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BSI Standards Publication

Explosive atmospheres

Part 36: Non-electrical equipment for
explosive atmospheres — Basic method
and requirements (ISO 80079-36:2016)

National foreword

This British Standard is the UK implementation of EN ISO 80079-36:2016. It supersedes BS EN 13463-1:2009 which is withdrawn.

CEN have confirmed that errors exist in Annex ZC of this document. Specifically within Annex ZC, on page 9, the text "clause B) of the Annex ZB" should be updated to read "clause B) of the Annex ZC". Also, the heading for column 5 in Table ZC.1 should read "Major technical changes". These errors will be corrected in future versions of EN ISO 80079-36:2016.

The UK participation in its preparation was entrusted to Technical Committee EXL/23, Explosion and fire precautions in industrial and chemical plant.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Explosive atmospheres - Part 36: Non-electrical equipment for explosive atmospheres - Basic method and requirements (ISO 80079-36:2016)

Atmosphères explosives - Partie 36: Appareils non
électriques destinés à être utilisés en atmosphères
explosives - Méthodologie et exigences (ISO 80079-
36:2016)

Explosionsfähige Atmosphären - Teil 36: Nicht-
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Atmosphären - Grundlagen und Anforderungen (ISO
80079-36:2016)

This European Standard was approved by CEN on 18 February 2016.

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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European Foreword

This document (EN ISO 80079-36:2016) has been prepared by Technical Committee ISO/TMBG "Technical Management Board - groups" in collaboration with Technical Committee CEN/TC 305 "Potentially explosive atmospheres - Explosion prevention and protection" the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2016, and conflicting national standards shall be withdrawn at the latest by October 2016.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

The significant changes with respect to EN 13463-1:2009 are included in Annex ZB "*Significant changes between this European Standard and EN 13463-1:2009*".

This document supersedes EN 13463-1:2009.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of 2014/34/EU.

For relationship with EU Directive(s), see informative Annex ZA, which is an integral part of this document.

Extensions to the marking scheme described in the Directive are found in the ATEX Guidelines published by the European Commission. These are particularly useful for equipment that conforms to more than one category.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Endorsement notice

The text of ISO 80079-36:2016 has been approved by CEN as EN ISO 80079-36:2016 without any modification.

Annex ZA (informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2014/34/EU

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the New Approach Directive 2014/34/EU.

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

Table ZA.1 — Correspondence between this European Standard and Directive 2014/34/EU

Clauses/sub-clauses of this EN	Essential Requirements (ERs) of EU Directive 2014/34/EU	Qualifying remarks/Notes
4	1.0.1 1.0.2	
5.1	1.0.1 1.0.2 1.0.3	
5.2	1.0.2 1.3	
6.1	1.3	
6.2.1, 6.2.2, 6.2.3	1.2.8 1.3.1 1.4.1	
6.2.4	2.0.1 2.0.2	
6.2.5, 6.2.6	2.1.1 2.2.1 2.3.1	
6.2.7	2.1.2 2.2.2 2.3.2	
6.3	1.3.1	reference to EN 1127-1

Table ZA.1 (continued)

Clauses/sub-clauses of this EN	Essential Requirements (ERs) of EU Directive 2014/34/EU	Qualifying remarks/Notes
6.4	1.3.4	
6.5	1.0.1 1.3.1	reference to EN 60079 series
6.6	1.3.3	
6.7	1.3.2	
6.8 - 6.9	1.3.1	
7.1, 7.2	1.3.4	
7.3	1.2.6	
7.4	1.1.3 1.4.1 1.4.2	
7.5	1.2.2 1.2.6	
7.6	1.1.3 1.4.2	
7.7	1.1.3 1.4.1 1.4.2	
8	1.1.3 1.2.1 1.2.2 1.2.5	
9.1	1.0.1 1.0.3 1.0.4	
9.5	1.0.6	
10	1.0.5	
Annexes A - G	1.0.2 1.3.1	

WARNING — Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Annex ZB (informative)

Correspondence of equipment groups

In all cases Equipment Protection Levels (EPL) as defined by EN 60079-0 are related to the corresponding Equipment Groups and Equipment Categories according to the following table. The same applies if a standard makes reference to the intended use of equipment in Zones according to the definitions in EN 60079-10.

Table ZB.1 — Correspondence of equipment groups

EN 60079-0		Directive 2014/34/EU		EN 60079-10-1 and EN 60079-10-2
EPL	Group	Equipment Group	Equipment Category	Zones
Ma	I	I	M1	NA
Mb			M2	
Ga	II	II	1G	0
Gb			2G	1
Gc			3G	2
Da	III		1D	20
Db			2D	21
Dc			3D	22




Instructions

The manufacturer or his authorized representative in the Community is to draw up the instructions for use in the required Community languages.

Marking

The marking according to this standard is to be supplemented by the marking according to Directive 2014/34/EU. Examples are given below.

European marking examples

Directive part	Standard part	Equipment example
 I M2	Ex h I Mb	Non-electrical equipment for Mining Industry,
 II 2 G	Ex h IIB T4 Gb	Non-electrical equipment intended to be used in Surface Industry classified as Gas Explosive Atmosphere - Zone1
 II 1 D	Ex h IIIC 120°C Da	Non-electrical equipment intended to be used in Surface Industry classified as Explosive Atmosphere of Combustible Dust - Zone 20

Annex ZC
(informative)

**Significant changes between this European Standard and
EN 13463-1:2009**

This European Standard supersedes EN 13463-1:2009

Table ZC.1 — Significant changes between this European Standard and EN 13463-1:2009

Modifications significatives	Clause	Minor and formal changes	Extensions	Extensions
Introduction of new definitions and slight redefinitions concerning ignition sources to improve ignition hazard assessment	Clause 3	X		
Introduction of Equipment Protection Level instead of Category relating to ATEX Directive	Clause 4.1		X	
Introduction of Dust groups defined as Group IIIA, IIIB, & IIIC	Clause 4.4		X	
Introduction in the instructions for safe use and required maintenance for the equipment shall be specified by the manufacturer	Clause 5.1		X	
Change of wording regarding the formal Ignition hazard identification and assessment	Clause 5.2.1	X		
Introduction of what the assessment shall show	Clause 5.2.2.1		X	
Change of wording regarding EPL Mb equipment requirement	Clause 5.2.2.2	X		
Introduction of a new note regarding the risk of ignition due to other ignition source	Clause 6.1		X	
Change of wording regarding the ambient temperature	Clause 6.2.2	X		
Introduction of a new note regarding the option to calculate maximum temperatures	Clause 6.2.3		X	
Introduction of a new note regarding the layers of coal dust	Clause 6.2.3		X	
Introduction of a new note regarding the instructions	Clause 6.2.5		X	

Table ZC.1 (continued)

Modifications significatives	Article	Minor and formal changes	Extensions	Extensions
Introduction of a new column regarding requirement for T5 classification	Clause 6.2.6.1		X	
Introduction of two new notes regarding the enclosed volume	Clause 6.2.6.2		X	
Introduction of requirement regarding External hot surfaces	Clause 6.2.6.3		X	

NOTE 1 The technical changes referred to include the significant technical changes from the revised EN but this is not an exhaustive list of all modifications from the previous version.

Explanations:

A) Definitions

Minor and editorial changes clarification
 decrease of technical requirements
 minor technical change
 editorial corrections

Changes in a standard classified as ‘Minor and editorial changes’ refer to changes regarding the previous standard, which modify requirements in an editorial or a minor technical way. Also changes of the wording to clarify technical requirements without any technical change are classified as ‘Minor and editorial changes’.

A reduction in level of existing requirement is also classified as ‘Minor and editorial changes’

Extension addition of technical options

Changes in a standard classified as ‘extension’ refers to changes regarding the previous standard, which add new or modify existing technical requirements, in a way that new options are given, but without increasing requirements for equipment that was fully compliant with the previous standard. Therefore these ‘extensions’ will not have to be considered for products in conformity with the preceding edition.

Major technical changes

addition of technical requirements

increase of technical requirements

Changes in a standard classified as 'Major technical change' refer to changes regarding the previous standard, which add new or increase the level of existing technical requirements, in a way that a product in conformity with the preceding standard will not always be able to fulfil the requirements given in the standard. 'Major technical changes' have to be considered for products in conformity with the preceding edition. For every change classified as 'Major Technical Change' additional information is provided in clause B) of the Annex ZB.

NOTE 2 These changes represent current technological knowledge¹. However, these changes should not normally have an influence on equipment already placed on the market.

B) Information about the background of 'Major Technical Changes'

None

¹ see also ATEX Guideline 10.3 and Annex ZA

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

EXPLOSIVE ATMOSPHERES –

Part 36: Non-electrical equipment for explosive atmospheres – Basic method and requirements

FOREWORD

- 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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International Standard ISO 80079-36 has been prepared by IEC sub-committee 31M: Non-electrical equipment and protective systems for explosive atmospheres, of IEC 31: Equipment for explosive atmospheres.

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

FDIS	Report on voting
31M/103/FDIS	31M/109/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. In ISO, the standard has been approved by 15 P members out of 22 having cast a vote.

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

"A list of all parts in the IEC 60079 series, under the general title *Explosive atmospheres*, as well as the International Standard 80079 series, 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

This part of ISO/IEC 80079 addresses for the first time basic requirements and protection concepts for mechanical explosion protected equipment on an international level. Up to now, with some exceptions, only the design, manufacture, installation and operation of electrical equipment in explosive atmospheres have been addressed in ISO and IEC standards. Examples of non-electrical equipment are: couplings, pumps, gearboxes, brakes, hydraulic and pneumatic motors and any combination of devices to realise a machine, fan, engine, compressor, assemblies, etc.

Although many but not all of such machines use an explosion protected electric motor for motive power the measures needed to reduce the risk of ignition in mechanical equipment as part of the machine may be different to those applied to electrical equipment.

Whereas electrical equipment working within design parameters often contains effective ignition sources such as sparking parts, this is not necessarily true for mechanical equipment which is designed to operate without break-down between predetermined maintenance operations.

Generally there are two mechanical ignition scenarios that need to be considered. These are, ignition resulting from a failure in the machine such as a bearing over-heating or ignition created by the normal functioning of the machine such as a hot brake surface.

Experience has shown that it is essential to perform a comprehensive ignition hazard assessment on the complete mechanical equipment to identify all potential ignition sources and determine if they can become effective ignition sources during the expected lifetime of the mechanical equipment. Once these ignition risks are understood and documented it is then possible to assign protective measures, depending on the required Equipment Protection Level (EPL), to minimise the probability that these ignition sources will become effective.

This standard addresses mechanical equipment and assemblies intended for the generation, transfer, storage, measurement, control and conversion of energy and/or the processing of material and which are capable of causing an explosion through their own potential sources of ignition.

Potential ignition sources are not limited to those created by the equipment but include any ignition sources created by the operation of the equipment; for example hot surfaces when pumping hot fluids or electrostatic charging when handling plastics.

If the only source of ignition of an item comes from the external process such items are not considered to have their own source of ignition, and they are not in the scope of this part of ISO/IEC 80079.

NOTE Examples are items made from plastics (polymers) like plastic pipes and containers that can become charged due to an external process (and not by the operation of the equipment), or items that can become hot due to an external process (like a pipe). These are not considered to be "non-electrical equipment" on their own. If on the other hand such items are incorporated into non-electrical equipment, and could become an ignition source by the intended operation of the equipment, they need to be assessed together with the equipment under consideration (for example a plastic pipe as part of a petrol dispenser could become charged due to the operation of this dispenser).

EXPLOSIVE ATMOSPHERES –

Part 36: Non-electrical equipment for explosive atmospheres – Basic method and requirements

1 Scope

This part of ISO/IEC 80079 specifies the basic method and requirements for design, construction, testing and marking of non-electrical Ex equipment, Ex Components, protective systems, devices and assemblies of these products that have their own potential ignition sources and are intended for use in explosive atmospheres.

Hand tools and manually operated equipment without energy storage are excluded from the scope of this standard. This standard does not address the safety of static autonomous process equipment when it is not part of equipment referred to in this standard.

NOTE 1 Static autonomous process equipment includes items such as tanks, vessels, fixed pipework and hand operated valves which do not have their own source of energy that could create a potential ignition source during operation.

This standard does not specify requirements for safety, other than those directly related to the risk of ignition which may then lead to an explosion. The standard atmospheric conditions (relating to the explosion characteristics of the atmosphere) under which it may be assumed that equipment can be operated are:

- temperature -20 °C to +60 °C;
- pressure 80 kPa (0,8 bar) to 110 kPa (1,1 bar); and
- air with normal oxygen content, typically 21 % v/v.

Such atmospheres can also exist inside the equipment. In addition, 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.

NOTE 2 Although the standard atmospheric conditions above give a temperature range for the atmosphere of -20 °C to +60 °C, the normal ambient temperature range for the equipment is -20 °C to +40 °C, unless otherwise specified and marked. It is considered that -20 °C to +40 °C is appropriate for most equipment and that to manufacture all equipment to be suitable for a standard atmosphere upper ambient temperature of +60 °C would place unnecessary design constraints.

NOTE 3 The requirements of this standard can also be helpful for the design, construction, testing and marking of equipment intended for use in atmospheres outside the validity range stated above. In this case however, the ignition hazard assessment, ignition protection provided, additional testing (if necessary), manufacturer's technical documentation and instructions to the user, clearly demonstrate and indicate the equipment's suitability for the conditions it may encounter. It is also recognized that changes in temperature and pressure can have a significant influence on characteristics of the explosive atmosphere, such as ignitability.

This part of ISO/IEC 80079 specifies the requirements for the design and construction of equipment, intended for explosive atmospheres in conformity with all Equipment Protection Levels (EPLs) of Group I, II and III.

NOTE 4 It is not unusual for equipment designed and constructed in accordance with this standard for a particular EPL to be used in areas requiring an EPL with a higher level of safety by including the application of additional measures. Such measures include for example inerting, suppression, venting or containment or for example by dilution, drainage, monitoring and shut-down. Such measures are outside the scope of this standard.

This standard supplements and modifies the general requirements of IEC 60079-0, as shown in Table 1. Where a requirement of this standard conflicts with a requirement of IEC 60079-0, as far as applicable for non-electrical equipment, the requirement of this standard takes precedence.

This standard is supplemented or modified by the following standards concerning specific types of protection:

- ISO 80079-37, *Explosive atmospheres – Part 37: Non-electrical equipment for explosive atmospheres – Non-electrical type of protection constructional safety "c", control of ignition source "b", liquid immersion "k"*
- IEC 60079-1, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*
- IEC 60079-2, *Explosive atmospheres – Part 2: Equipment protection by pressurized enclosures "p"*
- IEC 60079-31, *Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure "t"*

The nature and ignition sources of non-electrical equipment shall be considered when applying types of protection "d", "p", or "t" on non-electrical equipment (see Annex G).

Table 1 – Applicability of specific clauses of IEC 60079-0 (1 of 5)

Clause of IEC 60079-0		IEC 60079-0 application to			
Ed 6.0 (2011) (Inf.)	Clause / Sub-Clause Title (Normative)	ISO 80079-36	ISO 80079-37		
			"c"	"b"	"k"
4	Equipment grouping	Modified (see Clause 4)	(*)	(*)	(*)
4.1	Group I	Applies	(*)	(*)	(*)
4.2	Group II	Applies	(*)	(*)	(*)
4.3	Group III	Modified (see 4.4)	(*)	(*)	(*)
4.4	Equipment for a particular explosive atmosphere	Applies	(*)	(*)	(*)
5	Temperatures	Modified (see 6.2 and Table 2)	(*)	(*)	(*)
5.1	Environmental influences	Applies	(*)	(*)	(*)
5.1.1	Ambient temperature	Applies <i>to be read as non-electrical equipment</i>	(*)	(*)	(*)
5.1.2	External source of heating or cooling	Applies <i>to be read as non-electrical equipment</i>	(*)	(*)	(*)
5.2	Service temperature	Applies <i>to be read as non-electrical equipment</i>	(*)	(*)	(*)
5.3.1	Determination of maximum surface temperature	Modified (see 6.2.3) non-electrical	(*)	(*)	(*)
5.3.2.1	Group I electrical equipment	Modified (see 6.2.4) non-electrical	(*)	(*)	(*)
5.3.2.2	Group II electrical equipment	Modified (see 6.2.5) non-electrical	(*)	(*)	(*)
5.3.2.3	Group III electrical equipment	Modified (see 6.2.7) non-electrical	(*)	(*)	(*)

Table 1 (2 of 5)

Clause of IEC 60079-0		IEC 60079-0 application to			
Ed 6.0 (2011) (Inf.)	Clause / Sub-Clause Title (Normative)	ISO 80079-36	ISO 80079-37		
			"c"	"b"	"k"
5.3.3	Small component temperature for Group I and Group II electrical equipment	Modified (see 6.2.6) non-electrical	(*)	(*)	(*)
6.	Requirements for all electrical equipment	Applies <i>to be read as non-electrical equipment</i>	(*)	(*)	(*)
6.1	General	Applies <i>to be read as non-electrical equipment</i>	(*)	(*)	(*)
6.2	Mechanical strength of equipment	Applies	(*)	(*)	(*)
6.3	Opening times	Modified (see 7.3)	(*)	(*)	(*)
6.4	Circulating currents in enclosures (e.g. of large electrical machines)	Applies	(*)	(*)	(*)
6.5	Gasket retention	Applies	(*)	(*)	(*)
6.6	Electromagnetic and ultrasonic energy radiating equipment	Excluded	-	-	-
7	Non-metallic enclosures and non-metallic parts of enclosures	Applies	(*)	(*)	(*)
7.1	General	Applies	(*)	(*)	(*)
7.1.1	Applicability	Applies	(*)	(*)	(*)
7.1.2	Specification of materials	Applies	(*)	(*)	(*)
7.2	Thermal endurance	Applies	(*)	(*)	(*)
7.3	Resistance to light	Applies	(*)	(*)	(*)
7.4	Electrostatic charges on external non-metallic materials	Modified (see 6.7.4, 6.7.5 and 6.7.6)	(*)	(*)	(*)
7.5	Accessible metal parts	Applies	(*)	(*)	(*)
8	Metallic enclosures and metallic parts of enclosures	Modified (see 6.4.2.1 Footnote 1) and ref. to ISO 6507-1	(*)	(*)	(*)
8.1	Material composition	Modified (see 6.4.2.1 Footnote 1) and ref. to ISO 6507-1	(*)	(*)	(*)
8.2	Group I	Modified (see 6.4.2.1 Footnote 1) and ref. to ISO 6507-1	(*)	(*)	(*)
8.3	Group II	Modified (see 6.4.2.1 Footnote 1) and ref. to ISO 6507-1	(*)	(*)	(*)

Table 1 (3 of 5)

Clause of IEC 60079-0		IEC 60079-0 application to			
Ed 6.0 (2011) (Inf.)	Clause / Sub-Clause Title (Normative)	ISO 80079-36	ISO 80079-37		
			"c"	"b"	"k"
8.4	Group III	Modified (see 6.4.2.1 Footnote 1) and ref. to ISO 6507-1	(*)	(*)	(*)
9	Fasteners	Excluded	-	-	-
10	Interlocking devices	Excluded	-	-	-
11	Bushings	Excluded	-	-	-
12	Materials used for cementing	Applies (see 7.6)	(*)	(*)	(*)
13	Ex Components	Applies	(*)	(*)	(*)
14	Connection facilities and termination compartments	Excluded	-	-	-
15	Connection facilities for earthing or bonding conductors	Excluded	-	-	-
16	Entries into enclosures	Excluded	-	-	-
17	Supplementary requirements for rotating machines	Excluded	-	-	-
18	Supplementary requirements for switchgear	Excluded	-	-	-
19	Supplementary requirements for fuses	Excluded	-	-	-
20	Supplementary requirements for plugs, socket outlets and connectors	Excluded	-	-	-
21	Supplementary requirements for luminaires	Excluded	-	-	-
22	Supplementary requirements for caplights and handlights	Excluded	-	-	-
23	Equipment incorporating cells and batteries	Excluded	-	-	-
24	Documentation	Modified (see 9)	(*)	(*)	(*)
25	Compliance of prototype or sample with documents	Applies	(*)	(*)	(*)
26	Type Tests	Modified (see 8)	(*)	(*)	(*)
26.1	General	Applies	(*)	(*)	(*)
26.2	Test configuration	Applies <i>to be read as non-electrical equipment</i>	(*)	(*)	(*)
26.3	Tests in explosive test mixtures	Applies	(*)	(*)	(*)

Table 1 (4 of 5)

Clause of IEC 60079-0		IEC 60079-0 application to			
Ed 6.0 (2011) (Inf.)	Clause / Sub-Clause Title (Normative)	ISO 80079-36	ISO 80079-37		
			"c"	"b"	"k"
26.4.1	Order of tests	Excluded	-	-	-
26.4.2	Resistance to impact	Applies (see 8.3.1)	(*)	(*)	(*)
26.4.3	Drop test	Applies (see 8.3.2)	(*)	(*)	(*)
26.4.4	Acceptance criteria	Applies (see 8.3.3)	(*)	(*)	(*)
26.4.5	Degree of protection (IP) by enclosure	Applies	(*)	(*)	(*)
26.5.1.1	General	Applies	(*)	(*)	(*)
26.5.1.2	Service temperature	Applies	(*)	(*)	(*)
26.5.1.3	Maximum surface temperature	Modified (see 8.2)	(*)	(*)	(*)
26.5.2	Thermal shock test	Applies	(*)	(*)	(*)
26.5.3	Small component ignition test (Group I and Group II)	Excluded	-	-	-
26.6	Torque test for bushings	Excluded	-	-	-
26.7	Non-metallic enclosures or non-metallic parts of enclosures	Applies	(*)	(*)	(*)
26.8	Thermal endurance to heat	Applies (see 8.4.4)	(*)	(*)	(*)
26.9	Thermal endurance to cold	Applies (see 8.4.5)	(*)	(*)	(*)
26.10	Resistance to light	Applies	(*)	(*)	(*)
26.11	Resistance to chemical agents for Group I electrical equipment	Applies (see 8.4.6)	(*)	(*)	(*)
26.12	Earth continuity	Excluded	-	-	-
26.13	Surface resistance test of parts of enclosures of non-metallic materials	Applies	(*)	(*)	(*)
26.14	Measurement of capacitance	Excluded	-	-	-
26.15	Verification of ratings of ventilating fans	Excluded	-	-	-
26.16	Alternative qualification of elastomeric sealing O-rings	Applies	(*)	(*)	(*)
27	Routine tests	Applies	(*)	(*)	(*)
28	Manufacturer's responsibility	Modified (see 9.1)	(*)	(*)	(*)
29	Marking	Modified (see 11)	(*)	(*)	(*)

Table 1 (5 of 5)

Clause of IEC 60079-0		IEC 60079-0 application to			
Ed 6.0 (2011) (Inf.)	Clause / Sub-Clause Title (Normative)	ISO 80079-36	ISO 80079-37		
			"c"	"b"	"k"
30	Instructions	Modified (see 10)	(*)	(*)	(*)
30.1	General	Applies	(*)	(*)	(*)
30.2	Cells and batteries	Excluded	-	-	-
30.3	Electrical machines	Excluded	-	-	-
30.4	Ventilating fans	Excluded	-	-	-
(*) This requirement concerns also equipment protected by types of protection "c", "b" and "k".					
Applies – This requirement of IEC 60079-0 is applied without change.					
Excluded – This requirement of IEC 60079-0 does not apply.					
Modified – This requirement of IEC 60079-0 is modified as detailed in this standard.					
The applicable requirements of IEC 60079-0 are identified by the clause title which is normative. This document was written referring to the specific requirements of IEC 60079-0 Ed. 6.0:2011, The clause numbers for the 6th edition are shown for information only. This is to enable the General Requirements IEC 60079-0 Ed. 5.0:2007 to be used where necessary with this part of ISO 80079. Where there were no requirements for the 5th edition or where there is a conflict between requirements, the 6th edition requirements should be considered.					

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

IEC 60079-1, *Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"*

IEC 60079-2, *Explosive atmospheres – Part 2: Equipment protection by pressurized enclosure "p"*

IEC 60079-28, *Explosive atmospheres – Part 28: Protection of equipment and transmission systems using optical radiation*

IEC 60079-31, *Explosive atmospheres – Part 31: Equipment dust ignition protection by enclosure "t"*

ISO 80079-37:—, *Explosive atmospheres – Part 37: Non-electrical equipment for explosive atmospheres – Non-electrical type of protection constructional safety "c", control of ignition source "b", liquid immersion "k" 1*

1 (to be published)

ISO/IEC 80079-38, *Explosive Atmospheres – Part 38: Equipment and components in explosive atmospheres in underground mines*

ANSI/UL 746B, *Polymeric Materials – Long Term Property Evaluations*

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 ignition source scenarios

3.1.1 possible ignition source

type of ignition source to be considered for the identification of ignition hazards

Note 1 to entry: Possible ignition sources include:

- Hot surfaces
- Flames and hot gases (including hot particles)
- Mechanically generated sparks
- Electrical source
- Stray electric currents, cathodic corrosion protection
- Static electricity
- Lightning
- Radio frequency (RF) electromagnetic waves from 10^4 Hz to 3×10^{12} Hz
- Electromagnetic waves including optical radiation from 3×10^{11} Hz to 3×10^{15} Hz
- Ionizing radiation
- Ultrasonics
- Adiabatic compression and shock waves
- Exothermic reactions, including self-ignition of dusts

Note 2 to entry: See also Annex B for information of possible ignition sources.

Note 3 to entry: See Figure 1.

3.1.2 equipment related ignition source

possible ignition source which could be caused by the equipment under consideration regardless of its ignition capability

Note 1 to entry: These are sometimes called "relevant ignition sources", however this can lead to misunderstanding as to whether the ignition source is relevant in terms of it being present, in terms of its ignition capability or in terms of whether it is present in the equipment or not.

Note 2 to entry: All equipment related ignition sources are considered in the ignition hazard assessment to determine whether they are potential ignition sources.

Note 3 to entry: See Figure 1.

3.1.3 potential ignition source

equipment related ignition source which has the capability to ignite an explosive atmosphere (i.e. to become effective)

Note 1 to entry: The likelihood of becoming effective determines the EPL (they may arise in normal operation, expected malfunction, rare malfunction).

3.1.4

effective ignition source

potential ignition source which is able to ignite an explosive atmosphere when consideration is taken of when it occurs (i.e. in normal operation, expected malfunction or rare malfunction)

Note 1 to entry: This is important for establishing the EPL.

Note 2 to entry: An effective ignition source is a potential ignition source which can ignite the explosive atmosphere if protective measures are not used.

Note 3 to entry: For example the frictional heat which may be produced by a bearing is a possible ignition source. This is an equipment related ignition source if the piece of equipment contains a bearing. If the energy which may be produced by the friction in the bearing is capable of igniting an explosive atmosphere then this is a potential ignition source. Whether this potential ignition source is effective depends on the likelihood that it will occur in a particular situation.

3.2

normal operation

operation of equipment conforming to its design specification and used within the limits specified by the manufacturer

Note 1 to entry: Failures (such as a breakdown of pump seals, flange gaskets or releases of substances caused by accidents) which involve repair or shut-down are not considered to be part of normal operation.

Note 2 to entry: Minor releases of flammable material may be part of normal operation. For example, releases of substances from seals which rely on wetting by the fluid which is being pumped are considered to be minor releases.

3.3

malfunctions

3.3.1

malfunction

situation where equipment or components do not perform their intended function with respect to explosion protection

Note 1 to entry: See also ISO 12100:2010.

Note 2 to entry: For the purposes of this standard this can happen due to a variety of reasons, including

- variation of a property or of a dimension of the processed material or of the work-piece;
- failure of one (or more) of the component parts of the equipment, protective systems and components;
- external disturbances (e.g. shocks, vibration, electromagnetic fields);
- design error or deficiency (e.g. software errors);
- disturbance of the power supply or other services;
- loss of control by the operator (especially for hand-held machines).

3.3.2

expected malfunction

disturbance or equipment malfunction which normally occur in practice

[SOURCE: IEC 60079-0:2011, 3.41.1]

3.3.3

rare malfunction

type of malfunction, which may happen, but only in rare instances. Two independent expected malfunctions which, separately, would not create a source of ignition, but which, in combination, do create a source of ignition, are regarded as a single rare malfunction

[SOURCE: IEC 60079-0:2011, 3.41.2]

3.4

maximum surface temperature

highest temperature that can be attained in service under the most adverse operating conditions (but within the recognised tolerance) by any part or surface of equipment, protective system or component which can produce an ignition of the surrounding explosive atmosphere

Note 1 to entry: The maximum surface temperature marked on the equipment and includes safety margins depending on the EPL of the equipment.

Note 2 to entry: The surface temperature which is relevant can be internal or external depending upon the type of protection concerned.

Note 3 to entry: For Ex equipment in an explosive dust atmosphere, this temperature occurs on the external surface of the enclosure and may include a defined dust layer condition.

[SOURCE: IEC 60079-0:2011, 3.42, modified definition and addition of Notes to entry]

3.5

maximum possible potential energy

maximum amount of energy which can be stored in equipment or in parts of equipment and can dissipate into kinetic energy during release

3.6

type of protection

specific measures applied to equipment to avoid ignition of a surrounding explosive atmosphere

Note 1 to entry: Equipment designed and constructed in accordance with this standard for a particular EPL may be used in areas requiring an EPL with a higher level of safety by the application of additional measures. Such measures include for example inerting, suppression, venting or containment or for example by dilution, drainage, monitoring and shut-down. Such measures are outside the scope of this standard.

3.7

non-electrical equipment

equipment which can achieve its intended function mechanically

Note 1 to entry: Equipment addressed in this standard can be driven by any kind of energy including electrical equipment.

3.8

service temperature

T_s

maximum or minimum temperature reached at specific points of the equipment when the equipment is operating at rated conditions, including ambient temperature and any external sources of heating or cooling

Note 1 to entry: Equipment may reach different service temperatures in different parts.

3.9

Ex Component

part of Ex Equipment or a module, marked with the symbol "U", which is not intended to be used alone and requires additional consideration when incorporated into Ex Equipment or systems for use in explosive atmospheres

[SOURCE: IEC 60079-0:2011, 3.28, modified ("electrical" replaced by "Ex")]

3.10

equipment

machines, apparatus, fixed or mobile devices, control components and instrumentation thereof and detection or prevention systems which, separately or jointly, are intended for the generation, transfer, storage, measurement, control and conversion of energy for the

processing of material and which may be capable of causing an explosion through their own source(s) of ignition

3.11

Ex Equipment

equipment where measures have been applied to ensure that effective ignition sources are mitigated as required by the Equipment Protection Level (EPL)

Note 1 to entry: This includes the ignition hazard assessment and/or protective measures in accordance with this standard

4 EPL and equipment groups

4.1 EPL

Equipment for explosive atmospheres is divided into:

- a) Group I equipment for mines susceptible to firedamp; this group comprises two EPLs:
 - EPL Ma;
 - EPL Mb.
- b) Group II Equipment for locations with an explosive atmosphere caused by mixtures of air and gases, vapours or mists; this group comprises three EPLs:
 - EPL Ga;
 - EPL Gb;
 - EPL Gc.
- c) Group III Equipment for locations with an explosive atmosphere, caused by mixtures of air and combustible dusts; this group comprises three EPLs:
 - EPL Da;
 - EPL Db;
 - EPL Dc.

This standard may be used in conjunction with one or more types of protection described in the standards listed in Clause 1, depending on the ignition hazard assessment in 5.2, to provide the protection required.

4.2 Group I

Equipment of Group I is intended for use in mines susceptible to firedamp.

NOTE The types of protection for Group I take into account the ignition of both firedamp and coal dust along with enhanced physical protection for equipment used underground.

Equipment intended for mines where the atmosphere, in addition to firedamp, may contain significant proportions of other flammable gases or combustible dusts (i.e. other than methane or coal dust), shall be constructed and tested in accordance with the requirements relating to Group I and also to the subdivision of Group II and III corresponding to the other significant flammable gases or combustible dusts. This equipment shall then be marked appropriately.

4.3 Group II

Equipment of Group II is intended for use in places with an explosive gas atmosphere other than mines susceptible to firedamp.

Equipment of Group II is subdivided according to the nature of the explosive gas atmosphere for which it is intended.

Group II subdivisions:

- IIA, a typical gas is propane;
- IIB, a typical gas is ethylene;
- IIC, a typical gas is hydrogen.

NOTE 1 This subdivision is based on the maximum experimental safe gap (MESG) or the minimum igniting current ratio (MIC ratio) of the explosive gas atmosphere in which the equipment may be installed. (See IEC 60079-20-1).

NOTE 2 Equipment marked IIB is suitable for applications requiring Group IIA equipment. Similarly, equipment marked IIC is suitable for applications requiring Group IIA or Group IIB equipment.

4.4 Group III

Equipment of Group III is intended for use in places with an explosive dust atmosphere other than mines susceptible to firedamp.

Equipment of Group III is subdivided according to the nature of the explosive dust atmosphere for which it is intended.

Group III subdivisions:

- IIIA: suitable for combustible flyings;
- IIIB: suitable for combustible flyings and non-conductive dust;
- IIIC: suitable for combustible flyings, non-conductive dust and conductive dust.

The ignition hazard assessment shall take into account the special requirements for non-conductive dust due to electrostatic hazards generated by insulated moving parts of non-electrical equipment.

4.5 Equipment for specific explosive gas atmospheres

The equipment may be tested for a specific explosive gas atmosphere. In this case it shall be marked accordingly, see 11.2 e)

5 Ignition hazard assessment

5.1 General requirements

Non-electrical equipment for explosive atmospheres shall comply with the requirements of this standard, and if relevant, with the requirements as modified by the specific parts of IEC 60079, ISO 80079 and ISO/IEC 80079.

Service conditions, instructions for safety and required maintenance for the equipment shall be specified by the manufacturer (see Clause 10).

Equipment that has been designed and constructed according to the applicable safety requirements of relevant industrial standards, and where the ignition hazard assessment confirms that the equipment does not contain any effective ignition sources in normal operation, can be classified as EPL Gc or Dc.

NOTE 1 It is not a requirement of this standard that compliance with the relevant industrial standards be verified by a third party.

Where the ignition hazard assessment confirms that the equipment does not contain any effective ignition sources during normal operation and expected malfunctions, the equipment can be classified as EPL Mb, Gb or Db.

Where the ignition hazard assessment confirms that the equipment does not contain any effective ignition sources during normal operation, expected malfunctions and rare malfunctions, the equipment can be classified as EPL Ma, Ga or Da.

NOTE 2 Annex A provides guidance on the methodology for confirming the EPL.

Figure 1 explains the relationship of the types of ignition source.

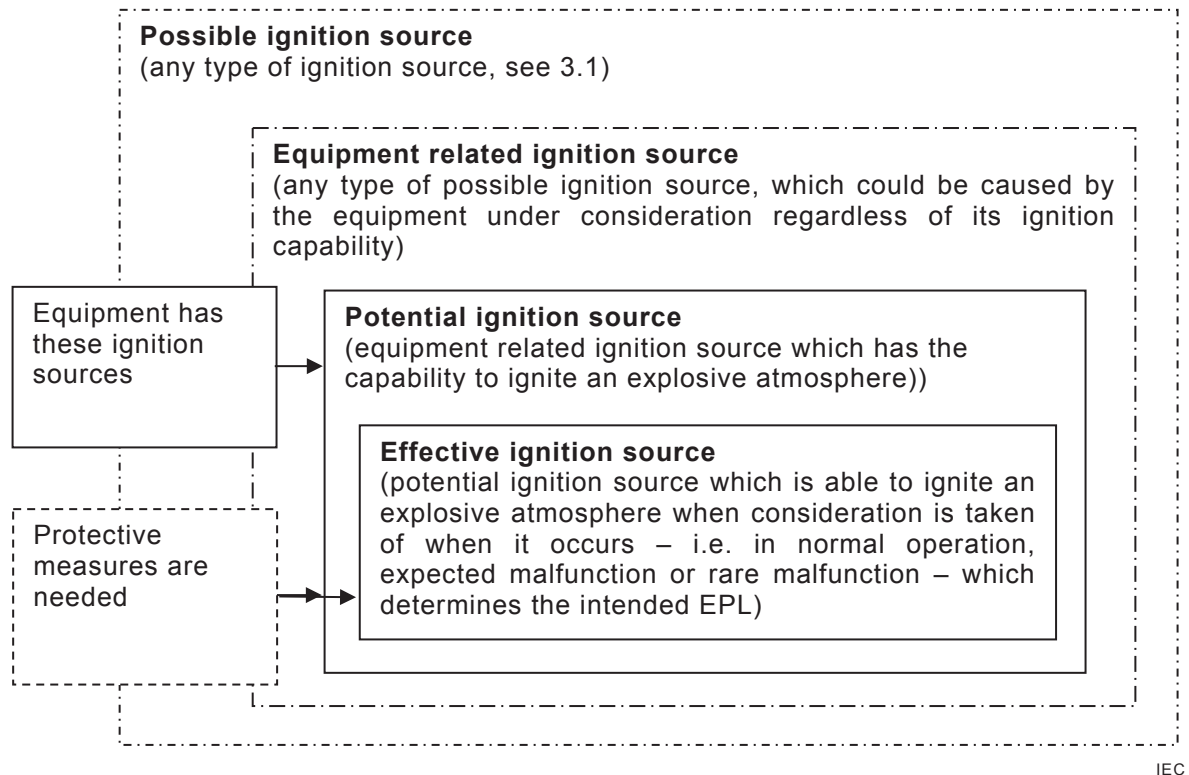


Figure 1 – Relationship between ignition source definitions

5.2 Procedure of ignition hazard assessment

5.2.1 Formal Ignition hazard identification and assessment

The equipment shall be subjected to a formal documented ignition hazard assessment to identify all potential ignition sources that could occur during normal operation, expected malfunction and rare malfunction. Then, depending on the intended EPL of the equipment, mitigation can be applied to each of these potential ignition sources to minimize the likelihood that they could become effective ignition sources.

The formalised process shall be applied to cover design, construction, installations, inspection, testing and maintenance requirements for the protective functions.

NOTE This assessment is typically carried out using a table listing each potential ignition source, together with the mitigation applied (see example in Table B.1)

Protective measures or types of protection shall be considered or applied in the following order:

- minimize the likelihood that ignition sources arise;
- minimize the likelihood that ignition sources become effective;
- minimize the likelihood of the explosive atmosphere reaching the ignition source; and
- contain the explosion and minimize the likelihood of flame propagation.

Depending on the intended EPL, all potential ignition sources shall be considered.

Ignition sources caused by misuse which can reasonably be anticipated shall also be considered. See Annex E.

5.2.2 Group I equipment assessment

5.2.2.1 For EPL Ma equipment

In the case of EPL Ma, the assessment shall list all of the potential ignition sources that are either effective or likely to become effective, taking account of the need to have a very high level of protection and the fact that EPL Ma equipment is required to be safe in normal operation, during expected malfunction or during rare malfunction, even when it is left energised in the presence of an outbreak of gas.

To minimise the likelihood of ignition, the assessment shall show either:

- a) in the event of failure of one means of protection, at least an independent second means of protection provides the required level of protection; or
- b) the required level of protection is ensured in the event of two faults occurring independently of each other.

5.2.2.2 For EPL Mb equipment

In the case of EPL Mb equipment, the assessment shall list all of the potential ignition sources, that are either effective or likely to become effective taking account the need to have a high level of protection and the fact that Mb equipment is required to be safe in normal operation and during expected malfunctions even under severe operating conditions, in particular those arising from rough handling and changing environmental conditions.

It shall also list those sources where the risk of them becoming effective remains, despite the equipment being designed to be de-energised in the event of an explosive atmosphere occurring. The assessment shall indicate the means used to minimize the likelihood of ignition. These means may either be according to this standard or to the type of protection standards listed in the scope of this standard.

NOTE An example is when the concentration of flammable gas in the atmosphere (e.g. 20 % of the LEL) is detected by a methanometer (EPL Ma) and the energy source to the equipment (EPL Mb) is automatically removed.

5.2.3 Group II and III equipment assessment

5.2.3.1 For EPL Ga or Da

In the case of EPL Ga or Da, the listed ignition sources shall include all potential ignition sources that are effective or may become effective during normal operation, expected malfunction and rare malfunction. It shall also indicate the measures which have been applied to minimize the likelihood of the ignition source becoming effective. These measures may either be according to this standard or to the specific type of protection standards listed in the scope of this standard which have been applied.

5.2.3.2 For EPL Gb, Db

In the case of EPL Gb, Db, the listed ignition sources shall include all potential ignition sources that are effective or may become effective during normal operation and expected malfunction. It shall also indicate the measures used to minimize the likelihood of ignition used according to this standard and to the specific type of protection standards listed in the scope of this standard which have been applied.

5.2.3.3 For EPL Gc or Dc

In the case of EPL Gc or Dc, the listed ignition sources shall include all potential ignition sources that are effective or may become effective during normal operation. It shall also indicate the measures used to minimize the likelihood of the ignition according to this standard and to the specific type of protection standards listed in the scope of this standard which have been applied.

5.2.4 Assessment with malfunctions

Where the EPL requires assessment to include expected malfunctions or rare malfunctions, the assessment shall also consider those parts which if they failed could:

- ignite any flammable or combustible substance contained within or forming part of the equipment (e.g. lubricating oil); or
- consequently become or create an ignition source.

5.2.5 Basic information necessary for the ignition hazard assessments

The ignition hazard assessment shall be based on the following information where appropriate:

- description of the equipment;
- intended use as described by the manufacturer e.g. in the marking and instructions;
- materials and their characteristics;
- design drawings and specifications;
- any relevant assumptions which have been made (e.g. loads, strengths, safety factors and duty cycle);
- results of design calculations made;
- results of examinations carried out;
- requirements for installation, operation and maintenance.

NOTE Examples of some ignition hazard assessments performed for equipment are given in Annex C.

5.2.6 Ignition hazard assessment report

The ignition hazard assessment report shall contain as a minimum the following information:

- basic information as described in 5.2.5;
- hazards identified and their causes;
- ignition hazard assessment;
- means implemented to eliminate or minimize identified ignition hazards (e.g. from standards or other specifications as described in Clause 6);
- result of the final ignition hazard assessment;
- remaining hazards that require actions from the user to minimize the likelihood of ignitions;
- reasons for assessment results if not self-explanatory; and
- resulting EPL and necessary safety-related limitations of the intended use.

The results of the ignition hazard assessment shall be reported in a clear and concise manner.

NOTE Annex B shows and explains an assessment reporting scheme. Examples are given in this reporting scheme (see Annex C).

The ignition hazard assessment report shall be included in the documentation which demonstrates compliance with this standard (see 9.1).

6 Assessment of possible ignition sources and control means

6.1 General

The following clauses address the ignition hazard assessment for different types of ignition sources and control means to minimize the potential for ignition arising from them, depending on the intended EPL.

NOTE 1 An explanation of the hazard assessment procedure is given in Annex B.

NOTE 2 The risk of ignition due to lightning is not significant for the manufacturer of mechanical equipment and are typically addressed by the user at the time of installation.

6.2 Hot surfaces

6.2.1 General

If an explosive atmosphere comes into contact with a heated surface, ignition can occur. Not only can a hot surface itself act as an ignition source, but a dust layer or a combustible solid in contact with a hot surface and ignited by itself can also act as an ignition source for an explosive atmosphere.

The maximum surface temperature which can occur determines whether it can act as an ignition source.

The maximum surface temperature shall be specified in relevant documentation according to Clause 9.

6.2.2 Ambient temperatures

Equipment designed for use in a normal ambient temperature range of -20 °C to +40 °C does not require marking of the ambient temperature range. However, equipment designed for use in other than this normal ambient temperature range is considered to be special and requires marking of the ambient temperature range.

See items i) and l) of 11.2 and Table 11.

NOTE Although the standard atmospheric conditions in the scope give a temperature range for the atmosphere of -20 °C to +60 °C the normal ambient temperature range for the equipment is -20 °C to +40 °C unless otherwise specified and marked.

6.2.3 Establishing the maximum surface temperature

As part of the ignition hazard assessment, the maximum surface temperature of the equipment shall be established. This is the highest surface temperature, adjusted by the safety margins given in 8.2. This highest surface temperature applies to any part of the equipment that could be exposed to an explosive atmosphere or where a dust layer could form, taking account of its size and ability to become an ignition source.

The assessment shall also take account of any integral device(s) fitted to limit the highest surface temperature (e.g. the use of a low melting point fusible drain plug in a fluid coupling). Where a temperature limiting device is used it shall fulfil the requirements for Type of Protection "b", control of ignition source. The maximum surface temperature shall be assessed at the maximum ambient temperature and the worst case operational state for which the equipment is designed.

The determination, by measurement or calculation, of the highest surface temperature shall be made with the equipment at worst case working conditions, but with those failures tolerated by the applied type of ignition protection. The measurement or determination by calculation of the highest surface temperature shall include the conditions of operation of expected malfunction for EPL Mb, Gb and Db equipment and of rare malfunction for EPL Ma, Ga and Da for which no additional protective measures are used.

NOTE The maximum surface temperature of the equipment is used – as determined according to 8.2 including safety margins given here – for marking of the equipment with a defined temperature, a temperature class of the equipment or an appropriate explosive gas atmosphere. The actual measured or calculated highest surface temperature is typically lower than the marked maximum surface temperature as a result of the application of the safety margins specified in 8.2.

The option to calculate maximum temperatures applies for equipment that cannot be practically tested at full or maximal intended load and maximum ambient temperature e.g. for very large machines.

Where the equipment is intended and marked for use only with one or more specific explosive gas atmospheres, then the maximum surface temperature shall not exceed the lowest ignition temperature of those explosive gas atmospheres.

6.2.4 Group I equipment

The maximum surface temperature shall not exceed:

- a) 150 °C on any surface where coal dust can form a layer;
- b) or 450 °C where coal dust is not expected to form a layer (for example inside an IP5X enclosure), in which case:
 - 1) the actual maximum surface temperature is marked on the equipment, and
 - 2) the symbol "X" marking as detailed in 11.2 I) is placed on the equipment and the Specific Conditions of Use shall be given in the instructions.

6.2.5 Group II equipment

Group II equipment shall be:

- classified in a temperature class depending on the maximum surface temperature as given in Table 2. In this case, the maximum surface temperature shall not exceed the temperature class limits according to Table 2; or
- defined by the maximum surface temperature of the equipment; or
- if appropriate, restricted to the specific explosive gas atmosphere for which it is intended; in this case the maximum surface temperature shall not exceed the auto-ignition temperature of the specific explosive gas atmosphere for which it is intended.

Group II equipment shall be marked accordingly, see also 11.2.

Table 2 – Classification of maximum surface temperatures for Group II equipment

Temperature class	Maximum surface temperature °C
T1	≤ 450
T2	≤ 300
T3	≤ 200
T4	≤ 135
T5	≤ 100
T6	≤ 85

Where the maximum surface temperature depends mainly on operating conditions (like a heated fluid in a pump), and not on the equipment itself, the relevant information shall be given in the instructions and the equipment shall be marked by using a range of temperature classes or a temperature range (e.g. T6...T4, or 85 °C...150 °C) in order to inform the user about this special situation (see Clause 11 on marking)

NOTE The maximum surface temperature of the equipment includes a safety margin to the auto-ignition temperature of the explosive atmosphere; see also 8.2 for further details.

6.2.6 Special cases for Group I and Group II equipment

6.2.6.1 Small surface areas

Small surface areas, whose temperature exceeds that permitted for the temperature classification, shall conform to Table 3:

Table 3 – Assessment for temperature classification for small surface areas

Total surface area	Maximum surface Temperature for T4 classification	Maximum surface Temperature for T5 classification	Maximum surface Temperature for Group I classification (Dust excluded)
< 20 mm ²	≤ 275 °C	≤ 150 °C	≤ 950 °C
≥ 20 mm ² and ≤ 1 000 mm ²	≤ 200 °C	≤ 150 °C	

In case of small parts heated by optical radiation IEC 60079-28 applies.

6.2.6.2 Enclosed volumes

The minimum ignition temperature of large volumes (more than 1 l) of an explosive gas atmosphere enclosed by the equipment can be below the auto-ignition temperature. This reduction shall be taken into account for these cases in the course of the ignition hazard assessment according to 5.2 if these volumes are part of the equipment.

NOTE 1 This effect occurs mainly where the walls enclosing the mixture are of a uniform temperature.

NOTE 2 A volume greater than 1 litre is considered a large volume by EN 1127-1.

For EPL Ga equipment this effect is taken into account by the safety margin used to determine the maximum surface temperature according to 8.2.1 b).

For EPL Gb equipment, the safety margin shall be the same as that used for EPL Ga equipment according to 8.2.1 b) unless auto-ignition tests of the larger volume confirm suitability.

NOTE 3 Annex H provides further information auto-ignition temperatures determined for larger volumes.

6.2.6.3 External hot surfaces

External hot surfaces exposed to explosive atmospheres under open air conditions (free convection) e.g. parts of equipment in hydrocarbon atmospheres may need higher surface temperatures to ignite the atmosphere than the auto-ignition temperature of the combustible material. If this is used during the ignition hazard assessment the non-capability to ignite the atmosphere shall be confirmed in accordance with 8.2.2.

6.2.7 Group III equipment

6.2.7.1 General

Group III equipment shall be defined by the actual maximum surface temperature and shall be marked accordingly.

Where the actual maximum surface temperature depends not on the equipment itself, but mainly on operating conditions (like a heated fluid in a pump), the relevant information shall be given in the instructions for use and the equipment shall be marked by using a temperature range (e.g. T85 °C...T150 °C) in order to inform the user about this special situation (see Clause 11 on marking).

6.2.7.2 Maximum surface temperature determined without a dust layer

The maximum surface temperature determined (see 8.2) shall not exceed the maximum surface temperature assigned.

6.2.7.3 Maximum surface temperature with respect to dust layers

In addition to the maximum surface temperature required in 6.2.7.2, the maximum surface temperature may also be determined for a given depth of layer, T_L , of dust surrounding all sides of the equipment, unless otherwise specified in the documentation, and marked with the symbol "X" to indicate this Specific Condition of Use defined in IEC 60079-0.

6.3 Flames and hot gases (including hot particles)

Where the ignition hazard assessment shows that flames and hot gases will be caused by the intended use of the equipment, appropriate measures shall be taken to minimise the likelihood of the ignition in accordance with intended EPL and those measures documented.

6.4 Mechanically generated sparks and hot surfaces

6.4.1 General

As a result of friction, impact or abrasion processes such as grinding, particles can become separated from solid materials and become hot owing to the energy used in the separation process. If these particles consist of oxidizable substances, for example iron or steel, they can undergo an oxidation process, thus reaching even higher temperatures. These particles (sparks) can ignite flammable gases and vapours and certain dust/air-mixtures (especially metal dust/air mixtures). In deposited dust, smouldering can be caused by the sparks, and this can be a source of ignition for an explosive atmosphere.

6.4.2 Assessment of sparks generated by single impacts

6.4.2.1 Assessment of single impact sparks as Potential Ignition Sources

This assessment does not apply to ignition sources:

- originating from grinding and friction (see 6.4.3); and
- single impact sparks in mining (see ISO/IEC 80079-38).

Single impacts between metal parts need not to be considered as potential ignition sources in the ignition hazard assessment if the following conditions are met.

Either

- a) the impact velocity is less than 1 m/s and the maximum potential impact energy is less than 500 J and
 - 1) aluminium, titanium and magnesium in combination with ferritic steel is not used, or

- 2) aluminium in combination with stainless steel (≥ 16.5 % Cr) can be only used if the stainless steel cannot corrode and no iron oxide and/or rusty particles can be deposited on the surface (appropriate reference to the properties of the stainless steel shall be given in the technical documentation and instructions for use), or
- 3) hard steel² in combination with hard steel is not used, or
- 4) hard steel is not used where it can impact on granite, or
- 5) aluminium in combination with aluminium is only used if no iron oxide and/or rusty particles can be deposited on the surface.

or

- b) where a combination of non-sparking metals³ is used and the impact velocity is less than or equal to 15 m/s and the maximum potential energy is less than 60 J for gas/vapour-atmospheres or less than 125 J for dust-atmospheres.

6.4.2.2 Assessment of single impact sparks as effective ignition sources

Ignition sources generated by impact need not be considered as effective ignition sources if the impact velocity is less than 15 m/s and the maximum possible potential energy is less than the values given in Tables 4, 5, 6 and 7.

Tables 4, 5, 6 and 7 support a manufacturer in his decision whether a potential ignition source can become an effective ignition source or not. If an impact to be assumed in the course of the ignition hazard assessment might have lower energies than given in the tables, the ignition source is not considered to become an effective ignition source.

On the other hand, if the energies exceed the values in Tables 4, 5, 6 and 7, this does not necessarily mean that the ignition source will become effective. In this case, the ignition hazard assessment needs to assess all aspects and may show that the likelihood of the impact is low enough to be acceptable.

If the impact energies are larger than those given in the following tables then they need to be assessed. In this case consideration shall be taken of when they occur and whether they are able to ignite the explosive atmosphere (i.e. in normal operation, expected malfunction or rare malfunction) which determines the intended EPL.

Where it can be demonstrated within defined operating parameters by an FMEA (Failure Mode Effect Analysis) or some other equally effective means that a single impact due to mechanical failure cannot occur this need not be considered as an effective ignition source depending on the EPL.

NOTE In some cases the combination stainless steel/stainless steel may avoid single impact sparking. Experience has shown that the use of copper clad forks on a lift truck reduces the ignition risk from impact sparks and brief frictional heating to a very low level and that this construction is suitable for Equipment Group IIB applications.

² Hard steel is understood as being either all kinds of hardened steel (surface hardened or heat treated in another way to improve surface hardness) or other steel types with Vickers Hardness greater than 230 HV (acc. to ISO 6507 with test load ≥ 98 N).

³ Non-sparking metals are e.g. copper (Cu), zinc (Zn), tin (Sn), lead (Pb), some brasses (CuZn) and bronze (CuSn), which are non-ferrous metals of high heat conductivity and are difficult to oxidize. Sparks can only be generated by these materials when they are used in combination with materials of extremely high hardness.

Table 4 – Single impact energy limits for EPL Ga

Equipment Group	Single impact energy limits	
	Non-sparking metals:	Other materials, excluding materials specified in 6.4.2.1 a):
IIC	60 J	5 J (Hydrogen) 3 J (Hydrocarbons incl. acetylene)
IIB	125 J	10 J
IIA	125 J	20 J
These criteria do not apply for atmospheres with flammable gases such as carbon disulfide, carbon monoxide and ethylene oxide		

Table 5 – Single impact energy limits for EPL Gb

Equipment group	Single impact energy limits	
	Non-sparking metals:	Other materials, excluding materials specified in 6.4.2.1 a):
IIC	125 J	10 J
IIB	250 J	20 J
IIA	500 J	40 J
These criteria do not apply for atmospheres with flammable gases such as carbon disulfide, carbon monoxide and ethylene oxide		

Table 6 – Single impact energy limits for EPL Gc

Equipment group	Single impact energy limits	
	Non-sparking metals:	Other materials, excluding materials specified in 6.4.2.1 a):
IIC	250 J	20 J
IIB	500 J	40 J
IIA	500 J	80 J
These criteria do not apply for atmospheres with flammable gases such as carbon disulfide, carbon monoxide and ethylene oxide.		

Table 7 – Single impact energy limits for EPL Da, Db and Dc

EPL	Single impact energy limits	
	Non-sparking metals:	Other materials, excluding materials specified in 6.4.2.1 a):
Da	125 J	20 J
Db and Dc	500 J	80 J
These values do not apply to explosive pyrotechnic or self reactive dusts which do not come under the scope of this standard.		

6.4.3 Assessment of sparks and hot surfaces generated by friction

Friction and grinding can lead to sparks as well as to hot surfaces and shall be considered. For hot surfaces 6.2 applies.

Whether a potential frictional ignition source shall be considered as effective depends on when it occurs i.e. during normal operation, expected malfunctions or rare malfunctions.

NOTE A relative contact speed of 1 m/s is often used as the limit value below which friction ignition sources are not capable to ignite an explosive atmosphere. The contamination of gaps with dusts results in frictional ignition sources at low speeds, (for example in bearings, seals, mechanical linear actuators or linkages). There are a few exceptions, for example with extremely ignition-sensitive dusts such as sulphur, and explosive gas atmospheres such as hydrogen and ethylene where there is a high contact load. Other ignition sensitive gas/air mixtures for example acetylene, carbon disulphide, carbon monoxide, ethylene oxide are also likely to be ignited.

6.4.4 External equipment parts containing light metals

Where the ignition hazard assessment shows that there is a risk of ignition from incendive friction, impact or abrasion sparks then the metallic enclosure requirements of IEC 60079-0 apply.

6.5 Electrical ignition sources except stray current

Where electrical equipment is used in conjunction with mechanical equipment, the electrical equipment shall comply with the relevant parts from the IEC 60079 series.

NOTE Radio frequency (RF), electromagnetic waves including optical radiation, ionizing radiation and ultrasonic radiation are also considered in IEC 60079-0.

6.6 Stray electric currents, cathodic corrosion protection

6.6.1 Internal sources

Where an ignition source due to stray electrical currents is created by stray electrical currents in the equipment itself, it shall be considered accordingly, (e.g. induction driven processes such as a slipping permanent magnet coupling).

6.6.2 External sources

These ignition sources are not normally significant for the manufacturer of non-electrical equipment. If external sources of stray currents can affect the explosion protection of the equipment, the instructions shall include guidance on reducing the risk of ignition.

NOTE Stray currents can flow in electrically conductive systems or parts of systems:

- as return currents in power generating systems – especially in the vicinity of electric railways and large welding systems – when, for example, conductive electrical system components such as rails and cable sheathing laid underground lower the resistance of this return current path;
- as a result of a short-circuit or of a short-circuit to earth owing to faults in the electrical installations;
- as a result of external magnetic induction (e.g. near electrical installations with high currents or radio frequencies); and
- as a result of lightning (see appropriate standards, e.g. IEC 62305).

6.7 Static electricity

6.7.1 General

Incendive discharges of static electricity can occur under certain conditions. The discharge of charged and insulated conductive parts can easily lead to incendive sparks. With charged parts made of non-conductive materials, and these include most plastics as well as some other materials, brush discharges can occur. In special cases, during fast separation processes (e.g. films moving over rollers, drive belts, loading arm operation and bulk hydrocarbon transfer), or by combination of conductive and non-conductive materials, propagating brush discharges are also possible. Cone discharges from bulk material can also occur.

Corona discharges (from sharp points or edges of conductors) and lightning like discharges (as in large ash clouds during eruption of volcanoes) are also known but need not be considered as ignition source within the scope of this standard.

Corona discharges are not incendive for explosive atmospheres and lightning like discharges have never been observed in charged clouds of the size encountered in industrial operations.

Spark discharges, propagating brush discharges and cone discharges can ignite explosive atmospheres, depending on their discharge energy.

Brush discharges can ignite almost all explosive gas atmospheres. Combustible dusts, independent of their Minimum Ignition Energy (MIE), cannot be ignited by brush discharges, provided there are no flammable gases or vapours.

The requirements for non-conductive parts of equipment and non-conductive layers on metal parts only apply if they are exposed to the explosive atmosphere and if there is a foreseeable electrostatic charging mechanism.

Further information is given in Annex F.

6.7.2 Connection facilities for earthing conducting parts

All conducting parts of equipment shall be arranged such that a dangerous potential difference is unlikely to exist between them. If it is likely that isolated metal parts can become charged and act as an ignition source, then earthing terminals shall be provided.

6.7.3 Prevention of highly efficient charge generating mechanisms (leading to propagating brush discharges on non-conductive layers and coatings)

Propagating brush discharges are considered to be an effective ignition source for explosive atmospheres. They can arise following highly efficient charging of non-conductive layers and coatings on metal surfaces. Propagating brush discharges can be prevented in equipment from occurring by ensuring that the breakdown voltage across the layers is less than 4 kV or exclude any charging mechanism stronger than manual rubbing of surfaces.

For Group III equipment, incendive propagating brush discharges can also be prevented by ensuring that the thickness of the non-conducting layer is greater than 8 mm.

NOTE 1 For such layers with a thickness of more than 8 mm brush discharges can occur, but for equipment of EPL Da, Db and Dc they are considered not to be an ignition source, as they are not incendive for dust atmospheres

NOTE 2 Processing of liquids or suspensions (mixing or stirring, filling or draining) can give rise to ignition risks due to static electricity including the risk of propagating brush discharges.

6.7.4 Equipment group I

Equipment with non-conducting surface areas projected in any direction of more than 10 000 mm² (for EPL Ma and Mb) shall be so designed that under normal conditions of use, maintenance and cleaning, danger of ignition due to electrostatic charges is avoided.

This requirement shall be satisfied by one of the following:

- a) Suitable selection of the material so that the surface resistance, measured according to the method given in 8.4.8 does not exceed $10^9 \Omega$ at $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity or $10^{11} \Omega$ measured at $(30 \pm 5) \%$ relative humidity at $(23 \pm 2) ^\circ\text{C}$.
- b) The size, shape and layout, or other protective methods, being such that dangerous electrostatic charges are not likely to occur. This requirement can be satisfied by using the test in Annex D provided propagating brush discharges cannot occur (see 6.7.3);
- c) Limiting the thickness to less than 2 mm when the non-conductive material is a coating on an earthed metal (conducting surface) provided propagating brush discharges cannot occur (see 6.7.3).

NOTE Measures according to b) and c) can limit only brush discharges, not propagating brush discharges.

6.7.5 Equipment group II

Group II equipment, where parts are susceptible to become electrostatically charged, shall be so designed that under conditions of use, maintenance and cleaning, ignition due to electrostatic charges is avoided.

This requirement shall be satisfied by one of the following:

- a) Suitable selection of the material so that the surface resistance of the enclosure, measured according to 8.4.8 does not exceed $10^9 \Omega$ at $(23 \pm 2) ^\circ\text{C}$ and $(50 \pm 5) \%$ relative humidity or $10^{11} \Omega$ measured at $(30 \pm 5) \%$ relative humidity at $(23 \pm 2) ^\circ\text{C}$;
- b) The size, shape and lay-out, or other protective methods, being such that dangerous electrostatic charges are not likely to occur. For EPL Gb this requirement can be satisfied by using the test in Annex D provided propagating brush discharges cannot occur (see 6.7.3);
- c) Limitation of the surface area projected in any direction of non-conductive parts of equipment liable to become electrostatically charged as follows, see Table 8, provided propagating brush discharges cannot occur (see 6.7.3).

Table 8 – Permitted maximum projected areas for non-conductive parts of equipment liable to become electrostatically charged

EPL	Permitted projected area ^c		
	mm ²		
	IIA	IIB	IIC
Ga	5 000	2 500	400
Gb	10 000 ^a	10 000 ^a	2 000 ^a
Gc	no size limit ^b	no size limit ^b	no size limit ^b
^a where the intended use of the equipment can result in frequent incendive discharges occurring in normal operation, the criteria for EPL Ga equipment shall apply. ^b where the intended use of the equipment can result in frequent incendive discharges occurring in normal operation, the criteria for EPL Gb equipment shall apply. ^c Projected area: For sheet materials the area is defined by the exposed (chargeable) area. For curved and projecting objects the area is the projection of the object giving the maximum area i.e. the shadow image. For long narrow materials such as cable, sheaths or pipes the maximum size is defined by the transverse dimension (i.e. the diameter for cable, sheaths or pipes) when it is coiled it should be treated as a sheath.			
These values may be multiplied by 4 if the exposed flat areas of plastics are surrounded by and in contact with conductive earthed frames.			

- d) The non-conductive material in Group II equipment is a coating on an earthed metal or conducting surface which can become charged, the thickness is limited to not more than 2 mm in the case of gases and vapours of Group IIA and IIB, or not more than 0,2 mm in the case of gases and vapours of Group IIC provided in both cases propagating brush discharges cannot occur (see 6.7.3).

NOTE Measures according to b), c) and d) can limit only brush discharges but not propagating brush discharges.

- e) Where the danger of ignition by electrostatic discharges cannot be avoided by the design of the equipment, the marking shall include the symbol "X" marking as detailed in 11.2 I) and a warning label in accordance with item a) of Table 11 The relevant safety measures to be applied in service shall be included in the instructions, see Clause 10.

6.7.6 Equipment group III

For Group III equipment brush discharges will not ignite the explosive dust atmosphere, and therefore there is no restriction on the thickness or surface area of such coatings provided propagating brush discharges cannot occur. Where propagating brush discharges can occur the requirements given in 6.7.3 apply.

6.8 Adiabatic compression and shock waves

If hazards due to compression and/or shock waves have been identified, dependent on the EPL the following specific requirements for equipment, protective systems and components shall be complied with:

Processes that can cause compressions or shock waves which could produce ignition shall be avoided or otherwise protected.

- EPL Ma and Ga: This shall be ensured in the case of normal operation, expected malfunctions and rare malfunctions.
- EPL Mb and Gb: This shall be ensured in the case of normal operation and expected malfunctions.
- EPL Gc: This shall be ensured in the case of normal operation.

NOTE 1 Hazardous compressions and shock waves can often be reduced with proper design to limit the compression ratio, for example: the slides and valves between sections of the system where high pressure ratios are present can only be opened slowly.

NOTE 2 Explosion protected, reciprocating, internal combustion engines will often employ a special design to control those hazards resulting from the adiabatic compression within the engine.

6.9 Exothermic reactions, including self-ignition of dusts

If hazards due to exothermic reactions have been identified, the following specific requirements for equipment and components shall be complied with.

Pyrophoric Substances shall be avoided whenever possible.

When such substances have to be handled, the necessary protective measures shall be adapted in each individual case. The following protective measures can be suitable:

- inerting;
- stabilization;
- improvement of heat dissipation, e.g. by dividing the substances into smaller portions;
- limiting temperature and pressure;
- storage at lowered temperatures;
- limiting residence times.

Construction materials which react hazardously with the substances being handled shall be avoided.

For protective measures against hazards due to impact and friction involving rust and light metals (e.g. aluminium, magnesium, or their alloys), see 6.4.

NOTE Materials not normally pyrophoric can become pyrophoric under certain conditions, e.g. in the storage of sulphur containing petroleum products or milling of light metal in inert atmosphere.

7 Additional considerations

7.1 Dust deposits and other material in the gap of moving parts

The ignition hazard assessment shall consider the ignition risk that arises from dust or other material trapped between two moving parts or a moving part and a fixed part. If dust or other material remains in contact with the same moving part for a long period, it can heat up and can cause a burning deposit of dust or other material which can later ignite an explosive atmosphere. Even slow moving parts can cause a large rise in temperature.

In certain types of powder handling equipment, this type of ignition risk cannot be avoided. In this case, one or more protective measures shall be used.

7.2 Dust deposits and other material in the flame arresters incorporated in the equipment

The ignition hazard assessment shall consider the ignition risk that arises from dust or other material trapped or coated between the fixed components of flame arresters.

NOTE Autonomous flame arresters are defined by ISO 16852.

7.3 Opening times of enclosures

Enclosures which can be opened more quickly than the time necessary for an ignition source to become non-effective, (e.g. to allow the cooling of enclosed hot parts to a surface temperature below the marked temperature class or the marked maximum surface temperature of the equipment) shall be marked with the warning in b) of Table 11. Alternatively the equipment may be marked with the warning in c) of Table 11.

NOTE The above marking information is also required to be included in the instructions by 10.

7.4 Non-metallic enclosures and non-metallic parts of the equipment

7.4.1 General

The following requirements, and also those of 8.3, shall apply to non-metallic enclosures and non-metallic parts of the equipment which are relevant, according to the ignition assessment, for the explosion protection, e.g. plastic parts, glass windows, etc. and to non-conductive layers on metal parts.

7.4.2 Specification of the materials

Materials shall be specified and documented according to 9.1. This specification shall include the material specification details shown for non-metallic enclosures and parts of enclosures in IEC 60079-0.

7.4.3 Thermal endurance

Plastic materials shall have a temperature index TI of at least 20 K greater than the maximum service temperature (see IEC 60079-0).

As an alternative to the TI, the relative thermal index (RTI – mechanical) may be determined in accordance with ANSI/UL 746B.

Elastomers shall have a continuous operating temperature (COT) range that includes a minimum temperature that is below, or equal to, the minimum service temperature and a maximum temperature that is at least 20 K above the maximum service temperature.

7.5 Removable parts

It shall be ensured that parts necessary for maintaining the level of explosion protection cannot be unintentionally or inadvertently removed. This may be achieved by, for example, the use of fasteners that need a tool or key to remove them.

7.6 Materials used for cementing

Where safety or a type of protection depends on materials used for cementing, requirements of IEC 60079-0 apply.

7.7 Light transmitting parts

For Group I equipment, Group II equipment EPL Ga and Gb and Group III equipment EPL Da and Db, light transmitting parts, whose integrity is of relevance for the ignition protection shall be capable of passing the relevant tests according to 8.3.1 or provided with a cover or permanent guard that is capable of passing the relevant test.

NOTE Sight glasses are commonly used to check the status (e.g. level, quality) of lubricating agents used for equipment with rotating parts.

Before a decision on testing is made, it shall be checked whether the damage of a sight glass is likely to occur, depending on its location and mounting position, and whether the damage can result in:

- a) a loss of liquids that can lead to spontaneous dry run and cannot be detected within routine maintenance cycle or;
- b) an auto-ignition of the leaking product because it comes into contact with hot surfaces and thus can act as an ignition source for the explosive atmosphere.

If a loss of liquid is not dangerous according to a) or auto-ignition is not relevant according to b) a damaged sight glass is not deemed to be critical for the type of protection and an impact test according to 8.3.1 need not to be applied.

7.8 Stored energy

When equipment is designed to be de-energised when an explosive atmosphere is detected, the instructions shall include guidance on:

- reduction of the risk of ignition in the period from the detection of the explosive atmosphere and the de-energisation of the equipment,
- avoidance of ignition hazards that might be caused as a result of the de-energisation.

8 Verification and tests

8.1 General

The prototypes or samples shall be tested in accordance with the requirements for type tests of this standard and of the specific standards for the Types of Protection concerned. However, certain tests judged to be unnecessary, may be omitted from the testing programme. A record shall be made of all tests carried out and of the justification for those omitted.

It is not necessary to repeat the tests that have already been carried out on an Ex Component.

NOTE Due to the safety factors incorporated in the types of protection, the uncertainty of measurement inherent in good quality, regularly calibrated measurement equipment is considered to have no significant detrimental effect and need not be taken into account when making the measurements necessary to verify compliance of the equipment with the equipment requirements of the relevant part of ISO 80079.

8.2 Determination of the maximum surface temperature

8.2.1 General

The maximum surface temperature shall be determined under the most adverse conditions at the most unfavourable load defined by the manufacturer and according to the EPL. The determination of the maximum surface temperature shall take account of normal operation for EPL Gc and Dc equipment, expected malfunction for EPL Gb and Db equipment and of both expected and rare malfunctions for EPL Ga and Da equipment and any additional measures to control or limit the maximum surface temperature.

The adverse conditions defined by the manufacturer, shall consider the duty cycle and/or the maximum continuous overload that can occur without overload protection devices activating.

Similarly for Group I, EPL Mb the determination of the maximum surface temperature shall take account of those expected malfunctions that cannot be disregarded by virtue of the equipment being designed to be de-energised in the event of an explosive atmosphere.

The measurement of the surface temperatures and temperatures of other parts as prescribed in this standard and the specific standards for the types of protection concerned shall be made in still air, with the equipment mounted in its normal service position. Air movement due to the function of the equipment is permitted. The temperature of the hottest point of the equipment in contact with the explosive atmosphere shall be determined resulting in the highest surface temperature.

For equipment which can be normally used in different positions, the temperature in each position is to be determined and the highest temperature is to be considered. When the temperature is determined for certain positions only, this shall be specified in the test report and instructions. The equipment shall also be marked – by including the symbol "X" marking as detailed in 11.2 I) .

NOTE 1 The above marking information is also included in the instructions as required by 10.

The measuring devices (thermometers, thermocouples, contactless temperature measuring device, etc.) and the connecting cables should be selected and so arranged that they do not significantly affect the thermal behaviour of the equipment.

The final temperature is considered to have been reached when the rate of rise of temperature does not exceed 2 K/h or after operation of any temperature limiting device forming part of the equipment.

Where there is no temperature limiting device, the result shall be corrected for the maximum ambient temperature specified in the rating by adding the difference between the ambient temperature used in the test and the rated ambient temperature to the measured temperature.

The highest surface temperature measured shall not exceed:

- a) for Group I equipment, those values as given in 6.2;
- b) for Group II EPL Ga equipment, 80 % of the marked maximum surface temperature or 80 % of the maximum surface temperature corresponding to the marked temperature class or 80 % of the auto-ignition temperature in °C of the substance name shown in the marking;

NOTE 2 This increased safety factor for mechanical EPL Ga equipment compared to electrical equipment is necessary as rare mechanical malfunctions that need to be considered for EPL Ga equipment cannot easily be represented by surface temperature determination.

- c) for Group II EPL Gb and EPL Gc equipment:
 - where each manufactured equipment is subjected to routine testing for maximum surface temperature, the temperature as marked on the equipment;
 - where the equipment is subjected to type testing for maximum surface temperature, the marked maximum surface temperature, or the temperature class limit:
 - i) less 5 K for temperature classes T6, T5, T4 and T3 (or marked maximum surface temperatures ≤ 200 °C), and
 - ii) less 10 K for temperature classes T2 and T1 (or marked maximum surface temperatures > 200 °C),
- d) for Group III equipment: the marked maximum surface temperature on the equipment, which shall be the actual maximum surface temperature.

Where direct measurement of surface temperature is not practical, other methods can be applied, e.g. calculation.

8.2.2 Hot Surface Ignition Test

8.2.2.1 General

In special cases, the above temperature limits may be exceeded, if there is documented evidence, that the explosive atmosphere cannot be ignited by the hot surface under consideration.

The sample shall be tested to demonstrate that it does not cause auto-ignition of a flammable mixture when tested in the presence of a specified gas/air mixture as described in 8.2.2.2.

The assessment shall include conditions according to the EPL required as given in 8.2.1.

Ignition tests are carried out to determine the temperature at which auto-ignition occurs or to determine the maximum temperature at which no auto-ignition occurs. The following safety margins are then applied to this temperature:

- a) 25 K for T4, T5 and T6 and Group I;
- b) 50 K for T1, T2 and T3.

These safety margins shall be ensured by experience of similar parts or by tests of the equipment itself in representative mixtures for the specific temperature class.

8.2.2.2 Procedure

The test shall be carried out with the part of the equipment either:

- a) mounted in the equipment as intended and precautions shall be taken to ensure that the test mixture is in contact with the part which is intended to be tested, or
- b) mounted in a model which ensures representative results. In this case, such a simulation shall take into account the effect of other parts of the equipment in the vicinity of the part being tested which affect the temperature of the mixture and the flow of the mixture around the part being tested as a result of ventilation and thermal effects.

The part of the equipment shall be tested under normal operation, or under the malfunction conditions specified in the standard for the type of protection which produces the highest surface temperature. The test shall be continued either until thermal equilibrium of the component and the surrounding parts is attained or until the component temperature drops. Where component failure causes the temperature to fall, the test shall be repeated five times using five additional samples of the component. Where, in normal operation or under the malfunction conditions specified in the standard for the type of protection, the temperature of more than one part exceeds the temperature class of the equipment, the test shall be carried out with all such parts at their maximum temperature.

The safety margin required by 8.2 shall be achieved either by raising the ambient temperature at which the test is carried out or, where this is practical, by raising the temperature of the component under test and other relevant adjacent surfaces by the required margin.

For Group I, the test mixture shall be a homogeneous mixture between 6,2 % and 6,8 %, v/v methane and air.

For T4 temperature classification, the mixture shall be either:

- a) a homogeneous mixture of between 22,5 % and 23,5 % v/v diethyl ether and air, or
- b) a mixture of diethyl ether and air obtained by allowing a small quantity of diethyl ether to evaporate within a test chamber while the ignition test is being carried out.

For other temperature classifications, a suitable test mixture shall be selected.

8.2.2.3 Acceptance criteria

The appearance of a cool flame shall be considered as an ignition. Detection of ignition shall either be visual or by measurement of temperature, for example, by a thermocouple.

8.3 Mechanical tests

8.3.1 Test for resistance to impact

Impact tests of IEC 60079-0 apply.

When a piece of equipment is submitted to tests corresponding to the low risk of mechanical danger, it shall be marked with the symbol "X" according to 11.2 I).

Most Group I applications can be considered as high risk, any impact testing should be done at the high risk level, except where the manufacturer clearly specifies the special circumstances that permit low risk levels to be applied.

8.3.2 Drop test

In addition to being submitted to the resistance to impact test according to 8.3.1, handheld equipment or equipment carried on the person, ready for use, shall be submitted to the drop tests of IEC 60079-0 with the "electrical equipment" term used by that test to be the "non-electrical equipment" under consideration.

8.3.3 Required results

The resistance to impact and drop tests shall not produce damage which invalidates the level of protection of the equipment.

After testing the equipment, casings and components shall not be displaced or deformed causing rubbing of the moving parts.

8.4 Additional tests of non-metallic parts of the equipment relevant for explosion protection

8.4.1 Test temperatures

When, according to this standard or to the specific type of protection standards listed in Clause 1, tests shall be made as a function of the permissible upper and lower service temperature, the test temperatures used during the tests shall be:

- for the upper test temperature, the maximum service temperature (see 6.2.2) increased by at least 10 K but at most 15 K;
- for the lower test temperature, the minimum service temperature (see 6.2.2) reduced by at least 5 K but at most 10 K.

8.4.2 Tests for Group I equipment

The tests shall be made as follows:

- 2 samples shall be submitted to the tests of thermal endurance to heat (see 8.4.4), then the tests of thermal endurance to cold (see 8.4.5), then the mechanical tests (see 8.4.7) and finally to the tests specific to the Type of Protection concerned.
- 2 samples shall be submitted to the tests of resistance to oils and greases (see 8.4.6) then to the mechanical tests (see 8.4.7) and finally to the tests specific to the Type of Protection concerned.

- 2 samples shall be submitted to the tests of resistance to hydraulic liquids for mining applications (see 8.4.6) then to the mechanical tests (see 8.4.7) and finally to the tests specific to the Type of Protection concerned.

The objective is to demonstrate the performance of the non-metallic material relevant to the level of protection or the type of protection listed in Clause 1 after exposure to extremes of temperature and harmful substances likely to be met in use. In an attempt to keep the number of tests to a minimum it is not necessary to perform all of the tests specific to the Type of Protection on every sample if it is obvious that a sample has not been damaged in such a way as to impair the Type of Protection offered. Similarly, the number of samples can be reduced if it is possible for the exposure tests and protection proving tests to be performed in parallel on the same two samples.

8.4.3 Tests for Group II and III equipment

The tests shall be made on 2 samples which shall be submitted to the tests of thermal endurance to heat (see 8.4.4) then to tests of thermal endurance to cold (see 8.4.5) then to the mechanical tests (see 8.4.7) and finally to the tests specific to the Type of Protection concerned.

8.4.4 Thermal endurance to heat

The thermal endurance to heat shall be determined by submitting the enclosures or parts of enclosures in non-metallic materials, on which the integrity of the Type of Protection depends, to tests according to Table 9.

Table 9 – Thermal endurance test

Service temperature T_S	Test condition	Alternative test condition
$T_S \leq 70 \text{ °C}$		
	672 ⁰ ₊₃₀ h at (90 ± 5) % RH, at T_S (20 ± 2) °C (but not less than 80 °C test temperature)	
$70 \text{ °C} < T_S \leq 75 \text{ °C}$	672 ⁰ ₊₃₀ h at (90 ± 5) % RH at T_S (20 ± 2) °C	504 ⁰ ₊₃₀ h at (90 ± 5) % RH at (90 ± 2) °C followed by 336 ⁰ ₊₃₀ h dry at T_S (20 ± 2) °C
$T_S > 75 \text{ °C}$	336 ⁰ ₊₃₀ h at (90 ± 5) % RH at (95 ± 2) °C, followed by 336 ⁰ ₊₃₀ h dry at T_S (20 ± 2) °C	504 ⁰ ₊₃₀ h at (90 ± 5) % RH at (90±2) °C followed by 336 ⁰ ₊₃₀ h dry at T_S (20 ± 2) °C
T_S is the temperature defined in 3.8 and shall NOT include the increase stated in 8.4.1.		

At the conclusion of the test according to Table 9, the enclosures or parts of enclosures in non-metallic materials that were tested shall be subjected to (20 ± 5) °C at (50 ± 5) % relative humidity for 24⁰₊₄₈ h, followed by the thermal endurance to cold test (8.4.5).

NOTE 1 The test values given in Table 9 include two test conditions. The conditions shown in the 2nd column were used in editions of IEC 60079-0 prior to Edition 6, and allow previously obtained test results to remain valid for this edition. The conditions shown in the 3rd column have been added to allow testing at temperature/humidity conditions that are more readily achieved, although at an increased test time.

NOTE 2 It is generally acknowledged that glass and ceramic materials are not adversely affected by the thermal endurance to heat test, and testing may not be necessary.

8.4.5 Thermal endurance to cold

The thermal endurance to cold shall be determined by submitting the enclosures and parts of enclosures of non-metallic materials, on which the type of protection depends, to storage for 24 h_{+2}^0 in a test temperature corresponding to the minimum service temperature reduced according to 8.4.1.

NOTE It is generally acknowledged that glass and ceramic materials are not adversely affected by the thermal endurance to cold test, and testing may not be necessary.

8.4.6 Resistance to chemical substances for Group I equipment

Resistance to chemical agent test of IEC 60079-0 applies.

At the end of the test, the enclosure samples concerned shall be removed from the liquid bath, carefully wiped and then stored for (24 ± 2) h in the laboratory atmosphere. Subsequently, each of the enclosure samples shall pass the mechanical tests according to 8.4.7.

8.4.7 Mechanical resistance tests

In the case of non-metallic parts of the equipment relevant to the level of protection mechanical tests according to 8.3 shall be carried out.

The following detailed conditions shall be observed:

a) Test for resistance to impact:

- The places of impact shall be on the external parts potentially exposed to impact. If the enclosure of non-metallic material is protected by another enclosure, only the external parts of the assembly shall be subjected to the resistance to impact tests.
- The test shall first be made at the highest test temperature, then at the lowest test temperature, according to 8.4.1.

b) Drop test.

The drop test for equipment which is held in the hand or carried on the person, shall be made at the lowest test temperature, according to 8.4.1.

8.4.8 Surface resistance test of non-conductive parts of the equipment relevant for explosion prevention and protection

Surface resistance test of IEC 60079-0 applies.

8.4.9 Thermal shock test

Thermal shock test of IEC 60079-0 applies.

9 Documentation

9.1 Technical documentation

The manufacturer shall prepare documents that give a full and correct specification of the explosion safety aspects of the equipment.

This documentation shall include ignition hazard assessment report and when necessary according to this report, the following:

- description of the equipment;
- design and manufacturing drawings as far as required by ignition hazard assessment;
- all descriptions and explanations necessary for the understanding of drawings;
- material certificates if necessary;
- reports of tests described in Clause 8;
- instructions specified in Clause 10.

9.2 Conformity with the documentation

The manufacturer shall carry out the verifications or tests necessary to ensure that the non-electrical equipment produced complies with the technical documentation.

It is not the intent of this subclause to require 100 % inspection of parts. Statistical methods may be employed to verify compliance.

9.3 Certificate

The manufacturer shall prepare, or have prepared, a certificate confirming that the equipment is in conformity with the requirements of this standard along with its other applicable parts and additional standards mentioned in Clause 1. The certificate can relate to Ex Equipment or an Ex Component.

An Ex Component certificate (Identified by the symbol "U" suffix to the certificate number) is prepared for parts of equipment that are incomplete and require further evaluation prior to incorporation in Ex Equipment. The Ex Component certificate shall include a Schedule of Limitations detailing specific additional evaluation required as part of incorporation into Ex equipment. An Ex Component certificate shall clarify that it is not an Ex Equipment certificate.

9.4 Responsibility for marking

By marking the equipment in accordance with Clause 11, the manufacturer attests on his own responsibility that the equipment has been constructed in accordance with the applicable requirements of the relevant standards in safety matters.

10 Instructions

The documentation prepared as required by 9.1 shall include instructions which provide the following particulars as a minimum:

- a recapitulation of the information with which the equipment is marked, except for the serial number (see Clause 11), together with any appropriate additional information to facilitate maintenance (for example, address of the importer, repairer, etc.);
- instructions for safety, i.e.
 - putting into service;
 - use;
 - assembling and dismantling;
 - maintenance;
 - installation;
 - adjustment;
 - where necessary, training instructions;
 - details which allow a decision to be made as to whether the equipment can be used safely in the intended area under the expected operating conditions;

- relevant parameters, maximum surface temperatures and other limit values;
- where applicable, Specific Conditions of Use including remaining hazards identified in the ignition hazard assessment report that require additional protective means by the installers or users;
- where applicable, any additional Specific Conditions of Use, including particulars of possible misuse, which experience has shown might occur;
- where necessary, the essential characteristics of tools which may be fitted to the equipment;
- a list of the standards, including the issue date, with which the equipment is declared to comply. The certificate can be used to satisfy this requirement;
- a summary of the relevant ignition hazards identified and the protective means implemented.

11 Marking

11.1 Location

The equipment shall be legibly and indelibly marked on a main part on the exterior of the equipment and shall be visible prior to the installation of the equipment.

NOTE 1 It is useful for the marking to be visible after installation of the equipment.

NOTE 2 Where the marking is located on a removable part of the equipment, a duplicated marking on the interior of the equipment may be useful during installation and maintenance by helping to avoid confusion with similar equipment. Additional guidance on extremely small equipment and Ex Components is given in IEC 60079-0 and in 11.4.

11.2 General

The marking shall include:

- a) name of the manufacturer or its registered trade mark;
- b) manufacturer's type identification;
- c) symbol Ex;
- d) letter "h";

NOTE 1 A Level of Protection is not applied to the letter "h".

- e) where appropriate, the symbol of the equipment Group I, II or III, including the subdivision according to 4.3 and 4.4. When the equipment is designed for use only in a particular gas, the chemical formula, or name of the gas in parentheses.
- f) for Group II equipment, the symbol indicating the temperature class or the maximum surface temperature in °C, or both. When the marking includes both, the temperature class shall be given last in parentheses. Accessories used for connecting equipment parts need not be marked with the temperature class.

EXAMPLE: T1 or 350 °C or 350 °C (T1).

Equipment for Group II, having a maximum surface temperature greater than 450 °C, shall bear only the inscription of the maximum surface temperature in degrees Celsius and the unit of measurement °C. Example: 600 °C.

Equipment for Group II, designed and marked for use in a particular gas, need not have a temperature reference.

Where the actual maximum surface temperature depends not on the equipment itself, but mainly on operating conditions (like a heated fluid in a pump), a single temperature class or maximum surface temperature cannot be marked by the manufacturer. A reference to this situation shall be included in the marking by using a T range or a temperature range

(e.g. T6...T4 or 85 °C...150 °C) marking and the relevant information shall be given in the instructions.

- g) for Group III equipment, the maximum surface temperature in degrees Celsius and the unit of measurement °C preceded with the letter “T”, (e.g. T90 °C).
- h) the EPL “Ma”, “Mb”, “Ga”, “Gb”, “Gc”, “Da”, “Db” or “Dc” as appropriate
- i) where appropriate, for Group I, II and III equipment, the ambient temperature marking as shown in Table 10:

Table 10 – Ambient temperature marking

Equipment	Ambient temperature in service	Additional marking
Normal	Maximum: + 40 °C Minimum: – 20 °C	None
Special	Stated by the manufacturer and specified in the instructions for use.	Ta or Tamb with the special range, for example “0 °C ≤ Ta ≤ 60 °C” or the symbol “X”

- j) a serial number (a batch number can be considered to be an alternative to the serial number).
- k) the name or mark of the certificate issuer and the certificate reference in the following form: the last two figures of the year of the certificate followed by a “.” followed by a unique four character reference for the certificate in that year;

NOTE 2 For some regional third-party certification, the separating character “.” is sometimes replaced by another separating designator such as “ATEX”.

- l) If Specific Conditions of Use apply, the symbol “X” shall be placed after the certificate reference described in k) above. The use of a warning marking giving appropriate instructions can be used as an alternative to the requirement for the “X” marking.

NOTE 3 It is the intent that the requirements of the Specific Conditions of Use, e.g. mounting position, are passed to the user together with any other relevant information in the instructions for use.

- m) any additional marking prescribed in the specific standards for the Types of Protection concerned, as listed in Clause 1;

NOTE 4 Any marking normally required by the standards of construction of the equipment.

- n) the markings c) to h) shall be placed on the same line in the order in which they are given in c) to h) and shall each be separated by a small space.

11.3 Warning markings

Where any of the following warning markings are required on the equipment, the text as described in Table 11, following the word “WARNING”, may be replaced by technically equivalent text. Multiple warnings may be combined into one equivalent warning.

Table 11 – Text of warning markings

	Reference	WARNING marking
a)	6.7.5	WARNING – POTENTIAL ELECTROSTATIC CHARGING HAZARD – SEE INSTRUCTIONS
b)	7.3	WARNING – AFTER DE-ENERGIZING, DELAY Y MINUTES BEFORE OPENING (Y being the value in minutes of the delay required)
c)	7.3	WARNING – DO NOT OPEN WHEN AN EXPLOSIVE ATMOSPHERE IS PRESENT

11.4 Marking on very small equipment

On very small equipment where there is limited space, a reduction in the marking is permitted and all other marking may be given on the packaging and the accompanying documents, but at least the following information is required on the equipment itself:

- a) name or registered trade mark of the manufacturer;
- b) symbol "Ex" followed by the letter "h" (see 11.2 d));

NOTE 1 A Level of Protection is not applied to the letter "h".

- c) the certificate number, including the symbol "X" if appropriate (See 11.2 I).

11.5 Examples of marking

Non-electrical equipment conforming to this standard for EPL Gb for use in explosive gas atmospheres of Group IIB and ignition temperature greater than 135 °C.

BEDELLE FR,	=	name
Type AB 5	=	type of equipment
Ex h IIB T4 Gb	=	marking according to Ex symbol, the letter "h", equipment group II, (subgroup IIB), temperature class T4, EPL Gb
Ser. No. 32567	=	serial number
ABC 12.1234	=	certificate number
.....		
.....		

Non-electrical equipment with EPL Db for explosive dust atmospheres containing dusts of Group IIIC and maximum surface temperature less than 120 °C.

BEDELLE FR,	=	name
Type AB8	=	type of equipment
Ex h IIIC T120°C Db	=	marking according to Ex symbol, the letter "h", equipment group III, (subgroup IIIC), maximum surface temperature T120°C, EPL Db
Ser. No. 12456	=	serial number
ABC 12.1234	=	certificate number

Non-electrical equipment conforming to this standard for EPL Gb for use in explosive gas atmospheres of Group IIB and ignition temperature greater than 135 °C and for EPL Db for explosive dust atmospheres containing dusts of Group IIIC and maximum surface temperature less than 120 °C.

BEDELLE FR,	=	name
Type AB8	=	type of equipment
Ex h IIB T4 Gb	=	marking according to Ex symbol, the letter "h", equipment group II, (subgroup IIB), temperature class T4, EPL Gb
Ex h IIIC T120°C Db	=	marking according to Ex symbol, the letter "h", equipment group III (subgroup IIIC), maximum surface temperature T120°C, EPL Db
Ser. No. 12456	=	serial number
ABC 12.1234	=	certificate number

.....

Annex A (informative)

Methodology for confirming the EPL

A.1 Methodology for confirming the EPL of Group I

A.1.1 EPL Ma

Apply the appropriate requirements of this Standard. If no single type of protection is suitable to provide protection for EPL Ma, it will be necessary to employ simultaneously two types of protection.

A.1.2 EPL Mb

Identify potential ignition sources which are effective or can become effective in normal operation and expected malfunctions in the event of severe operating conditions such as those arising from rough handling and changing environmental conditions.

If effective ignition sources are identified, apply the appropriate requirements for at least level of protection Mb of one of the standards for the specific types of ignition protection listed in Clause 1.

A.2 Methodology for confirming the EPL of Group II and III

A.2.1 EPL Ga and Da

Identify potential ignition sources which are effective or can become effective in normal operation, in the case of expected malfunctions and in the case of rare malfunctions.

If effective ignition sources are identified, apply the appropriate requirements for at least EPL Ga or Da of one of the standards for the specific types of ignition protection listed in Clause 1 of this Standard. If no single type of ignition protection is suitable to provide protection for EPL Ga or Da, it will be necessary to employ simultaneously two independent types of protection, each of them suitable for EPL Gb or Db in accordance with Clause 5.

A.2.2 EPL Gb and Db

Identify potential ignition sources which are effective or can become effective in normal operation and in the case of expected malfunctions.

If effective ignition sources are identified, apply the appropriate requirements for at least EPL Gb or Db, of one of the standards for the specific types of ignition protection listed in Clause 1.

A.2.3 EPL Gc and Dc

Identify potential ignition sources which are effective or can become effective in normal operation.

If effective ignition sources are identified, apply the appropriate requirements for at least EPL Gc or Dc of one of the standards for the specific types of ignition protection listed in Clause 1.

Annex B (informative)

Explanation of the ignition hazard assessment procedure

B.1 Overview

B.1.1 General

It 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 C.

B.1.2 Reporting with the help of a table

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

Annex C shows different examples of an ignition hazard assessment report using a reporting scheme. Therewith, it is possible to proceed in a clear way, to structure methodically and to identify necessary statements, measures and evidence i.e. essential parts of the technical documentation. Therefore, it should ease a well directed fulfilment of the requirements by the manufacturers. This reporting scheme provides for assimilating all necessary information and should not require additional statements beyond the table.

NOTE The reporting scheme presented in Annex C is only one of the alternatives. Different ways of reporting are possible provided the required content is completely covered (see 5.2.6). Unused parts of the table can be left blank or can be deleted.

B.2 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 protective measures, if necessary, to reduce the likelihood of an ignition hazard according to step 2),
- 4) Finally ignition hazard estimation and categorisation (estimation of the ignition hazards regarding the frequency of occurrence after including protective measures determined in step 3),
- 5) Determination of the EPL.

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

B.3 Assessment Steps

B.3.1 Identification of Ignition Hazards

This step will result in a complete list of all ignition hazards applicable to the equipment (see Clause 4, 5.2.1 and Clause 6). At first, the known list of potential ignition sources representing different physical ignition mechanisms should be examined (see Table B.1). It should be determined which types of ignition sources are possible (see Table B.2, Column 1 a).

Table B.1 –Table showing recommended documentation of an example of initial assessment of equipment related ignition sources

Possible Ignition Sources	Equipment Related Yes/No	Reason
Hot surfaces	Yes	Inside and outside – Gas compression, vane friction, particle ingress
Mechanical sparks	Yes	Particles could produce hot-spots
Flames, hot gases	Outside No Inside Yes	Inside compression temperature to be measured – gas temperature directly at exhaust
Electrical sparks	No	Not present
Stray electric currents and cathodic corrosion protection	No	Not present
Static electricity	Yes	Vanes, lipseal, exhaust filter, float valve
Lightning	No	Not present
Electromagnetic waves	No	Not present
Ionising radiation	No	Not present
High frequency radiation	No	Not present
Ultrasonic	No	Not present
Adiabatic compression	Yes	Inside chamber
Chemical reaction	Yes	Possible with process fluid/gas

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 environment (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.

Table B.2 – Example for reporting of the identification of ignition hazards (step 1) and the first assessment (step 2)

	1		2				
No.	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	foreseeable malfunction	during rare malfunction	not relevant	Reasons for assessment
1	electrostatic discharge	parts of non-metallic material with a surface resistance exceeding $10^9 \Omega$		X			no charging during normal operation; material is an outer part of the casing; charging could be done by a person (operator)

Constructive features (e.g. non-conductive material with a resistance below $1 \text{ G}\Omega$) may be assumed provided that they will not be changed because they are necessary for other reasons (see Table B.2, Column 1 b). Types of Protection like Flameproof Enclosure "d" (see IEC 60079-1) or Control of Ignition Sources "b" (see ISO 80079-37) 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 the 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 FTA (failure tree analysis).

NOTE IEC 60812, relevant to FMEA (Failure Mode and Effect Analysis) and IEC 61025, relevant to FTA (Fault tree analysis) applies for these systematic methods.

In this step, the individual ignition hazards are evaluated to determine, how often an individual ignition source may become effective (see Table B.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 B.2, Column 2 a) to d) it is clear whether additional measures are necessary in step 3 in order to meet the target EPL. In Table B.2, Column 2 e) the reasons for the results of the evaluation can be reported if not self-explanatory (see 5.2.6).

The individual estimation results and decisions can be never 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 constructive 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.

B.3.2 Determination of measures

If the evaluation shows the application is required to meet the target EPL adequate protective measures are determined in this step (see Table B.3, Column 3). It is necessary to define these measures in such a way that possible ignition sources cannot become effective or the likelihood of the ignition source becoming effective is sufficiently low. These measures should

not be confused with types of protection according the list in Clause 1. The term protective measures is meant in a broader sense: measures with the purpose of explosion protection. Therefore, the term contains also all measures during putting into service, maintenance and repair, operation, warning notices, experimental investigations providing for evidence etc. which will decrease the likelihood of the ignition source becoming effective. Types of protection are only a subset of the measures.

Table B.3 – Example for reporting of the determination of protective measures (step 3) and the concluding estimation and categorisation (step 4)

3			4					
Measures applied to prevent the ignition source becoming effective			Frequency of occurrence incl. all measures					
a	b	c	a	b	c	d	e	f
Description of the measure	References (standards, technical rules, experimental results known from literature)	Technical documentation (evidence including relevant features listed in column 3 a)	during normal operation	during anticipated malfunction	during rare malfunction	No need for further consideration	resulting EPL in respect of this ignition hazard	necessary restrictions
largest area less than 2 500 mm ²	ISO 80079-36:-, 6.7.5 c), 7.4.2 and 7.4.3	- specifications of the material - (7.4.2 and 7.4.3); - parts list, pos. Z; - drawing No. Y				X	Ga Da	IIB IIIC

Table B.3 includes the description of the measure (see Table B.3, Column 3 a), the reference showing the capability of the measure to avoid or reduce the ignition hazard (see Table B.3, Column 3 b) and the link to the necessary specifications or evidence for inclusion in the technical documentation (see Table B.3, Column 3 c). The link to the necessary specifications or evidence should be given for each measure in order to meet the requirements for the technical documentation. During compilation of the technical documentation attention should be paid to the following aspects:

- completeness of the manufacturers specifications (technical descriptions, drawings, parts lists, results of calculations etc.),
- provision of evidence about all required experimental test results and certificates,
- recognition and determination of necessary specifications for manufacturing (e.g. tolerances or test specifications for quality assurance) and safe operation of the equipment (e.g. for installation, maintenance and repair).

B.3.3 Concluding ignition hazard estimation and categorisation

In this step a concluding estimation of an individual ignition hazard (only a single row of the assessment table) is performed regarding the frequency of its occurrence considering the information reported in step 1 and 2 and the measures determined in step 3 (see Table B.3, Column 4 a) to d). From this follows directly the resultant categorisation regarding the individual ignition hazard (see Table B.3, Column 4 e). Moreover, in addition to the EPL determined, restrictions of the intended use are often necessary. These restrictions could refer to the temperature class or the maximum surface temperature, to a specific subdivision (see Table B.3, Column 4 f) or possibly to a single substance in whose explosive atmospheres the product may be used or is not allowed to be used. Besides this, attention should be paid to other limitations of the intended use arising from the ambient temperature, ambient pressure, supply sources etc.

B.3.4 Determination of the EPL

The resultant EPL is finally the worst case of all individual categorisations summarised from all lines in the reporting table.

Annex C (informative)

Examples of ignition hazard assessment

C.1 General remarks

The following examples (see also Table C.1) are not definitive. Alternative measures can normally be applied. The most important ignition sources of non-electrical equipment are electrostatic discharges, hot surfaces and mechanical sparks. Real equipment may have different and/or further ignition sources.

It is expressly pointed out that an ignition hazard assessment is always dependent on the individual design and the specific intended use of a product. Therefore, the following ignition hazard assessment examples are neither complete nor directly applicable to real products without detailed analysis.

Table C.1 – List of examples

Clause	Example	Table
C.2	Common cases demonstrating the use of the scheme – Electrostatic discharge Common cases demonstrating the use of the scheme – Hot surfaces Common cases demonstrating the use of the scheme – Mechanical spark	C.2 C.3 C.4
C.3	Ignition hazard assessment report for a pump	C.5
C.4	Ignition hazard assessment report for an agitator	C.6

C.2 Examples for common cases demonstrating the use of the scheme

The examples in Table C.2, Table C.3 and Table C.4 show a few common cases for typical parts of non-electrical equipment to explain the use of the reporting scheme described in Annex B. The examples should be read row by row and stand alone.

A resulting EPL cannot be indicated in this case.

The examples alert to typical potential ignition hazards and their assessment. Specific importance is attached to measures applied to prevent the ignition source becoming effective. For purpose of evidence, the identification and specification of the parts causing ignition hazards and the description of the measures applied form part of the essential technical documentation.

Table C.2 – Common cases demonstrating the use of the scheme – Electrostatic discharge (1 of 2)

No.	1		2					3			4					
	ignition hazard		assessment of the frequency of occurrence without application of an additional measure					measures applied to prevent the ignition source becoming effective			frequency of occurrence incl. measures applied					
	a	b	a	b	c	d	e	a	b	c	a	b	c	d	e	f
		description / basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	Basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
1	potential ignition source	parts of non metallic material with an undefined surface resistance	during normal operation	X			assessment is provided for by a (harmonised) standard; highly efficient charge generating mechanisms is excluded	limiting the surface resistance so it does not exceed 10 ⁹ Ω; verification of the surface resistance of the individual materials used	7.4.2; 7.4.3; 6.7.5 a)	– specifications of the material (7.4.2; 7.4.3); – parts list, pos: ... – test report according to 8.4.8				X	G a D a	
2	electrostatic discharge	parts of non metallic material with an undefined surface resistance		X			no charging during normal operation; material is an outer part of the casing; charging could be done by a person (operator)	largest area less than 2 500 mm ²	7.4.2; 7.4.3; 6.7.5 a)	– specifications of the material (7.4.2; 7.4.3); – parts list, pos: ... – drawing no: ...				X	G a D a	IIB
3	electrostatic discharge	examples of processes where charging can give rise to significant amount of electrostatic charging: Filling and draining of vessels, transfer of liquid, agitation	X				acknowledged rule of technology	limitation of the intended use: Only liquids with a high conductivity (> 1 000 pS/m) can be used	IEC TS 60079-32-1	– specific Conditions of Use (X) – specification of the liquid in the instructions, chapter ..., Clause ...				X	G a D a	yes ^a

Table C.2 (2 of 2)

No.	1		2					3				4								
	ignition hazard		assessment of the frequency of occurrence without application of an additional measure					measures applied to prevent the ignition source becoming effective				frequency of occurrence incl. measures applied								
	a	b	a	b	c	d	e	a	b	c	d	e	f	a	b	c	d	e	f	
4	potential ignition source	description / basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	Basis (citation of standards, technical rules, experiential results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions				
	electrostatic discharge	circumferential speed of a belt drive	X				acknowledged rule of technology	conductivity criteria and conditions of use for belts: limitation of the maximum speed because of the type of construction of the drive, e.g. exclusion of frequency converters to avoid overspeed	IEC TS 60079-32-1	- instructions, chapter ..., clause ...			X		G b D b					
Resulting EPL including all existing ignition hazards: b b																				
a Limitation of the intended use required. b A resulting EPL cannot be indicated in this case.																				

Table C.3 – Common cases demonstrating the use of the scheme – Hot surface (1 of 2)

No.	1		2					3			4						
	ignition hazard	description/basic cause (Which conditions originate which ignition hazard?)	a	b	c	d	e	a	b	c	a	b	c	d	e	f	
1	hot surface	hot surface of a frictional wheel drive	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	c	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	T4
2	hot surface	hot surface of a ball bearing	during normal operation	X			bearing has negligible heating during normal operation	The bearing is calculated according to ISO 281 for a specified lifetime. A malfunction is generally agreed as a rare incident under these conditions. The maximum surface temperature is determined under the most adverse conditions (110 °C)	ISO 80079-37 "c"		test report no. ... about the thermal type test			X		Gb Db	T4

Table C.3 (2 of 2)

No.	1		2						3			4					
	potential ignition source	ignition hazard	assessment of the frequency of occurrence without application of an additional measure						measures applied to prevent the ignition source becoming effective			frequency of occurrence incl. measures applied					
	a	B	a	b	c	d	e	a	b	c		a	b	c	d	e	f
			during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)		during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
3	hot surface	heating of a viscosity meter (stirrer system)				X	mechanical input energy can cause heating The maximum surface temperature under the most adverse conditions. Maximum temperature rising ΔT 3 K		8.2	- test report no. ... about the thermal type test					X	Ga Da	T6
Resulting EPL including all existing ignition hazards:																	
a	The conformity assessment procedure for a monitoring system according to control of ignition source "b" is variable and depends on the EPL																
b	A resulting EPL cannot be indicated in this case.																

Table C.4 – Common cases demonstrating the use of the scheme – Mechanical spark (1 of 2)

No.	1		2					3			4					
	ignition hazard		assessment of the frequency of occurrence without application of an additional measure					measures applied to prevent the ignition source becoming effective			frequency of occurrence incl. measures applied					
	a	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
		description/basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
1	potential ignition source	breakdown of the bearing of an EPL Gb equipment (gear) could cause grinding of a stirrer in a vessel (zone 0); the distance between the stirrer and the vessel may be unacceptably reduced			X		A breakdown of the bearing needs to be considered as a rare malfunction (for EPL Ga equipment), because this is not considered in EPL Gb equipment. Therefore, mechanical grinding cannot be excluded inside the vessel.	The shaft feed through is designed with an additional emergency bearing to avoid contact between stirrer and vessel (sleeve bearing in EPL 2 part; EPL of the gear remains unchanged) in addition the failure of the bearing will be controlled by a temperature monitoring and limiting system (ignition prevention type "b1"). Limiting temperature < 155 °C.	Clause 5, ISO 80079-37:–, 6.1 and 8.1	– test report no. ... about the thermal type test – Instructions of the monitoring system (purchased from an external supplier)				X	Ga Da	T3
2	mechanical spark fan	mechanical generated sparks due to a grinding fan		X			mechanical grinding cannot be excluded. Assessment is provided by a (harmonised European) standard.	The minimum clearance between rotating elements and the casing is defined.	EN 14986: 2005, 4.15	– constructional measures design according to drawing no. ...			X		Gb Db	

Table C.4 (2 of 2)

No.	1 ignition hazard		2 assessment of the frequency of occurrence without application of an additional measure					3 measures applied to prevent the ignition source becoming effective			4 frequency of occurrence incl. measures applied					
	a	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
	potential ignition source	description/basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
3	mechanical spark	mechanical generated sparks due to a grinding roots pump rotor at dry run conditions			X		mechanical grinding of a the rotor and particulate material	A shock pressure resistant casing and mounting of an autonomous protective system (flame arresters to avoid flame transmission into the inlet and outlet)	ISO 16852	- test report no. ... about the thermal type test - Attestation of conformity and instructions of the autonomous protective system (purchased from an external supplier) and test report of flame transmission test of combination of pump and flame arrester				X	Ga Da	
4																
<p>^a A resulting EPL cannot be indicated in this case.</p> <p style="text-align: right;">Resulting EPL including all existing ignition hazards:</p>																

C.3 Example of an ignition hazard assessment for a pump

Table C.5 gives an (incomplete) example of how a manufacturer could record the ignition hazard assessment for a pump. This example is not definitive and alternative measures could be applied. The EPL of the pump is the outcome at the end of the assessment table. It is assumed that the pump is located in zone 1 and is intended to pump flammable liquid from a storage tank to a reactor.

Aspects of normal operation (EPL Gc) are heating during continuous operation with maximum load at the highest ambient temperature. The fluid pressure at the inlet and the outlet should be considered as well as corrosion and the temperature of the fluid conveyed. If the maximum surface temperature depends not on the pump itself, but mainly on the heated fluid conveyed, the temperature class cannot be determined by the manufacturer. It shall be determined by the user in accordance to the information provided by the manufacturer in the instructions (see Clause 10).

In the event of expected disturbances or equipment malfunctions which normally have to be taken into account (EPL Gb) attention should be paid to: continues operation at maximum pressure with low feed rate, failure of parts and components because of the operating conditions and the dimensioning, suction of contaminants, loosening of mechanical fasteners or stress because of impacts or friction.

Rare malfunctions (EPL Ga; not dealt with in Table C.5) may be the operation with closed pressure line (closed outlet), the failure of an ignition control device or a newly-created ignition hazard in consequence of any combination of two expected malfunctions.

Table C.5 – Ignition hazard assessment report for a pump (1 of 3)

No.	1 ignition hazard		2 assessment of the frequency of occurrence without application of an additional measure					3 measures applied to prevent the ignition source becoming effective			4 frequency of occurrence incl. measures applied					
	A	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
		description / basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	a	b	c	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
1	potential ignition source	losses dissipate into heat	X				The pump has a maximum temperature during normal operation	The maximum surface temperature is determined under the most adverse conditions (ΔT 45 K). A bypass (overflow) is installed to insure the minimum flow rate. The minimum residual volume of the storage tank is specified	8.2	technical documentation (evidence including relevant features listed in column 1)			X		Gb	T4
2	hot surface	dissipation of mechanical energy into heat		X			external valve closed upstream	The maximum surface temperature is determined under the most adverse conditions. A temperature monitoring and limiting system (IPL 1; type of protection "b1") is mounted. Limiting temperature is 100 °C.	8.2 and ISO 80079-37 "b"	test report no. ... about the thermal type test - Attestation of conformity and instructions of the monitoring system (purchased from an external supplier) for the use in explosive atmosphere and the use as a monitoring device for control of ignition source "b" (ignition prevention type b1)			X		Gb	T4 _a

Table C.5 (2 of 3)

No.	1		2					3			4					
	ignition hazard	description / basic cause (Which conditions originate which ignition hazard?)	assessment of the frequency of occurrence without application of an additional measure					measures applied to prevent the ignition source becoming effective			frequency of occurrence incl. measures applied					
	A	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
	potential ignition source		during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
3	hot surface	friction of the clutch plate		X			The clutch starts to slip and generates heat.	The maximum surface temperature (ΔT 30K) is determined under the most adverse conditions. The coupling time and max. torque is specified. The overload is limited and switched off before reaching the temperature class limit.	ISO 80079-37 "c"	- test report no. ... about the thermal type test			X		Gb	T5
4	electrical equipment	electric motor inside the assembly		X			Electrical equipment is a possible ignition source.	Only electrical equipment with certification of conformity is used.	IEC 60079 series	- Certificate and instructions			X		Gb	IIB T3 Gb
5	mechanical spark	a grinding rotor at dry run conditions		X			Mechanical grinding of the rotor cannot be excluded. A breakdown of a bearing shall be considered.	The bearing is calculated according to ISO 281 for a specified lifetime. A malfunction is generally agreed as a rare incident under these conditions.	Clause 5 and ISO 80079-37 "c"	- description and calculation no. ..., drawing no. ... about the design			X		Gb	

Table C.5 (3 of 3)

No.	1		2					3			4							
	ignition hazard		assessment of the frequency of occurrence without application of an additional measure					measures applied to prevent the ignition source becoming effective			frequency of occurrence incl. measures applied							
	A	B	a	b	c	d	e	a	b	c	b		a	b	c	d	e	f
							reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	during EPL in respect of this ignition hazard	necessary restrictions		
6	potential ignition source	description / basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant												
	electrostatic discharge	transfer of non-conductive liquid causes electrostatic charge	X				The conductivity of the liquid is not defined	limitation of the intended use: Only liquids with a high conductivity (> 1000 pS/m) can be used. Only a conductive liquid is foreseen. Ethanol is a conductive liquid. Proper earthing of the equipment is required.	IEC TS 60079-32-1	- instructions chapter ..., clause ...: WARNING in the instruction: pump operation involves the risk of producing an electrostatic charge in flowing liquids. The user should take measures according to IEC TS 60079-32-1				X	Ga			
7	...	further ignition sources					...											
Resulting EPL including all existing ignition hazards:																		
Gb T3																		

^a Limitation of the intended use required.

C.4 Example of an ignition hazard assessment for an agitator

Table C.6 gives an (incomplete) example of how a manufacturer could record the ignition hazard assessment for an agitator which is assumed to be inside of EPL Ga and outside of EPL Gb. This example is only for the EPL Ga part of the agitator. It is not definitive and alternative measures could be applied.

Potential ignition hazards by hot surfaces, mechanical sparks and electrostatic charging, e.g. in the stirrer vessel, are assessed by the manufacturer. Mechanical sparks can be generated by grinding contacts of stirrer elements with the vessel wall or by foreign solid particles between stirrer elements and the vessel wall. Other possibilities for grinding contact are vibrations of the stirrer shaft because of critical revolution speed, external oscillation or in consequence of a bearing failure.

The agitator is designed and manufactured so that it fulfils its safe function within the limits of the operating conditions stipulated by the manufacturer. If a stirrer is e.g. combined with a movable vessel it cannot be expected that the mould alignment is satisfactory only by use of the instructions. The safe centring between the moving parts is considered ensured by the conceptual design. This could be achieved by a mechanical clamping unit and a safety circuit. Stirrer designs should not support misuse. Stirrers are designed to be not mountable on vessels where it is not intended (e.g. on Intermediate Bulk Containers – IBCs).

EPL Gc equipment does not create effective ignition sources during normal operation. An example is the charging due to agitation of chargeable suspensions and fluids. This ignition hazard cannot be avoided by the equipment design only. In such case the explosive atmosphere should be avoided which is a restriction of the intended use. The choice of materials, an adequate dimensioning and minimum distances between moving parts and fixed parts are also meant to avoid mechanical sparks and hot surfaces.

To meet the requirements of EPL Gb apparatus expected malfunctions, e.g. defect of a fluid lubricated slide ring seal because of the absence of lubrication, are avoided. A monitoring of the fluid level including an actuation switch-off is regarded as adequate. Further examples for expected malfunctions are mechanical wear, exceeded service life of the lubrication or corrosion.

For EPL Ga equipment rare malfunctions as well as ignition hazards as consequence of two expected malfunctions are considered. As example, the failure of a rolling contact bearing of the shaft guiding is mentioned here. The bearings are used in zone 1 and can be assessed to meet EPL Gb requirements, but in case of a bearing failure it may create an ignition hazard in Zone 0. Appropriate action would be for example, a continuous monitoring device for the bearing including an actuator switch-off. Other examples are insufficient stability, impermissible operation at the critical rotary frequency, losing of parts, failures of safety devices or the intrusion of explosive mixtures into not adequate protected parts of the equipment because of defective sealing elements, e.g. gaskets or rotating mechanical seals.

For EPL Ga equipment, combinations of two rare malfunctions or a rare malfunction in combination with an expected malfunction can be disregarded. In these cases an ignition hazard is regarded as sufficiently improbable. Examples are on the one hand the grinding between shaft and vessel even though an adequate strength is chosen for the parts that exert influence on the move of the shaft or, on the other hand, the operation at the critical rotary frequency even though this speed shall not be possible because of the agitator's design.

Table C.6 – Ignition hazard assessment report for an agitator (1 of 10)

No.	1 ignition hazard		2 assessment of the frequency of occurrence without application of an additional measure					3 measures applied to prevent the ignition source becoming effective			4 frequency of occurrence incl. measures applied					
	a	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
		description/basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	a	b	c	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
1	electro-static discharge	isolated electrical conductive parts	X				isolated conductive parts creates a capacitor, which e.g. can be charged by electrostatic induction to a hazardous static	description of the measure applied	6.7.2	technical documentation (evidence including relevant features listed in column 1)				X	Ga	
2	electro-static discharge	isolating parts e.g. of non metallic material		X			no charging during normal operation; material is an outer part of the casing; charging could be done by a person (operator)	equipotential bonding between the parts, earthing of the housing, information for installation	6.7.5 a), 8.4.8	specification of the material (7.3.2) – parts list, pos: ... (or drawing no: ...)				X	Ga	
3	electro-static discharge	isolating parts e.g. of non metallic material		X			no charging during normal operation; materials is an outer part of the casing; charging could be done by a person (operator)	surface resistance < 1 GΩ at 50 % relative humidity	6.7.5 and Table 8	specification of the material (6.7, 7.4.2, 7.4.3) – parts list, pos: ... drawing no: ...				X	Ga	IIB

Table C.6 (3 of 10)

No.	1		2					3			4					
	ignition hazard	assessment of the frequency of occurrence without application of an additional measure	a	b	c	d	e	a	b	c	a	b	c	d	e	f
	potential ignition source	description/basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
6	hot surface	breakdown of the bearing with influence to zone 0; (the bearing is located in zone 1 near the separating plate of the vessel)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	A breakdown of the bearing shall be considered as a rare malfunction (for EPL Ga equipment)	The malfunction of the bearing will be detected by a thermal sensor. Maximum temperature < 150 °C (Type of Protection "b")	Clause 5, ISO 80079-37 "c" and "b"	<ul style="list-style-type: none"> test report no... about the thermal type test certificate and instructions of the monitoring system (purchased from an external supplier) for the use in explosive atmosphere and the use as a monitoring device for control of ignition source "b" (ignition prevention type b1) 	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions

Table C.6 (4 of 10)

No.	1		2					3			4					
	ignition hazard	assessment of the frequency of occurrence without application of an additional measure	a	b	c	d	e	a	b	c	a	b	c	d	e	f
7	<p>potential ignition source</p> <p>hot surface</p>	<p>description/basic cause (Which conditions originate which ignition hazard?)</p> <p>breakdown of the bearing of an EPL Gb or Db equipment (gear) with influence to zone 0; (the bearing is located in zone 1 near the separating plate of the vessel)</p>	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	<p>description of the measure applied</p> <p>frictional losses could heat up the separating plate</p>	<p>basis (citation of standards, technical rules, experimental results)</p> <p>Clause 5, ISO 80079-37 "c" and "b"</p>	<p>test report no... about the thermal type test</p> <p>certificate and instructions of the monitoring system (purchased from an external supplier) for the use in explosive atmosphere and the use as a monitoring device for control of ignition source "b" (ignition prevention type b1)</p>	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions

Table C.6 (5 of 10)

No.	1		2					3			4						
	potential ignition source	ignition hazard	assessment of the frequency of occurrence without application of an additional measure					measures applied to prevent the ignition source becoming effective			frequency of occurrence incl. measures applied						
	a	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f	
8	hot surface	frictional heat at the wiper; relative motion of the rotating mechanical seal	during normal operation	X			heating < 80 % of the temperature class T4 during normal operation	The maximum surface temperature is determined under the most adverse conditions. Alternatively a temperature monitoring and limiting system (type of protection "b1") can be mounted. Limiting maximum temperature is 100 °C	Clause 5, ISO 80079-37"b"	<ul style="list-style-type: none"> - test report no. ... about the thermal type test - certificate and instructions of the monitoring system (purchased from an external supplier) for the use in explosive atmosphere and the use as a monitoring device for control of ignition source "b" (ignition prevention type b1) 	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions	T4

Table C.6 (6 of 10)

No.	1		2					3			4					
	ignition hazard	assessment of the frequency of occurrence without application of an additional measure	a	b	c	d	e	a	b	c	a	b	c	d	e	f
9	<p>potential ignition source</p> <p>mechanical spark</p>	<p>description/basic cause (Which conditions originate which ignition hazard?)</p> <p>mechanical generated sparks due to a breaking shaft due to unacceptable vibration</p>	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	<p>basis (citation of standards, technical rules, experimental results)</p> <p>ISO 800 79-37 "b"</p>	<p>technical documentation (evidence including relevant features listed in column 1)</p> <p>certificate and instructions of the monitoring system (purchased from an external supplier) for the use in explosive atmosphere and the use as a monitoring device for control of ignition source "b" (ignition prevention type b1)</p>	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
					X		equipment is not designed for liquid surface passage under motion, foreseeable misuse cannot be exclude	liquid level monitoring system (ignition prevention type "b1") to avoid liquid surface passage					X	Ga		

Table C.6 (8 of 10)

No.	1 ignition hazard		2 assessment of the frequency of occurrence without application of an additional measure					3 measures applied to prevent the ignition source becoming effective			4 frequency of occurrence incl. measures applied					
	a	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
12	mechanical spark	breakdown of the bearing of the shaft guidance could cause grinding of a stirrer in a vessel (zone 0); the distance between the stirrer and the vessel may be unacceptably reduced	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment A breakdown of the bearing shall be considered as a rare malfunction (for EPL 1 equipment).	description of the measure applied failure of the bearing will be detected by a vibration monitoring system (ignition prevention type "b1")	Clause 5 and ISO 800 79-37 "b"	technical documentation (evidence including relevant features listed in column 1) - certificate and instructions of the monitoring system (purchased from an external supplier) for the use in explosive atmosphere and the use as a monitoring device for control of ignition source "b" (ignition prevention type b1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard Ga	necessary restrictions
13	mechanical spark	loosening of the shaft	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	unsecured joints	force looked joints secured with an additional measure e.g. screw retention	ISO 800 79-37 "c"	technical documentation (evidence including relevant features listed in column 1) - test report no... about the thermal type test - constructional measures, design according to no. instructions	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard Ga	necessary restrictions

Table C.6 (9 of 10)

No.	1 ignition hazard		2 assessment of the frequency of occurrence without application of an additional measure					3 measures applied to prevent the ignition source becoming effective			4 frequency of occurrence incl. measures applied					
	a	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
14	mechanical spark	description/basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	description of the measure applied	basis (citation of standards, technical rules, experimental results)	technical documentation (evidence including relevant features listed in column 1)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
14	mechanical spark	unacceptable durability of parts e.g. the shaft		X	X		possible corrosion	adequate material selection	ISO 800 79-37 "C"	- constructional measures, design according to drawing no. ...				X	Ga	
15	mechanical spark	breakdown of a clutch (clutch in zone 0)		X	X		design according to the state of the art, safety factor > 3	only stiff in the rotational senses clutches are used	ISO 800 79-37 "C"	- constructional measures, design according to drawing no. ...				X	Ga	
16	mechanical spark	unacceptable vibration of the vessel causes damage of the agitator		X	X		internal and external sources of vibration cannot be excluded.	experimental determination and exclusion of the critical speed, limitation of the intended use	ISO 800 79-37 "C"	- test report no. ... about the determination of the critical speed - specific conditions for safe use - alert in the instructions, chapter ... - marking of the range of the critical speed on the name plate				X	Ga	yes ^a

Table C.6 (10 of 10)

No.	1 ignition hazard		2 assessment of the frequency of occurrence without application of an additional measure					3 measures applied to prevent the ignition source becoming effective			4 frequency of occurrence incl. measures applied					
	a	B	a	b	c	d	e	a	b	c	a	b	c	d	e	f
	potential ignition source	description/basic cause (Which conditions originate which ignition hazard?)	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	reasons for assessment	a	b	c	during normal operation	during foreseeable malfunction	during rare malfunction	not relevant	resulting EPL in respect of this ignition hazard	necessary restrictions
17	mechanical spark	accidental entry of metal items like tools through the manway			X		Multiple sparks formed if no liquid present	Information to user to prevent loose metal items from falling into the vessel	-	- instructions			X		Ga	
18	electrical spark	electrical equipment Gb IIB, T3 in contact with zone 0			X		shift of zone 0 in consequence of an undetected leakage	natural ventilation, constructional measures to avoid zone 0 where electrical equipment is placed	IEC 600 79-26	- constructional measures, design according to drawing no. ...			X		Ga	
19	...	further ignition access				...										
a	Limitation of the intended use required.															
Resulting EPL including all existing ignition hazards:																
															Ga	IIB T3 ^a

Annex D (normative)

Charging tests with non-conductive materials

D.1 General

This Annex describes the test to decide whether a non-conductive material is capable of being charged to produce brush discharges and therefore can act as an ignition source for an explosive gas/air or vapour/air mixture. This test is performed with the part itself, or a 225 cm² flat sample of the material from which the equipment is constructed.

The size of the flat sample is relevant because experimental evidence shows that 225 cm² is an optimum value for the surface area in terms of charge distribution density. Other factors influencing the validity of the test results are the humidity of the test environment, which should be kept to 30 % RH or less at (23 ± 2) °C to minimize leakage of the electrostatic charge. Also, the size of the spark discharge electrode to produce a single spark is important. Too small electrodes can lead to multiple discharge sparks and/or corona discharging of lower energy. Therefore a spherical electrode with a diameter of 25 ± 5 mm (see Figure D.2) should be used to produce a single point discharge spark. Furthermore, the extent of the person's perspiration is also of influence.

D.2 Principle of the test

Either the actual component, or if it is not possible because of its size or shape, a 150 mm × 150 mm × 6 mm plate shaped sample of the material should be conditioned for 24 hours at (23 ± 2) °C and a relative humidity not higher than 30 %. Its surface is then electrically charged, under the same environmental conditions as it was conditioned, by three separate methods. The first method involves rubbing the surface with a polyamide material (e.g. a polyamide cloth). The second, rubbing the same surface with a cotton cloth and the third exposing the same surface to a high voltage spray electrode.

After completion of each of the charging methods, the charge Q from a typical surface discharge is measured. This is done by discharging the sample by a spherical electrode (with a diameter of 25 ± 5 mm) into a known value fixed capacitor C and measuring the voltage V across it. The charge Q is given by the formula $Q = C V$, where C is the value of the fixed capacitor in Farads and V is the highest voltage. This procedure is used to find the method that produces the highest measured charge to assess of the incendivity of the discharge according to D.4.2.4.

Where there is a general trend of decreasing stored charges during these tests, new samples should be used for the following tests. The highest value should be used for the assessment procedure according to D.4.2.4.

NOTE In some cases the properties of the charged material could be changed due to the discharges so that the transferred charge decreases in subsequent tests. Due to possible multiple discharges of textile clothes such samples are assessed conservative by this method.

As this kind of experiment can be influenced by, for example the person's perspiration, it should be demonstrated by a calibration experiment with a reference material of PTFE that the transferred charge is at least 60 nC.

D.3 Samples and apparatus

The test sample comprises either the actual component, or if it is not practical because of its size or shape, a 150 mm × 150 mm × 6 mm flat plate of the non-conductive material. The test apparatus comprises:

- a) DC high voltage power supply capable of delivering at least 30 kV;
- b) electrostatic voltmeter (0 V to 10 V) with a measuring uncertainty of 10 % or better and an input resistance higher than 10^9 Ohm;
- c) 0.10 μ F capacitor for at least 400 Volt (0.01 μ F is also suitable if the input resistance of the voltmeter is greater than 10^{10} Ohm);
- d) cotton cloth large enough to avoid contact between the test sample and the operator's fingers during the rubbing process;
- e) polyamide cloth large enough to avoid contact between the test sample and the operator's fingers during the rubbing process;
- f) PTFE handle, or tongs, able to move the test sample without discharging its charged surface;
- g) flat disk made of PTFE with an area of 100 cm² as a highly chargeable reference;
- h) earthed table made of wood or an earthed metal plate;
- i) single pointed electrode, or array of pointed electrodes mounted on a common plate, connected to the minus pole of a dc high voltage power supply.

D.4 Procedure

D.4.1 Conditioning

All the tests are conducted in a room with a temperature of (23 ± 2) °C and no more than 30 % relative humidity.

Clean the test piece with isopropyl alcohol, rinse with distilled water and dry it e.g. in a drying oven at no more than 50 °C. Store in the room for 24 h at (23 ± 2) °C and at a relative humidity of no more than 30 % \pm 5 % RH.

D.4.2 Determination of the most efficient charging method

D.4.2.1 Rubbing with a pure polyamide cloth (see Figure D.1)

Lay the sample on the wooden or earthed metal table plate (thickness at least 10 mm) with its surface upwards. Charge the surface by rubbing it 10 times with the polyamide cloth. The last rub should finish on the edge of the sample. Move the sample carefully away from the table plate without discharging it. If such a procedure is not possible fasten the sample between ceiling and floor far away from any wall and charge it. Discharge the sample by slowly approaching the spherical electrode into a 0,1 μ F or 0,01 μ F capacitor (see Figure D.2) until a discharge occurs and measure the voltage on the voltmeter immediately after removing the spherical electrode from the sample (the voltage decreases with time due to the non infinity input resistance of the voltmeter). The surface charge is given by the formula: $Q = C V$ where V is the voltage across the capacitor at $t = 0$ s. The test should be repeated 10 times. Make sure that only a single discharge is recorded and that the spark gap is at least 1,5 mm in the case of Group I and IIA, 1 mm in the case of Group IIB and 0.5 mm in the case of Group IIC. In any case of doubt use a field mill to check the voltage before discharging (should be > 6 kV for I and IIA, > 4 kV for Group IIB and > 2 kV for Group IIC). If the voltages occurring are too low, they result in an outcome which is too conservative.

Due to possible charge binding effects of table surfaces it is recommended to raise the sample in the air and provoke a discharge there.

NOTE Discharges occurring at gaps less than 2 mm for Group IIA, 1 mm for Group IIB and 0,5 mm for Group IIC are less incendive than expected by their transferred charge due to quenching effects at the electrodes.

D.4.2.2 Rubbing with a cotton cloth

Repeat the procedure of D.4.2.1 using a pure cotton cloth instead of the polyamide cloth. The test should be carried out 10 times. The highest value should be used for the assessment procedure according to D.4.2.4.

D.4.2.3 Charging with a DC high voltage power supply (Figure D.3)

Position the spray electrode above the test sample 30 mm from the centre of the exposed surface and charge it with a voltage of at least 30 kV between the negative electrode and ground. Move the sample for 1 min in order to charge the whole surface and discharge the sample according to D.4.2.1. The test should be carried out 10 times. The highest value should be used for the assessment procedure according to D.4.2.4. If the electrode according to Figure D.3, Key, Item 4, is used, the 100 needle electrodes are put on the surface of the sample, high voltage is applied for some seconds, and then the electrodes are removed. The high voltage must only be switched off when the electrodes have been removed far away from the sample to avoid discharges from the charged sample back to the electrode.

In the following cases charging by influence with a DC high voltage power supply is not suitable and should not be used:

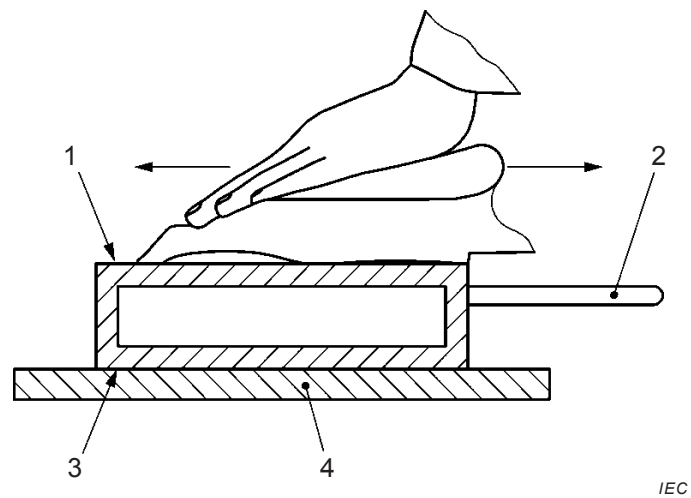
- 1) the test sample is made of conducting material which is not earthed;
- 2) the test sample is backed with metal if, according to 6.7.3, propagating brush discharges may occur;
- 3) the test sample is concavely shaped. In this case use D.4.2.1.

WARNING – In the cases of 1) to 3) strong discharges may occur which are hazardous to the health of the testing person and which may destroy the measuring instrument.

D.4.2.4 Assessment of discharge

If the transferred charge of the reference material lies clearly above 60 nC and the maximum transferred charge Q measured in any of the above tests is less than

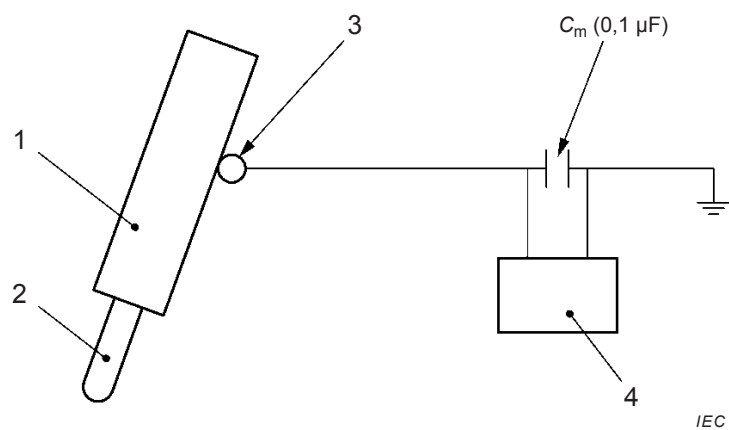
- 60 nC, the non-conductive material is suitable for use with Group I or IIA;
- 30 nC, the non-conductive material is suitable for use with Group I or IIB;
- 10 nC, the non-conductive material is suitable for use with Group I or IIC.



Key

- 1) largest exposed surface in any plane
- 2) PTFE handle (or carrying tongs if a flat plate)
- 3) opposite face
- 4) PTFE insulator

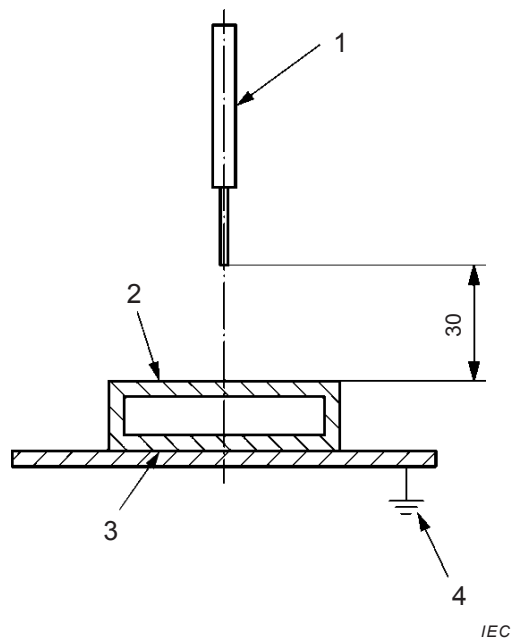
Figure D.1 – Rubbing with a pure polyamide cloth



Key

- 1) charged test piece
- 2) PTFE handle
- 3) 25 ± 5 mm diameter spherical probe
- 4) voltmeter 1 V to 10 V touching the charged surface

Figure D.2 – Discharging the charged surface of the test piece with a probe connected to earth via a 0,1 μF capacitor



Key

- 1) negative charge needle electrode
- 2) largest exposed surface in any plane
- 3) opposite face
- 4) earthed conducting plate (brass); positive electrode

Figure D.3 – Charging by the influence of a DC high voltage power

Annex E (informative)

Consideration of misuse which can reasonably be anticipated during ignition hazard assessment procedure

E.1 General

The following explanations are designated to assist the manufacturer during preparation of the ignition hazard assessment. An approach is explained in which misuse which can reasonably be anticipated (see 5.2.1) could be considered and could form part of the tabular assessment report explained in Annex B.

E.2 Identification and analysis of the ignition hazards

In this step the potential ignition sources caused by misuse, e.g. possible mistakes during installation, maintenance and operation of the equipment, should be reported. A good source of information could be customers practice as can be obtained in the course of repair orders or reported in other ways. Some questions to identify misuse which can reasonably be anticipated:

- What actions by individuals are necessary or can be assumed during intended use of the equipment considering transport, storage, installation, operation, maintenance and repair?
- Which typical abnormal handling due to carelessness is well-known during these activities?
- Which non intended operation by people who could come into contact with the equipment (the aforementioned persons but also other persons e.g. cleaning staff, craftsman, fire fighters etc.) can be anticipated?

E.3 First assessment of the ignition hazards

Misuse which can reasonably be anticipated should be taken into account independently of the EPL. Therefore, an assessment of the frequency of its occurrence is necessary. Column 2 d) (if applicable) and Column 2 e) of the reporting scheme (see Annex B) could be used. Furthermore, it could be helpful to ask, which of the listed misuses are not to be expected in the case of well-trained staff (well-trained with respect to work in hazardous areas) or due to safeguards against unwanted access to hazardous areas.

E.4 Determination of safety measures

Appropriate design measures should be used to avoid misuse or to limit the effects of misuse. In case this is not possible, warning notices in the instructions and/or labels e.g. in the form of pictograms on the equipment should be adopted. Logical, ergonomic and easy ways to operate the equipment should be established. In some cases the use of special tools (e.g. for adjustment or mechanical linkage) can assure that only well trained and equipped specialists can be considered to intervene and that unwanted manipulation is avoided. Using warning labels attention should be paid to ensure that they are durable and fixed to an appropriate place on the equipment. The information content should not allow misinterpretation and, if necessary, should be understandable independent of the users language (e.g. by use of symbols or figures).

E.5 Final assessment of the ignition hazards

Column 4 d) (not relevant) of the reporting scheme (see Annex B) should be used to make clear that the measures are deemed to be adequate.

Annex F (informative)

Development of different types of incendive electrostatic discharges

The Figure F.1 shows the development of different types of incendive electrostatic discharges.

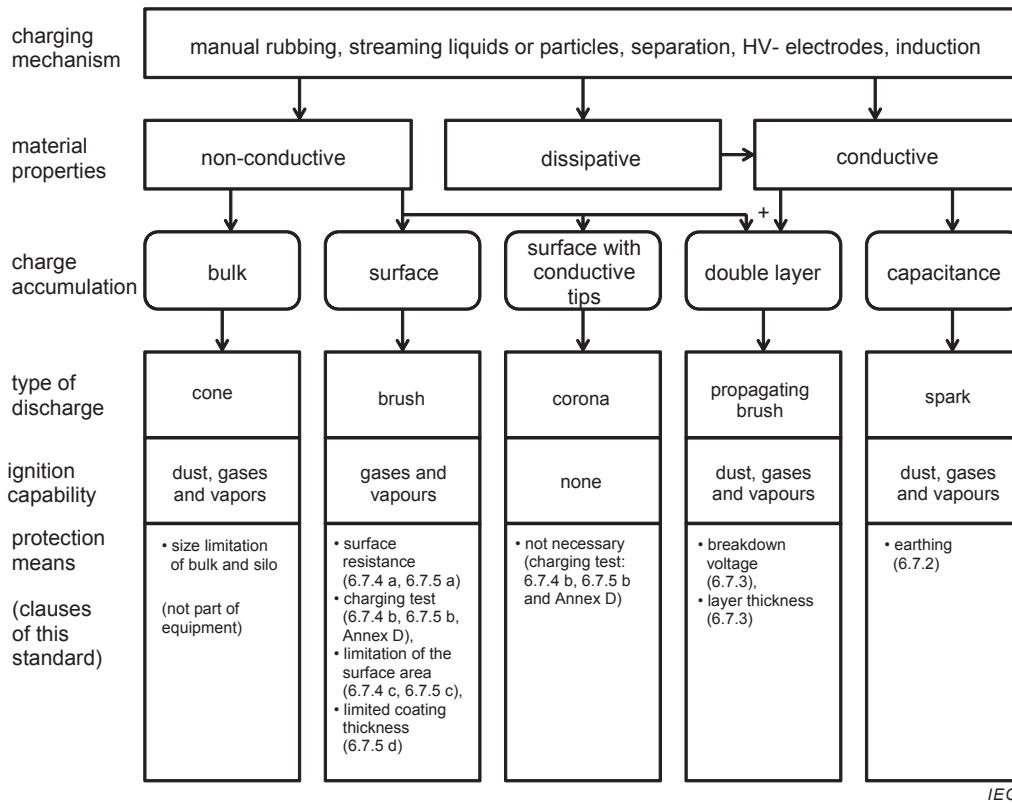


Figure F.1 – Different types of incendive electrostatic discharges

More information can be found in CLC/TR 50404 or in IEC TS 60079-32-1.

Test procedures can be found in IEC 60079-32-2 (in preparation).

Annex G (normative)

Protection concepts of types of protection "d", "p" and "t" acceptable for non-electrical equipment

The protection concepts for the types of protection "d", "p" and "t" are based respectively on the types of protection available for electrical equipment:

- "d" defined in IEC 60079-1,
- "p" defined in IEC 60079-2 and,
- "t" defined in IEC 60079-31.

All technical requirements apply.

The nature and ignition sources of non-electrical equipment shall be considered when applying types of protection "d", "p", or "t" to non-electrical equipment.

Annex H (informative)

Volume dependence of auto-ignition temperature

The auto-ignition temperature of a flammable gas or liquid depends on the size and shape of the test vessel. It decreases with increasing test vessel volume. As the standard test vessel according to IEC 60079-20-1 is a 200 ml vessel, auto-ignition temperatures in larger enclosures will be below the listed standard auto-ignition temperatures (AIT) according to IEC 60079-20-1. This effect should be considered at volumes larger than 1 l. The amount of this volume dependence can be taken from Figure H.1 for some common flammable liquids. The AITs taken from IEC 60079-20-1 for the combustibles of Figure H.1 are given in Table H.1.

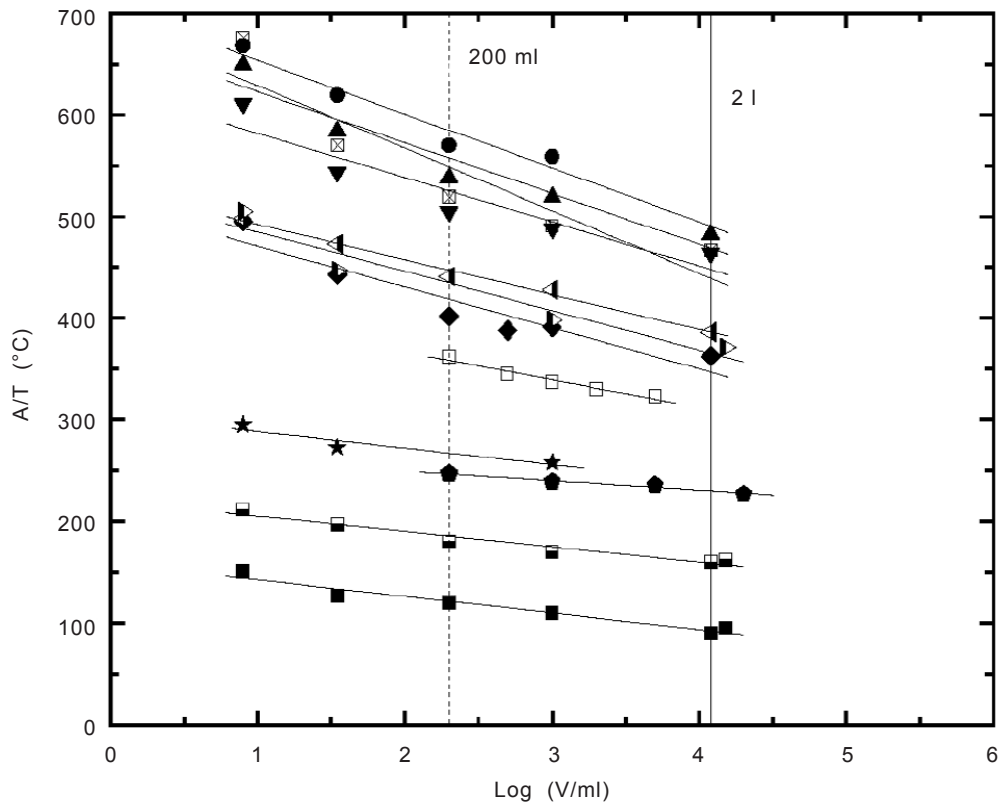
NOTE 1 Data in Table H.1 may differ from data in Figure H.1 as the reference authors of Figure H.1 have not necessarily used the test method according to IEC 60079-20-1.

NOTE 2 Care is intended to be taken when extrapolating the data out of Figure H.1 to larger volumes.

Table H.1 – AITs of combustibles taken from IEC 60079-20-1 as contained in Figure H.1.

Combustible	Auto-ignition temperatures
	°C
Carbon disulfide	90
Cyclohexane	244
Acetic acid	510
Toluene	530
Diethyl ether	175
Pentane	243
Ethanol	400
Methanol	440
Acetone	539
Benzene	498

NOTE 3 Data for Isobutyric anhydride and Ethandiol are not available from IEC 60079-20-1.



Key

- | | |
|----------------------------|--------------------|
| ■ Carbondiasulfide (1) | □ Diethylether (1) |
| ● Cyclohexane (2) | ★ Pentane (1) |
| □ Isobutyric anhydride (3) | ◆ Ethanol (1) |
| ▶ Ethandiol (1) | ◁ Methanol (1) |
| ▼ Acetic acid (1) | ◻ Acetone (1) |
| ▲ Toluene (1) | ● Benzene (1) |

Data from literature

- 1 N. Setchkin: J. of Research NBS 53 (1954), p. 49-66.
- 2 T.J. Snee, J.F. Griffiths: Comb. Flame 75 (1989), P. 381-395.
- 3 R.D. Coffee: 13th Loss Prev. Symp. AIChE (1979), p. 74-82.

IEC

Figure H.1 – Volume dependence of auto-ignition temperature

Annex I (informative)

Relationship between Equipment protection levels (EPLs) and zones

Equipment Protection Levels (EPL) as defined by ISO 80079-36 are related to the corresponding Equipment Groups and Equipment Categories according to Table I.1. The same applies if a standard makes reference to the intended use of equipment in zones according to the definitions in IEC 60079-10-1 and IEC 60079-10-2.

Table I.1 – Relationship between Equipment protection levels (EPLs) and zones

ISO 80079-36		Directive 94/9/EC		IEC 60079-10-X
EPL	Group	Equipment Group	Equipment Category	Zones
Ma	I	I	M1	Not Applicable
Mb			M2	
Ga	II	II	1G	0
Gb			2G	1
Gc			3G	2
Da	III	II	1D	20
Db			2D	21
Dc			3D	22

Bibliography

- IEC 60079-14, *Explosive atmospheres – Part 14: Electrical installations design, selection and erection*
- IEC 60079-10-1, *Explosive atmospheres – Part 10-1: Classification of areas – Explosive gas atmospheres*
- IEC 60079-10-2, *Explosive atmospheres – Part 10-2: Classification of areas – Explosive dust atmospheres*
- IEC 60079-20-1, *Explosive atmospheres – Part 20-1: Material characteristics for gas and vapour classification – Test methods and data*
- IEC 60079-26, *Explosive atmospheres – Part 26: Equipment with Equipment Protection Level (EPL) Ga*
- IEC TS 60079-32-1, *Explosive atmospheres – Part 32-1: Electrostatic hazards, guidance*
- IEC 60079-32-2, *Explosive atmospheres – Part 32-2: Electrostatics hazards – Tests*
- IEC 60812, *Analysis techniques for system reliability – Procedure for failure mode and effects analysis (FMEA)*
- IEC 61025, *Fault tree analysis (FTA)*
- IEC 62305 (all parts), *Protection against lightning*
- ISO 281, *Rolling bearings – Dynamic load ratings and rating life*
- ISO 6507-1, *Metallic materials – Vickers hardness test – Part 1: Test method*
- ISO 6507-4, *Metallic materials – Vickers hardness test – Part 4: Tables of hardness values*
- ISO 12100, *Safety of machinery – General principles for design – Risk assessment and risk reduction*
- ISO 16852, *Flame arresters – Performance requirements, test methods and limits for use*
- EN 13237, *Potentially explosive atmospheres – Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*
- EN 1127-1, *Explosive atmospheres. Explosion prevention and protection. Basic concepts and methodology*
- EN 1755, *Safety of industrial trucks. Operation in potentially explosive atmospheres. Use in flammable gas, vapour, mist and dust*
- EN 15198, *Methodology for the risk assessment of non-electrical equipment and components for intended use in potentially explosive atmospheres*
- CLC/TR 50404, *Electrostatics. Code of practice for the avoidance of hazards due to static electricity*

Beyer, M.: *On the Method of Ignition Hazard Assessment for Explosion Protected Non-Electrical Equipment*, Ex-Magazine 31 (2005), pp. 78-85

Beyer, M.: *Assessment Method for Ignition Hazards Caused by Mechanical Ignition Sources*, 2nd Petroleum and Chemical Industry Conference (PCIC) Europe, Basle, 2005, pp. 131-138

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