a standard, e.g. for encapsulation.

The following are typical of the approaches that shall be considered:

• only the aspect that is not covered by the IEC standard(s) shall be dealt with under this standard. All other aspects shall be shown to comply with the appropriate IEC standard(s);

• appropriate tests shall be specified;

• support from previous research shall be supplied;

• requirements covered by national or regional standards shall be specified where they are used as a justification.

### 10.2.3 Equipment outside the scope of recognized types of protection

For equipment that aligns with a recognized type of protection, but falls outside the parameters of the scope of the standard for that technique, the following are examples of the application:

• example – aspects of equipment used above the voltage range in the standard such as an increased safety motor at 15 kV;

• example – the need to use equipment such as a gas detector in an oxygen enriched atmosphere.

The following are typical of the approaches that shall be considered:

• for high voltage, specification of creepage and clearance where relevant shall be based on appropriate standards;

• for oxygen enrichment, higher factors of safety than in existing standards shall be introduced together with justification;

• for an Ex “d” enclosure in a pressure higher than atmospheric, where appropriate enhanced factors of safety for the flamepaths than in existing standards shall be introduced together with justification;

• appropriate tests shall be specified;

• support from previous research shall be supplied;

• requirements covered by national or regional standards shall be specified where they are used as a justification.

NOTE Current discussions in IEC committees, working groups etc. may be relevant.

### 10.2.4 Protection technique with no alignment to the recognized types of protection

For equipment that uses an approach (technique) that is not covered by any of the existing standards in the IEC 60079 series. An example of the application is the immersion of a motor in a flammable liquid.

The following are typical of the approaches that shall be considered:

• full justification shall be provided for the design with any special aspects that relate to the installation, such as possible need for isolation when not immersed in above example;

• appropriate tests shall be specified;

• support from previous research shall be supplied;

• requirements covered by national or regional standards shall be specified where they are used as a justification.

NOTE Current discussions in IEC committees, working groups etc. may be relevant.

### 10.2.5 Enhanced EPL through additional means of protection

For equipment that meets one or more protection standards but is required to have a higher EPL than would normally be the case for the technique(s).

The following are typical of the approaches that shall be considered:

• the increased factors of safety shall be specified together with the validation plan;

• appropriate tests shall be specified;

• support from previous research shall be supplied;

• requirements covered by national or regional standards shall be specified where they are used as a justification.

NOTE Current discussions in IEC committees, working groups etc. may be relevant.

### 10.2.6 Combination of approaches

Where a combination of any of the methods specified in 10.2.2 to 10.2.5 is used, the approach shall include all of the requirements specified.

## 10.3 Adaption of recognized types of protection

This standard allows for the application of the concepts of recognized type of protection with expanded requirements, e.g. independent additional measures to allow for use as a higher EPL. As an example:

• A totally submerged pump relying on submersion in the petroleum for exclusion of the hazardous atmosphere, with additional measures to disconnect power in a fail-safe manner on liquid falling below a predetermined level may comply with special protection “s”.

NOTE Regional standards exist covering this application, e.g. EN 15268 [6] and UL 79 [7], and these could be used as the basis for developing requirements.

### 10.4 Other innovative means of ensuring safety

**10.4DV DR *DE Modification of Clause 10.4 to replace with the following:***

**Where additional control circuits are used to provide safety, for example, by detecting the presence of explosive concentrations of gas and causing withdrawal of power, it shall be ensured that an appropriate level of safety is achieved with suitable safety functions provided.**

**In demonstrating that an appropriate level of safety is achieved, the system for detecting the gas and causing removal of power shall conform to the appropriate standards (e.g. IEC 61508 series, the IEC 61511 series, IEC 62061, ISA-84.00.01, Parts 1-3, or ISO 13849~~-1 or ISO 13849-2~~ series, as appropriate [8]). For the selection and performance of the gas detector, ~~IEC~~ UL 60079-29-1 and ~~,IEC~~ UL 60079-29-2 ~~and future IEC 60079-29-3 [8]~~ shall be used.**

**NOTE The use of gas detection to withdraw power from equipment does not change the EPL of the equipment but represents a combination of techniques that may be employed in an installation.**

### 10.5 Connection of conductor and cables

Conductors, cables and connectors provided with, or as an integral part of, the equipment shall be protected in accordance with the requirements for the appropriate EPL.

## 11 Type verification and tests

### 11.1 General

All equipment shall be submitted to verification and tests according to the assessment and test specification of 8.2.

### 11.2 Temperature measurement test

The temperature measurement tests shall be performed as described in IEC 60079-0, with the application of malfunctions applied in accordance with Clause 7.

## 12 Routine verification and test

The manufacturer shall carry out any routine tests required by the assessment and test specification in 8.2.

## 13 Documentation

Documentation required by IEC 60079-0 shall include the assessment and test specification in 8.2.

## 14 Ex components

An Ex component shall only be permitted where all the necessary technical information to allow appropriate evaluation of the inclusion of an Ex component in equipment does not require any additional assessment of the Ex component to this standard. This technical information shall be in the schedule of

limitations included with the certificate. If the additional evaluation includes aspects relating to special protection “s” an Ex component is not permitted.

## 15 Marking

### 15.1 General

In addition to the requirements of IEC 60079-0, the following requirements apply:

### 15.2 Marking for Ex “s” only

Where only part of the requirements for one or more recognized types of protection have been employed, the marking of the product shall reference special protection “sa”, “sb” or “sc” as appropriate and NOT the mixed protection techniques. A reference to the specific instruction document shall be marked on the product and in the certificate.

### 15.3 Marking for Ex “s” with other recognized types of protection

The marking shall be according to IEC 60079-0 with the inclusion of special protection “sa”, “sb” or “sc”; as appropriate. A reference to the specific instruction document shall be marked on the product and in the certificate.

## 16 Certificate information

### 16.1 Certificate for Ex “s” only

Where only part of the requirements for one or more recognized types of protection have been employed, the certificate shall identify the requirements for those types of protection employed and if relevant, where on the equipment they apply.

### 16.2 Certificate for Ex “s” with other recognized types of protection

In this case, the certificate shall identify the recognized types of protection employed and where on the equipment they apply.

### 16.3 Specific conditions of use

Specific conditions of use shall always be included for Ex ‘s’ equipment.

### 16.4 Schedule of limitations

A schedule of limitations shall always be included for Ex ‘s’ components.

## 17 Instructions

Instructions shall be prepared in accordance with the requirements of IEC 60079-0 and, in addition, a specific instruction document shall be prepared giving full details regarding

• the concept, method and unique aspects applicable to the equipment,

• installation instructions including full connection details,

• recommendations for visual, close and detailed inspection items with time frames,

• routine maintenance requirements, and

• recommendations for repair and overhaul together with the essential details necessary for the work to be carried out.

# Annex A
# (informative)

## Explanation of the ignition hazard assessment procedure

NOTE Annex A and Annex B are adapted from EN 13463-1:2009 which has been identified as a document for a future item in the TC31 program of work. Some references to other regional standards have been included here as ISO/IEC equivalents do not yet exist.

### A.1 General

This annex is intended to provide assistance for implementing the assessment procedure and the individual assessment steps. A special way of reporting is explained, guiding systematically through the assessment procedure and resulting in well-directed and traceable statements. For manufacturers, the report offers additional support for the preparation of the essential technical documentation. Technical examples for the implementation of the procedure are shown in Annex B.

### A.2 Reporting with the help of a table

It is not essential to report the ignition hazard assessment in any specific manner. But it is useful to report in a well-structured way in order to ensure clarity and comprehension. Therefore, the use of a table is recommended, representing the structure of the assessment procedure and thus allowing for easy reassessment as well as supporting the compilation of the technical documentation.

Annex B gives different examples of an ignition hazard assessment report using an adequate reporting method. In this way, the report will be clear, being methodically structured to identify necessary statements, measures and evidence, i.e. essential parts of the technical documentation. This should ease the manufacturers' task in fulfilling the requirements. This reporting method is designed to assimilate all necessary information and should not require additional statements beyond that provided in the table.

NOTE The reporting method presented in Annex B is only one of the alternatives. Different ways of reporting are possible, provided the required content is completely covered. Unused parts of the table can be left blank or can be deleted.

### A.3 Assessment procedure

The ignition hazard assessment procedure can be divided into the following steps:

(1) identification of ignition hazards (analysis of the ignition hazards and their causes);

(2) preliminary ignition hazard estimation and evaluation (estimation of the ignition hazards determined in step 1 regarding the frequency of their occurrence and comparison with the target EPL);

(3) determination of measures (determination of preventive and/or protective measures, if necessary, to reduce the probability of an ignition hazard according to step (2);

(4) ignition hazard estimation and equipment protection level assignment (estimation of the ignition hazards regarding the frequency of occurrence after including preventive and/or protective measures determined in step (3);

(5) determination of the equipment protection level.

If modifications are made to the design to incorporate additional protective or preventative measures, the assessment process should be reviewed to check for new potential faults or ignition hazards. Particular attention should be paid to new interdependencies or combinations of malfunctions, if applicable for the EPL.

## A.4 Assessment steps

### A.4.1 Identification of ignition hazards

This step will result in a complete list of all ignition hazards applicable to the equipment (see Clause 9). At first, the known list of potential ignition sources representing different physical ignition mechanisms (given e.g. in 8.4 and in EN 1127-1 [9]) should be examined (see Table A.1). It should be determined which types of ignition sources are possible (see Table A.2, Column 1 a).

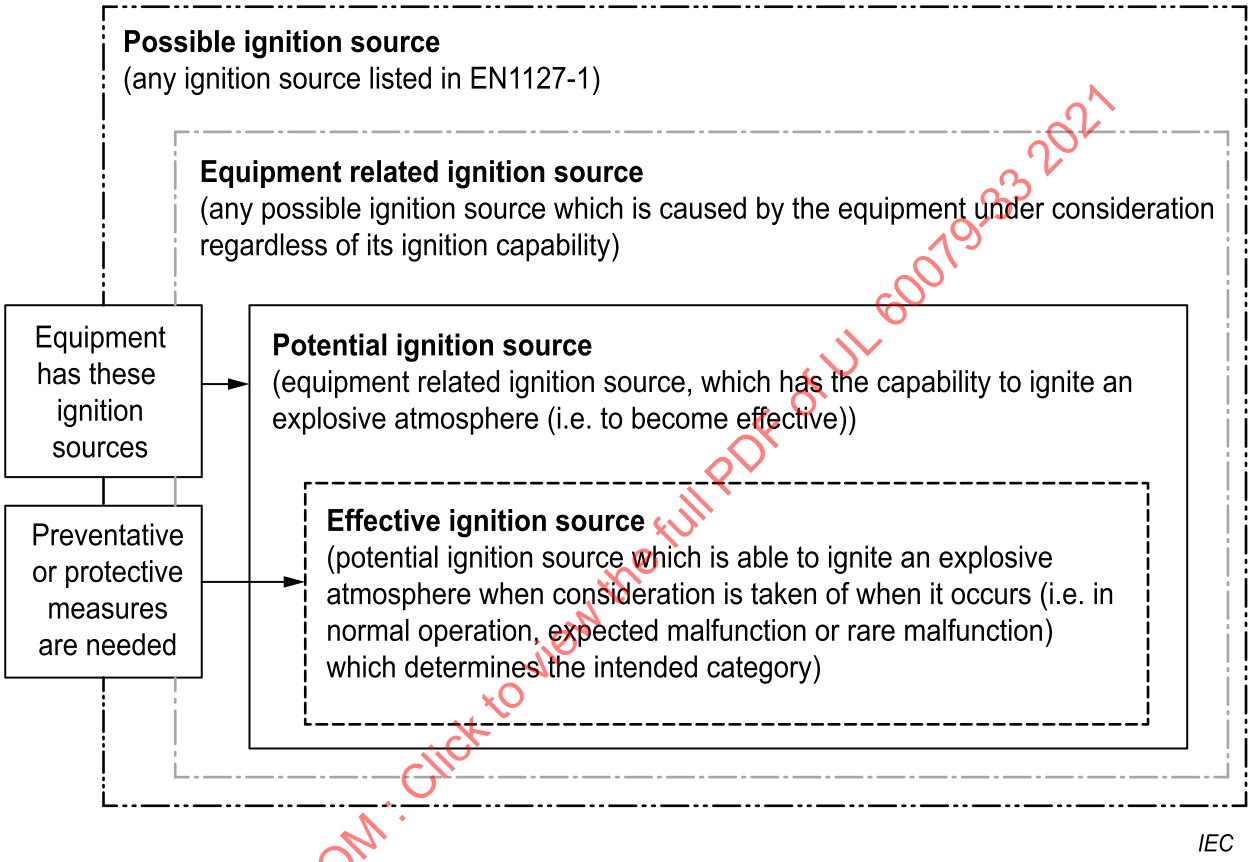


**Figure A.1**

**Relationship between ignitions source definitions**

**Table A.1**
**Recommended documentation of initial assessment of equipment related ignition sources**

| Possible ignition sources | Equipment related Yes/No | Reason |
|---|---|---|
| Hot surfaces | Yes | Motor windings |
| Mechanical sparks | Yes | Friction between moving parts |
| Flames, hot gases | No | Not present |
| Electrical sparks | Yes | Opening of an electrical circuit |
| Stray electric currents and cathodic corrosion protection | No | Equipment not large enough |
| Static electricity | Yes | Plastic enclosure |
| Lightning | No | Not present |
| Electromagnetic waves | No | Not present |
| Ionizing radiation | No | Not present |
| High frequency radiation | No | Not present |
| Ultrasonics | No | Not present |
| Adiabatic compression | No | Not present |
| Chemical reaction | No | Not present |

Subsequently these ignition sources should be considered separately with regard to differences in

• intended use or possible application,

• constructional variants,

• operating conditions or working cycles including their variations (start, stop, load alternations etc.),

• influences of the ambience (temperature, pressure, humidity, energy supply, etc.),

• material parameters or their interdependencies (metallic, non-metallic, electrostatic chargeable liquids etc.),

• interdependencies with components or other pieces of equipment,

• interdependencies with persons (including foreseeable misuse),

• if required, combinations of malfunctions (EPL Ma, Ga or Da).

**Table A.2**
**Example for reporting identification of ignition hazards (step 1) and first assessment (step 2)**

| No. | Step 1 | | Step 2 | | | | |
|---|---|---|---|---|---|---|---|
| | Ignition hazard analysis | | Assessment of the frequency of occurrence without application of an additional measure | | | | |
| | a | b | a | b | c | d | e |
| | Potential ignition source | Description of the basic cause (which conditions originate the ignition hazard?) | During normal operation | During foreseeable malfunction | During rare malfunction | Not relevant | Reasons for assessment |
| 1 | Electrostatic discharge | Parts of non-metallic material with a surface resistance exceeding 1 GΩ | | X | | | No charging during normal operation; material is an outer part of the casing; charging could be done by a person (operator) |

Construction features (e.g. non-conductive material with a resistance below 1 GΩ) may be assumed provided that they will not be changed because they are necessary for other reasons (see Table A.2, Column 1b). Types of protection like Ex 'd' (Flameproof Enclosure – see IEC 60079-1) should not be considered in this first step. Otherwise, it could be ignored that those measures are not necessary, or that other measures are more effective or may save costs. For the analysis of ignition hazards, all utilizable information sources should be used (discussions with experts from test houses, universities, users, other manufacturers, etc.) and all accessible examples should be examined. In the case of very complex equipment, ignition hazard analysis should be supplemented by one or more systematic methods like FMEA or fault tree analysis.

### A.4.2 Preliminary ignition hazard estimation and evaluation

In this step, the individual ignition hazards are evaluated to determine how often an individual ignition source may become effective (see Table A.2, Column 2). In doing so, the ignition sources are considered exactly in the form in which they are laid down in Column 1, i.e. under inclusion of the constructive features, that will be applied in any case. From the result of the preliminary ignition hazard estimation (see Table A.2, Columns 2a to 2d) it is clear whether additional measures are necessary in step 3 in order to meet the target EPL. In Table B.2, Column 2e, the reasons for the results of the evaluation can be reported if not self-explanatory.

The individual estimation results and decisions can never be of general validity, e.g. for a complete group of products like pumps, brakes or gears. As a general rule, they depend on the special design of the type or even of the individual piece of equipment. Thus, in this step – in contrast to the prior step 1 (hazard analysis) – all criteria shown as an example (including those from standards) should be treated carefully and with extreme reserve. The estimation should be based ultimately on a certain design and could differ even within the variants of a type design (size, alternative assembly, etc.). Typical ignition hazards, which are accessible to general consideration, are usually given in standards along with special construction requirements and test procedures. Such valuations given in the normative parts of standards (e.g. electrostatic requirements) meaning the appropriateness for a certain EPL, can be adopted without special analysis.

### A.4.3 Determination of measures

If the evaluation shows the application is required to meet the target EPL, adequate preventive and/or protective measures are determined in this step (see Table A.3, Column 3). It is necessary to define these measures in such a way that possible ignition sources cannot become effective, or the probability of the ignition source becoming effective is sufficiently low. These measures should not be confused with the types of protection according to IEC 60079-0. The term 'preventive and protective measures' is meant in a broader sense, i.e. measures with the purpose of explosion protection. Therefore, the term also embraces all measures taken during putting into service, maintenance and repair, operation, warning notices,