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Interested committees:

Title: Draft BS EN ISO /IEC 80079-41 BS EN ISO/IEC 80079-41 Explosive atmospheres. Part 41: Reciprocating internal combustion engines.

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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



DRAFT International Standard

ISO/IEC DIS 80079-41

Explosive atmospheres — Part 41: Reciprocating internal combustion engines

Atmosphères explosives —

Partie 41: Moteurs alternatifs à combustion interne

ICS: 29.260.20; 27.020

ISO/TMBG

Secretariat: **ISO**

Voting begins on:
2025-04-04

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This document is circulated as received from the committee secretariat.

This draft is submitted to a parallel vote in ISO and in IEC.

ISO/CEN PARALLEL PROCESSING

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

EXPLOSIVE ATMOSPHERES –

Part 41: Reciprocating internal combustion engines

FOREWORD

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ISO/IEC 80079-41 has been prepared by ISO/IEC subcommittee 31M: Non-electrical equipment and protective systems for explosive atmospheres, of IEC technical committee XX: Equipment for explosive atmospheres. It is an International Standard.

It is published as a double logo International Standard.

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

FDIS	Report on voting
31M/XX/FDIS	31M/XX/RVD

[Type here]

Full information on the voting for its approval can be found in the report on voting indicated in the above table. In ISO, the document was approved by XXX P members out of YYY having cast a vote.

The language used for the development of this International Standard is English.

A list of all parts in the ISO/IEC 80079 series, published under the general title *Explosive atmospheres*, can be found on the IEC website.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

EXPLOSIVE ATMOSPHERES –**Part 41: Reciprocating internal combustion engines****1 Scope**

This part of ISO/IEC 80079 specifies the technical requirements for design, construction, conversion, testing, marking, and the information required for use to avoid or minimise the possibility of ignition which could result from a reciprocating internal combustion engine intended for use in explosive atmospheres including:

- Group I EPL Mb for use in underground workings susceptible to firedamp or combustible dust,
- Group II EPL Gb and EPL Gc for use in explosive atmospheres of flammable gas and vapour, and
- Group III EPL Db and EPL Dc for use in explosive atmospheres of combustible dust.
- For EPL Gc and Dc engines, only normal operating conditions need to be considered. Malfunctions need not be considered (see B.2.1).

This document includes those tests of the engine and its ancillary devices that are required to verify compliance with this document.

This document applies to reciprocating internal combustion engines with compression ignition for EPL Mb, Gb, Gc, Db, Dc and gaseous fuelled spark ignition engines for EPL Gc. See Annex G.

This document does not define requirements relating to the driven machinery and equipment.

This document does not apply to

- explosive mixtures of vapours and gases, which tend to self-decompose (for example carbon disulphide (CS₂), ethylene oxide (C₂H₄O), acetylene (C₂H₂)) or which are chemically unstable;
- hydrogen fuelled engines, including blends;
- engines used in areas for the processing, manufacture or storage of explosives;
- gasoline and other spark ignited engines where the fuel is injected into the combustion chamber as a liquid; or
- electrical ignition spark systems.

Note 1 Spark ignition systems used with equipment covered by ISO/IEC 80079-41 is covered by IEC 60079-45

This document solely deals with explosion protection requirements. Requirements on gaseous or particulate exhaust emissions are not covered by this standard.

General safety requirements are not included in this International Standard.

NOTE 1 General safety requirements are covered for the EU in EN 1679-1:1998+A1:2011.

This document does not specify requirements for safety, other than those directly related to the possibility of ignition of flammable mixtures in the surrounding atmosphere which can lead to an explosion.

[Type here]

This document supplements and modifies the general requirements of IEC 60079-0 and ISO 80079-36. Where a requirement of this document conflicts with a requirement of IEC 60079-0 and ISO 80079-36 as is applicable for Ex engines, the requirement of this standard takes precedence.

The standard atmospheric conditions (relating to the explosion characteristics of the atmosphere) under which it may be assumed that the engine can be operated are:

- temperature $-20\text{ }^{\circ}\text{C}$ to $+60\text{ }^{\circ}\text{C}$
- pressure 80 kPa (0,8 bar) to 110 kPa (1,1 bar); and
- air with normal oxygen content, typically 21% v/v.

Additional consideration and additional testing may be required for Ex engines operating outside the standard atmospheric conditions. The ignition hazard assessment, ignition, protection provided, additional testing, (if necessary) manufacturer's technical documentation and instructions to the user are intended to clearly demonstrate the engine's suitability for the conditions. NOTE 2 Changes in temperature and pressure have an influence on the characteristics of the explosive atmosphere including ignitability

NOTE 3 IEC TS 60079-43 gives information for equipment used in explosive atmospheres in environmental conditions which include ambient temperatures below $-20\text{ }^{\circ}\text{C}$ and additional adverse conditions, including maritime applications.

NOTE 4 Reciprocating internal combustion engines are not considered as pressure vessels.

NOTE 5 On-going inspection, maintenance and repair aspects play an important role in control of hazardous area installations and the user's attention is drawn to IEC 60079-17, IEC 60079-19 and IEC 60079-14 and manufacturer's instructions for further information concerning these aspects.

2 Normative references

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

ISO 1813, *Belt drives — V-ribbed belts, joined V-belts and V-belts including wide section belts and hexagonal belts — Electrical conductivity of antistatic belts: Characteristics and methods of test*

ISO 2710-1, *Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and application programming requirements*

ISO 7967-1, *Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and application programming requirements*

ISO 7967-2, *Functional safety - Safety instrumented systems for the process industry sector - Part 1: Framework, definitions, system, hardware and application programming requirements*

ISO 7967-3, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 3: Valves, camshaft drives and actuating mechanisms*

ISO 7967-4, *Reciprocating internal combustion engines Vocabulary of components and systems Part 4: Pressure charging and air/exhaust gas ducting systems*

ISO 7967-8, *Reciprocating internal combustion engines — Vocabulary of components and systems — Part 8: Starting systems*

ISO 9563, *Belt drives Electrical conductivity of antistatic endless synchronous belts Characteristics and test method*

- 156 ISO 12100, *Safety of machinery — General principles for design — Risk assessment and risk*
157 *reduction*
- 158 ISO 15510, *Stainless steels — Chemical composition*
- 159 ISO 17025, *General requirements for the competence of testing and calibration laboratories*
- 160 ISO 29463 (all parts), *High efficiency filters and filter media for removing particles in air*
- 161 ISO 80079-36, *Explosive atmospheres - Part 36: Non-electrical equipment for explosive*
162 *atmospheres - Basic method and requirements*
- 163 ISO 80079-37, *Explosive atmospheres - Part 37: Non-electrical equipment for explosive*
164 *atmospheres - Non electrical type of protection constructional safety "c", control of ignition*
165 *source "b", liquid immersion "k"*
- 166 IEC 60034-5, *Rotating electrical machines - Part 5: Degrees of protection provided by the*
167 *integral design of rotating electrical machines (IP code) - Classification*
- 168 IEC 60079-0:2017, *Explosive atmospheres - Part 0: Equipment - General requirements*
- 169 IEC 60079-1, *Explosive atmospheres - Part 1: Equipment protection by flameproof enclosures*
170 *"d"*
- 171 IEC 60079-10-1, *Explosive atmospheres - Part 10-1: Classification of areas - Explosive gas*
172 *atmospheres*
- 173 IEC 60079-10-2, *Explosive atmospheres - Part 10-2: Classification of areas - Explosive dust*
174 *atmospheres*
- 175 IEC 60079-14:2014, *Explosive atmospheres - Part 14: Electrical installation design, selection*
176 *and installation of equipment, including initial inspection*
- 177 IEC 60079-25, *Explosive atmospheres - Part 25: Intrinsically safe electrical systems*
- 178 IEC 60079-29-1, *Explosive atmospheres - Part 29-1: Gas detectors - Performance requirements*
179 *of detectors for flammable gases*
- 180 IEC 60079-29-2, *Explosive atmospheres - Part 29-2: Gas detectors - Selection, installation, use*
181 *and maintenance of detectors for flammable gases and oxygen*
- 182 IEC 60079-29-3, *Explosive atmospheres - Part 29-3: Gas detectors - Guidance on functional*
183 *safety of fixed gas detection systems*
- 184 IEC TS 60079-32-1, *Explosive atmospheres - Part 32-1: Electrostatic hazards - guidance*
- 185 IEC 60079-32-2, *Explosive atmospheres - Part 32-2: Electrostatic hazards - Tests*
- 186 IEC 60079-45, *Electrical Ignition Systems for Internal Combustion Engines*
- 187 IEC TS 60079-46, *Explosive atmospheres - Part 46: Equipment assemblies*
- 188 IEC 60204-1:2016, *Safety of machinery - Electrical equipment of machines - Part 1: General*
189 *requirements*

[Type here]

190 IEC 61340-2-3, *Electrostatics - Part 2-3: Methods of test for determining the resistance and*
 191 *resistivity of solid materials used to avoid electrostatic charge accumulation*

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

194 IEC 61511 (all parts), *Functional safety - Safety instrumented systems for the process industry*
 195 *sector*

196 IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

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

199 ISO/IEC 80079-49, *Explosive atmospheres - Part 49: Flame arresters - Performance*
 200 *requirements, test methods and limits for use*

201 EN 1127-2, *Explosive atmospheres - Explosion prevention and protection - Part 2: Basic*
 202 *concepts and methodology for mining*

203 EN 1822-1, *High efficiency air filters (EPA, HEPA and ULPA) - Part 1: Classification,*
 204 *performance testing, marking*

205 **3 Definitions**

206 For the purposes of this document, the terms and definitions given in ISO 2710-1, ISO 7967-1,
 207 ISO 7967-2, ISO 7967-3, ISO 7967-4, ISO 7967-8, IEC 60079-0, IEC 60079-10-1, IEC 60079-
 208 10-2, ISO 80079-36, ISO 80079-37, ISO/IEC 80079-38 and the following apply.

209 ISO and IEC maintain terminology databases for use in standardization at the following
 210 addresses:

- 211 • IEC Electropedia: available at <https://www.electropedia.org/>
- 212 • ISO Online browsing platform: available at <https://www.iso.org/obp>

213 **3.1**

214 **maximum surface temperature**

215 highest temperature that can be attained in service under the most adverse operating conditions
 216 (but within the recognized tolerance) by any part or surface of the Ex equipment

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

219 Note 2 to entry: The surface temperature which is relevant can be internal or external depending upon the Type of
 220 Protection concerned.

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

223 Note 4 to entry: This includes exhaust temperature and other fluid temperatures that may come in contact with
 224 explosive atmospheres.

225 [SOURCE: IEC 60079-0:2017, 3.57, modified – definition modified and Notes to entry added]

226 **3.2**

227 **maximum exhaust gas temperature**

228 highest temperature under the most adverse operating conditions measured at the point where
 229 the gas stream first meets the surrounding atmosphere

3.3**gas path**

parts of an engine through which air and exhaust gas passes when the engine is running

3.4**flame arrester****FA**

device fitted to the opening of an enclosure, or to the connecting pipe work of a system of enclosures, and whose intended function is to allow fluid flow but prevent the transmission of flame

3.5**closed joint**

assembly between two parts which is intended to be gas or dust tight or both

3.6**open joint**

joint between two parts designed to reduce the heat energy from a gas explosion to the point where it will not ignite a similar external explosive gas mixture

3.7**spark arrester**

device, system, or method which controls the emission from an engine exhaust of particles potentially capable of igniting combustible material in the vicinity by virtue of their size and temperature

3.8**engine control module****ECM**

electronic processor managing the transfer of data between engine sensors, actuators, control elements, and information-storage and display units

3.9**safety devices**

devices intended for use inside or outside explosive atmospheres but required for, or contributing to, the safe functioning of equipment and protective systems on the engine with respect to the risks of explosion

Note 1 to entry: Safety devices differ from the term devices used in the IEC 61508 and IEC 61511 series. Safety devices are comparable to the terms like "safety-related system (IEC 61508)" or "safety instrumented system (IEC 61511)".

Note 2 to entry: In this standard the safety devices are intended to reduce the likelihood of a potential ignition source becoming effective.

[SOURCE: ISO 80079-37:2016, modified – "on the engine" and Notes 1 and 2 to entry have been added]

3.10**performance requirements**

verifiable requirements related to properties of safety devices and shutdown systems to ensure that the safety function is effective

Note 1 to entry: IEC TS 60079-42 includes information for diagnostics, capacity, functionality, response, effectiveness, integrity, reliability, availability, ability to withstand loads and robustness.

3.11**abnormal combustion**

unintended or uncontrolled combustion in the engine

[Type here]

3.12**explosion protection**

application of one or more types of protection to minimise the risk of a piece of equipment, apparatus, component, fitting or device causing an ignition of a surrounding explosive gas, vapour, mist or dust atmosphere

3.13**explosion protected engine**

engine with measures applied in the construction to prevent it becoming an ignition source when within an explosive atmosphere

4 Ignition hazards

Specific hazards for engine applications in potentially explosive atmospheres are listed below according to ISO 80079-36.

The main sources of ignition are:

- hot surfaces;
- flames and hot gases;
- mechanically generated sparks;
- electrically generated arcs and sparks;
- static electricity;
- stray electric currents;
- adiabatic compression.

The design specifications for the engine necessary to minimise the likelihood of the ignition of an external potential atmosphere depend on the application and are characterised by:

- temperature classification,
- presence of flammable gases, or
- presence of combustible dust and ventilation effects.

5 Safety requirements and measures**5.1 For all Equipment Protection Levels (EPLs)****5.1.1 General**

For EPL Mb, EPL Gb and EPL Db engines, normal operating conditions and expected malfunctions shall be taken into account. Rare malfunctions need not be considered (see A.1.1, A.1.2, A.1.3, B.2.1, B.2.2, B.2.3).

For EPL Gc and EPL Dc engines, only normal operating conditions need to be considered. Malfunctions need not be considered (see B.2.1).

For EPL Mb, if other gases besides firedamp are present, the engine shall comply in addition with 5.3.1 and also EN 1127-2 and ISO/IEC 80079-38

For EPL Db and EPL Dc, all hot surfaces shall be designed to reduce the possibility of a dust layer build up. In particular the potential of dust layer build-up in excess of 5 mm shall be avoided ((see also 8.2.3) in the instructions for use).

Equipment intended for mines where the atmosphere, in addition to firedamp, might contain flammable gases other than methane, shall be constructed and tested in accordance with the

317 requirements relating to Group I and to the subdivision of Group II corresponding to the other
318 significant flammable gases. This equipment shall be marked appropriately.

319 Group II engines suitable for potentially explosive atmospheres of gases, vapours or mists shall
320 be subdivided in accordance with IEC 60079-0 using the following Groups:

- 321 – IIA, a typical gas is propane
- 322 – IIB, a typical gas is ethylene, or
- 323 – IIB + H₂, a typical gas is hydrogen

324 NOTE 1 According to the Scope ethylene oxide is not considered in subdivision IIB and subdivision IIC is not used
325 in this document.

326 NOTE 2: if the machine works in hydrogen atmosphere, chemical corrosion needs to be considered.

327 Group III engines suitable for explosive dust atmospheres shall be subdivided in accordance
328 with IEC 60079-0 using the following Groups:

- 329 – IIIA: combustible flyings
- 330 – IIIB: non-conductive dusts, or
- 331 – IIIC: conductive dusts

332 5.1.2 Ignition hazard assessment

333 A detailed ignition hazard assessment, for the required EPL, shall be undertaken by the
334 manufacturer in accordance with ISO 80079-36. The assessment shall list all the potential
335 ignition sources, that are either effective or likely to become effective.

336 The assessment shall indicate the means used to minimise the likelihood of ignition.

337 See Annex A to Annex D for further information.

338 5.1.3 Joints

339 5.1.3.1 Joint types

340 5.1.3.1.1 General

341 Each joint within the gas path of an explosion-protected internal combustion engine system
342 shall be designated as a closed joint, open joint or liquid immersed joint (Type of Protection
343 "k").

344 5.1.3.1.2 Closed joints

345 A closed joint shall be either a permanent or a separable joint that is gas tight and shall pass
346 the relevant tests in accordance with 7.4, 7.5, 7.6. and 7.7.

347 The following shall apply:

- 348 a) the faces of the joints shall not be subjected to relative movement which can impair the
349 integrity of the closed joint;
- 350 b) the flanged connections shall have a metallic or fire-resistant gasket interposed between
351 the faces. If the non-metallic gasket material can affect the type of protection, it shall be
352 subjected to thermal endurance testing as specified in 60079-0:2018, 7.2, prior to testing in
353 7.4, 7.5, 7.6. and 7.7;
- 354 c) Welded or brazed construction of joints and cemented joints according to IEC 60079-1 are
355 permitted; and

[Type here]

d) all joints shall be subjected to the tests for the reference pressure as specified in 7.4, 7.5 and 7.6. Joints meeting 4 times reference pressure shall be exempt from the flame non-transmission test (7.7) except for welded and cemented joints.

5.1.3.1.3 Open joints

Open joints shall comply with the flame-path requirements of IEC 60079-1 and shall pass the tests in accordance with 7.4, 7.5, 7.6 and 7.7.

A joint with relative movement between the parts shall be an open joint.

NOTE 1 An example might be a rotating shaft through the wall of an enclosure is an open joint.

Seals may be fitted to open joints to exclude contaminants from the joint, retain non-flammable lubricants or inhibit corrosion. A seal shall not form part of the flame-path.

The joint between piston skirts and cylinder bores are exempt from this provision. The following components are also exempt from this requirement, provided they pass the pressure determination, propagation and overpressure tests in accordance with 7.4, 7.5, 7.6 and 7.7 .:

- a) Valve stems and valve guides;
- e) Intake and exhaust flame arresters;
- f) Water or reductant/reactant injection nozzles fitted to cool or clean the exhaust gas stream and system;
- g) Any turbocharger and any supercharger, where the flame arrester is mounted on the engine inlet side of the turbocharger or supercharger. That is, the intake flame arrester is located as close as possible to the intake valves, if possible after the turbo charger or supercharger and after the intercooler if installed. A position of the flame arrester before the turbo charger or supercharger could be accepted; and
- h) Fuel injectors.

NOTE 2 Overpressure test pressures are often determined by conducting pressure-determination tests (see 8.4.

5.1.3.2 Liquid immersed joints

When a turbocharger is fitted, the joint formed through the bearing assembly between the turbine and the compressor may be designated as a liquid immersed joint. The joint shall comply with the requirements of ISO 80079-37.

5.1.4 Electrical systems

5.1.4.1 General

Electrical equipment shall be explosion-protected in accordance with IEC 60079-0 and shall use explosion protection methods found in the IEC 60079 series of standards with at least the same EPL as the engine.

For EPL Gb, Gc, Db and Dc, the requirements of IEC TS 60079-46 for the design, selection, erection, and initial inspection of the electrical installation shall be met.

For EPL Mb, the applicable requirements of ISO/IEC 80079-38 shall be met.

High voltage ignition systems shall meet the requirements of IEC 60079-45.

All components including devices, cables, and enclosures within the installed electrical system of an explosion protected engine shall be able to withstand the temperatures measured during the temperature tests given in 8.3 without damage, deterioration, or failure.

396 NOTE The relevant electrical safety standards typically include IEC 60204-1 and IEC 60204-11. It is not a
397 requirement of this document that compliance with the relevant industrial standards be verified.

398 5.1.4.2 Protection against damage

399 The electrical system, including cables, shall be protected against damage as identified in the
400 ignition hazard assessment from mechanical impact, vibration, exposure to weather, water,
401 excessive dampness, ultraviolet radiation, corrosive substances, accumulation of dust or
402 debris, steam, oil, grease, fuel, high or low temperatures, high pressure water, or other adverse
403 conditions to which the explosion protected engine may be exposed, either in operation or
404 during maintenance.

405 NOTE IEC 60079-14 and IEC TS 60079-46 provide additional information and guidance to aid meeting the
406 requirements of this subclause.

407 5.1.4.3 Ingress protection

408 The electrical system shall have an ingress protection (IP) meeting the requirements of
409 IEC 60529 or IEC 60034-5 for electrical rotating machinery.

410 5.1.4.4 Cables and wiring systems

411 Engine primary wiring, including cables and connections, are not subject to the requirements in
412 IEC 60079-14. Engine primary wiring must be designed to withstand vibration, service
413 temperature, abrasion, UV exposure, chemical compatibility to which it will be exposed, and be
414 protected from damage including being cut.

415 NOTE 1 It is not a requirement of this standard that compliance with the relevant industrial standards for engine
416 primary wiring be verified.

417 Primary wiring insulation shall be selected based on the associated service temperatures and
418 be rated for the service temperature and voltage to which the wires will be exposed in normal
419 operation. Earth return (utilizing the metallic portions of the engine) circuits are permitted.

420 Engine primary wiring shall be routed such that it is:

- 421 a) sufficiently supported to minimize deleterious effects
- 422 b) installed to facilitate inspections.
- 423 c) not in direct contact with:
 - 424 1) hot surfaces that exceed the wiring assembly temperature rating
 - 425 2) fuel lines
 - 426 3) pneumatic lines
 - 427 4) hydraulic lines.
 - 428 5) abrasive surfaces or sharp edges

429 Engine primary wiring that passes through conduits, partition walls or terminal box walls shall
430 be restrained and protected from abrasion by cable glands, flexible bushings or grommets
431 suitable for the application.

432 If intrinsically safe circuit wiring is used, it may be provided with alternative forms of protection
433 if installed in a manner which guards against potential damage from the environment in which
434 it is installed.

435 NOTE 2 See IEC 60079-11, IEC 60079-14 and IEC 60079-25 for further information on intrinsically safe wiring and
436 systems.

437 5.1.4.5 Protection of cables and wiring harnesses

438 NOTE Further information on intrinsically safe wiring and systems is given in IEC 60079-14 and IEC 60079-25.

439 IEC 60079-14 can be used for the engine wiring harness. The following modifications to the
440 requirements in IEC 60079-14 are permitted for EPL Gc and Dc engines:
[Type here]

- a) The engine wiring harness is part of the Ex equipment certificate and not subject to field inspection.
- b) Where the engine block is used as the earth return, the requirements of IEC 60079-14:2014, 6.3.2, 6.3.3, 6.3.4, and 6.3.6 are not applicable.
- c) An Ex certified engine and its electrical system shall be treated as one item of equipment per IEC 60079-14:2014, 6.3.6.
- d) A grounded engine block is considered as an equal potential ground per IEC 60079-14:2014, 6.4.1.
- e) Single wires used in engine harnesses are not to be considered easy tear cables. per IEC 60079-14:2014, 9.3.1
- f) Single insulated wires that are mechanically protected (for example nylon braid) do not require conduit. as specified by IEC 60079-14:2014, 9.3.5.

NOTE 1 The intent of IEC 60079-14:2014, 9.3.5 is to protect wire from being cut.

- g) Actuators that do not continuously rotate are not considered rotating electrical machines as defined in IEC 60079-14:2014, Clause 11.
- h) Intrinsically safe wire may be bundled with other engine wiring if the intrinsically safe wire insulation exceeds the highest rated voltage in the bundle as required in IEC 60079-14:2014 16.2.2.5.2, 16.2.2.7 and 16.6. However, an assessment of the hazards involved shall be undertaken to confirm that the intrinsically safe circuit cannot be compromised.

NOTE 2 IEC 60079-25 provides additional information and guidance.

The first paragraph of IEC 60079-14:2014, 16.2.2.1 does not apply to engine wiring harnesses

5.1.4.6 service temperature

Equipment, materials, and components shall be selected taking into consideration the associated service temperatures. Temperature tests are specified in 7.5.

5.1.5 Static electricity and bonding requirements

5.1.5.1 Equipotential bonding

Dangerous, ignitable electrostatic charges can arise on non-conductive surfaces or surfaces made of conductive or dissipative materials that are insulated from the earthing point.

For conductive materials, the value of the measured discharge resistance must not exceed $10^6 \Omega$.

Dissipative materials have a discharge resistance between $10^6 \Omega$ to $10^9 \Omega$.

Discharge resistance values $>10^9 \Omega$ indicate non-conductive / non-dissipative materials.

The value for the surface resistance must be determined in accordance with 60079-0:2017, 26.13 or in accordance with IEC 61340-2-3, in which the correlations are described in detail.

The determined value of the surface resistance / discharge resistance must not exceed $10^9 \Omega$.

5.1.5.2 Electrical resistance to ground

The electrical resistance between the engine and the floor or ground shall not exceed $10^6 \Omega$.

NOTE Further information regarding conductivity of materials is given in IEC TS 60079-32-1 and IEC 60079-32-2.

5.1.5.3 Non-metallic materials**5.1.5.3.1 EPL Mb, EPL Gc and EPL Gb**

Non-metallic materials which are subjected to a foreseeable electrostatic charge generating mechanism shall comply with one of the following:

- 1) The surface resistance of the non-metallic material shall not exceed $10^9 \Omega$ measured at 50 % relative humidity or $10^{11} \Omega$ measured at 30 % relative humidity with a test voltage of $500 \text{ V} \pm 5 \%$ and shall be bonded to the chassis in accordance with 5.1.5.
- 2) The non-metallic material shall comply with the requirements for limitation of the transferred charge in accordance with IEC 60079-0:2017, 26.17, with the exclusion of charging the sample with the corona electrode (test with high voltage spray electrode).
- 3) The projected area of the non-metallic material shall not be larger than 100 cm^2 for Group I, IIA or IIB or 20 cm^2 for Group IIB + H₂. These areas may be multiplied by 4 if the parts are surrounded by conductive frames bonded to the engine frame in accordance with 5.1.5. These areas may be multiplied by 2 if the parts are bordered at the long opposite sides by conductive frames bonded to the engine in accordance with 5.1.5.
- 4) Where the non-metallic material is a coating or layer on an engine-bonded metal surface or on an engine-bonded conductive surface, the thickness of the coating or layer shall not exceed 2 mm for Group I, IIA or IIB and 0,2 mm for Group IIB + H₂.

NOTE 1 Further information is given in IEC TS 60079-32-1 and IEC 60079-32-2.

5.1.5.3.2 EPL Dc and EPL Db

The requirements for materials, marking and the avoidance of ignition hazards of IEC 60079-0:2017, 8.4 Group III apply.

5.1.5.4 Transmission belts

Transmission belts shall be dissipative in accordance with an appropriate standard (for example ISO 1813, ISO 9563, IEC TS 60079-32-1 or IEC 60079-32-2). The requirements for limitation of transferred charge in accordance with IEC 60079-0 shall apply.

5.1.6 Safety and automation systems**5.1.6.1 Safety devices or safety systems**

Where the ignition hazard assessment specified in 5.1.2 has revealed potential ignition sources the application of safety devices or safety systems may be used to reduce the likelihood of the ignition sources becoming effective. Safety devices or safety systems may be set to alarm and shutdown the engine in response to monitored ignition critical control parameters.

The ignition critical control parameters that are monitored by safety devices or safety systems include but are not limited to temperatures, engine speed and pressure. The ignition hazard assessment will determine potential ignition risks and the location for safety devices to monitor ignition control parameters most effectively.

NOTE 1 Normal engine operating technical data and tolerances from the engine manufacturer are typically established to use as an input into the ignition hazard assessment.

Warning systems (lamps, and audible alarms) shall be designed to avoid operator confusion or misunderstanding about the action required.

NOTE 2 An ignition protection device or system could have two or more levels of operation (for example the first level provides a warning to the operator while the second level actuates a shutdown system). The warning could reduce the likelihood of a spurious activation of the ignition protection system.

[Type here]

The operating characteristics of the safety devices intended to be suitable to assist in the control of the specific ignition source in the equipment shall be specified. Examples of factors that should be considered are:

- the time taken for a potential ignition source to become effective;
- response time of the sensor;
- response time of the ignition prevention system / device;
- difference in level between the normal parameters and critical parameters (for example normal temperature and critical temperature);
- safety factor if considered necessary.

5.1.6.2 Safety function

5.1.6.2.1 Function of safety systems

All monitoring, control, and activation of safety devices for effective ignition source prevention shall function independently of any measurement and control devices required for normal operation and be:

- suitable to control the specific ignition source, and
- sufficiently reliable for the EPL to be achieved.

Any failure of a safety device shall be detected. Any failure of a safety device shall not result in a hazardous condition.

5.1.6.2.2 Determination of the control parameters

Each control parameter shall be determined by the manufacturer as that value above or below the normal operating parameter at which a potential ignition source might become effective. The set points relevant for potential alarm or control of ignition sources shall be given in the instructions for the controlled equipment and shall be clearly identified as safety critical.

Examples of safety critical control parameters that may be determined in normal or abnormal (expected malfunction) condition include:

- maximum surface temperature arising from heat generated by the engine;
- maximum allowable overspeed;
- maximum allowable vibration, before clearances between fixed and moving parts are reduced to ignition capable levels;
- minimum pressure of lubricant needed to reduce the likelihood of ignition capable frictional heating or sparking;
- maximum allowable coolant temperature; and
- maximum allowable exhaust gas temperature.

5.1.6.3 Requirements for safety devices

5.1.6.3.1 General

Applying "simple" safety devices specified as type A in IEC 61508-2 or as Type of Protection "b" in ISO 80079-37 will make it possible to achieve the relevant levels of safety

This standard allows the use of simple safety devices or complex systems using software and digital technologies, to achieve the levels of protection specified in 5.1.6.4.

NOTE 1 Simple safety devices have well defined failure modes where the safety function does not depend on complex technology, for example mechanical switching systems (including hydraulic and pneumatic systems) or electro-mechanical switching systems such as:

- a sensor connected to a warning light which requires operator intervention;

- 566 – oil pressure switch on a machine which requires lubrication in order to be safe;
- 567 – a thermally actuated valve to control liquid temperature of a pump; or
- 568 – mechanical speed control by centrifugal governor.

569 NOTE 2 Complex safety devices are those where failure modes are not well defined or depend on complex
570 technology, for example similar to type b of IEC 61508-2 or with microprocessor.

571 The EPL required shall be achieved by;

- 572 1) Installing ignition prevention, safety devices that have proven reliability determined from
573 a previous evaluation and operating experience in accordance with functional safety
574 standards; and
- 575 1) Evaluating the operating performance requirements necessary for the control of the
576 ignition source identified and the construction of the equipment to meet the required
577 level. This evaluation shall take account of;
 - 578 – the types of ignition protection devices used to protect the equipment;
 - 579 – whether or not they are single or duplicated functions (for example by other
580 independent devices);
 - 581 – the ability of the device to continue to perform as designed when operating under
582 normal operating conditions or during expected malfunctions.
 - 583 – whether faults are self-revealing or not;
 - 584 – whether the ignition protection system is failsafe or not; and
 - 585 – the probability of a fault occurring at the same time as the ignition protection is lost
586 and a potential ignition source (being protected by a device) converts to an effective
587 ignition source relating to the Equipment Protection Level of the engine.

588 5.1.6.3.2 Simple safety devices:

589 Simple systems do not require functional safety analysis demonstrating a Safety Integrity Level
590 (SIL).

591 Systems including simple safety devices shall have proven a suitable level of reliability, be
592 assembled and installed in accordance with any relevant standards, adopt well tried safety
593 principles and be able to withstand expected influences during operation, and shall comply with
594 the following requirements (see note):

- 595 – if a control parameter passes a critical value, automatic action is taken to minimize the
596 likelihood of the potential ignition source becoming effective or a warning is given that an
597 ignition source may develop so that manual intervention may be taken;
- 598 – the ignition protection system shall be capable of being checked at suitable intervals and
599 the check shall detect the loss of any safety function;
- 600 – the equipment manufacturer's instructions shall specify the interval between the periodic
601 maintenance checks and include advice on the methods of detecting faulty sensors and
602 verify the safety function (for example the tests to be performed). They shall also specify
603 the action to be taken by the user if faults on the safety devices are detected during the
604 maintenance; and
- 605 – The evidence shall be available to support the suitability of the components and systems
606 for use in the safety system. The level of details of the evidence should be in accordance
607 with the complexity of the considered component or system and with the probability of
608 failure claimed to achieve the required Performance level or safety integrity level of the
609 safety function(s). The evidence of suitability shall include adequate identification and
610 specification of the components or sub-systems; demonstration of the performance of the
611 components or sub-systems in similar operating profiles and physical environments; the
612 volume of the operating experience. maintenance checks.
- 613 – The formal documentation requirements may be reduced where a component can be
614 documented as

[Type here]

- 615 – "proven in use" conforming to the requirements in IEC 61508-2;
- 616 – "prior use" can be claimed as specified in IEC 61511-1;
- 617 – the component is "low complexity" in accordance with IEC 61508-4:2010, 3.4.3; or
- 618 – dependable field experience exists (see IEC 61508-1:2010, 4.2), then

619 NOTE Usually, the instructions will specify that such faults need to be remedied before the equipment is put back
620 into service or is permitted to continue operating.

621 5.1.6.3.3 Complex safety devices

622 It is recognized that systems with proven reliability according to functional safety standards (for
623 example IEC 61508 and IEC 61511) are available and may be used to demonstrate that the
624 required reliability has been achieved.

625 Safety functions using software or digital technologies either as separate systems or forming
626 safety related parts of the engine control system (ECM/ECU) shall be evaluated and
627 implemented using standards as applicable to the design architecture and type of components
628 used.

629 Safety functions for the control of potential ignition sources will not need to operate under
630 normal conditions. Safety functions shall therefore be considered as operating in low demand
631 mode and safety integrity levels (SIL) in accordance with IEC 61508 and IEC 61511 apply (see
632 Table 1).

633 Equipment manufactures using SIL rated systems shall provide instructions for the safe testing,
634 and testing interval for the safety systems.

635 **Table 1 – Minimum integrity for a safety system for ignition source control**

Intended EPL of the equipment	Result of the ignition hazard assessment for the existing equipment	Safety system necessary	Safety system integrity
Gc, Dc	Effective ignition source in the case of foreseeable malfunction	A system to avoid ignition sources becoming effective during regular expected occurrences	SIL 1 or b1
	No effective ignition sources during normal operation including foreseeable malfunction	None	
Gb, Db Mb	Effective ignition source in the case of foreseeable malfunction	A system to avoid ignition sources becoming effective during regular expected occurrences	SIL 2 or b2
	Effective ignition source during expected malfunction	A system to avoid ignition sources becoming effective during expected malfunctions	SIL 1 or b1
	No effective ignition sources during normal operation and expected malfunctions	None	
NOTE For further guidance for the application of safety functions to provide a reduction of ignition risk see IEC TS 60079-42. Ignition sources in normal operation are considered as an unacceptable risk. b2 is equivalent to two b1 according to ISO 80079-37.			

636

637 5.1.6.4 Monitoring, alarm and response

638 The minimum requirements for monitoring, alarm and response to engine abnormal operating
639 conditions or malfunctions given in Table 2 shall apply.

640

Table 2 – Alarms and Shutdown

EPL	Mb		Gb		Gc		Db		Dc		Safety Integrity level
Monitored fault condition	AL	SD	AL	SD	AL	SD ³	AL	SD	AL	SD	normal SD ⁴ SIL 1/ b1 ²
High coolant temperature	Y	A	Y	A	Y	M	Y	A	Y	M	
Low coolant level	Y	A	O	O	O	O	O	O	O	O	
Low Engine lube oil pressure	Y	A	Y	A	Y	M	Y	A	Y	M	
High exhaust gas temperature	Y	A	Y	A	Y	M	Y	A	Y	M	
Low water level in a liquid seal flame arrester	Y	A	Y	A	Y	M	NA	A	NA	M	
Low water level or flow to water based spark arrester	Y	A	Y	A	Y	M	Y	A	Y	M	ESD ⁵ SIL 2/ b2 ²
Gas detection ¹⁾	O	O	O	O	O	O	NA	NA	NA	NA	
Engine overspeed	Y	A	Y	A	Y	A	Y	A	O	O	
¹ Gas detector(s) can be used in addition to engines already designed according to respectively applicable requirements for Mb, Gb, Gc, Db, Dc. ² For required safety integrity level for EPL, see also Table 1. ³ The safety shutdown for Gc or Dc following the alarm is achieved either by automatic intervention or by manual intervention. The decisions on which of these shall be used shall be based on the results from the ignition hazard assessment. ⁴ engine using normal shutdown according to 5.1.6.5.2 ⁵ engine using emergency shut down according to 5.1.6.5.3 Note For EPL Gb, Db or Mb automatic intervention is required. Key: AL= alarm; SD = shutdown; ESD = emergency shut down; Y = mandatory; O = optional; A = automatic; M = manual NA = not applicable											

641

642 The basic protection concept is that those "Monitored conditions" that may develop into an
643 active ignition source have to be considered.

644 Such fault conditions will be identified in the Ignition Hazard Assessment.

645 In practice the required safety functions may be implemented by the Engine protection system
646 (ECU/ECM), the system that protects against damage to the engine or operation.

647 It may be necessary that those monitored conditions and actions are at a higher defined level
648 of integrity than the engine control system may deliver. The level of integrity will be given in
649 Table 1 for the representative EPL and the type of malfunctions expected.

650 This does not necessarily mean that it cannot be integrated into the ECU/ECM but some
651 component and system requirements have to be fulfilled. Such requirements are specified in
652 IEC 61508, IEC 61511 and ISO 80079-37, SIL or b1/b2.

653 If the ECM will automatically shut down the engine (for example low lube oil pressure) for engine
654 protection, it may, according to Table 2, be required to have a second, functionally independent,

[Type here]

action to ensure the fault condition does not develop into an active ignition source (for example manual shut down circuit for Gc engine). For Gb engines this function shall be automatic.

5.1.6.5 Engine shutdown systems

5.1.6.5.1 General

Where the shutdown device / system is designed to stop the engine operating and thereby reduce the likelihood of a potential ignition source becoming effective, the device/system shall not be self-resetting. After shutdown, it shall only be possible to restart the engine by additional human intervention according to the information for use provided by the manufacturer.

5.1.6.5.2 Shutdown (engine using normal shutdown)

Table 2 gives the relationship between alarm, automatic and manual shutdown for the minimum identified fault conditions using the normal engine shutdown.

The designation of manual shutdowns linked to alarms and automatic shutdowns will depend on the application as well as the following factors:

- a) Design of safety devices/system;
- i) Ignition hazard assessment; and
- j) EPL.

Care shall be taken to ensure that the engine shutdown system does not introduce increased hazards or risks. In certain applications it may be necessary to alarm and manually activate the engine shutdown. The normal means of manual and automatic stopping the engines shall be:

- 5) Compression ignition engines: appropriately disconnect the load and either shutting off the fuel supply or removing power to the injectors.
- 6) Spark ignited engines: appropriately disconnect the load, shutting off the fuel supply and by removing power to the ignition system.

Automatic shutdown functions might be initiated and managed by the Engine Control Module (ECM) (see 5.1.6.2).

NOTE Often sensors fitted to the equipment are used to monitor the proper functioning of the equipment. In the case of deviation from normal operation they give an alarm or a switch function. The information of these sensors is processed locally or by the control-systems. This sensor information is used in some cases to generate alarms or shut down functions to reduce the likelihood of potential ignition sources becoming effective. In such cases functional independence or redundancy is to be considered.

It shall be possible to shutdown manually from a local and remote position. Alarm signals alerting personnel to accomplish manual shutdown shall be provided. For an attended engine the control shall be at the operator's position. For an unattended engine the control shall be in a prominent and accessible position (for example alarm warning signals to a location with personnel present or audible and visible signals if operating personnel only are in the vicinity).

When the normal shutdown feature is used to address conditions in Table 3 the shutdown shall have a safety integrity level according to 5.1.6.2 or if not achievable, then the ECM shall be set to a safe state.

5.1.6.5.3 Emergency shutdown

It shall be possible to shut down the engine in critical situations by both manual intervention and automatically. An emergency shutdown shall shut off the engine as shown in Table 2.

The requirements of IEC 60204-1:2016, 10.7 shall apply. See also 5.1.6.2.

For EPL Db, Mb, Gb and Gc compression ignition engines an air inlet shut off valve shall be provided. The protection device (for example overspeed, gas detection) shall automatically shut

698 off the fuel and close the air inlet shut off valve. For EPL Gc gaseous fueled spark ignited
 699 engines the protection device shall shut down the engine by disabling the ignition and shutting
 700 off the fuel independently of the speed governor. Depending on the hazard assessment, an air
 701 inlet shutoff valve may also be required.

702 NOTE If a gaseous fuelled spark ignited engine runs into overspeed, it will usually be shut down by disabling the
 703 ignition system and shutting off the fuel gas supply. In some situations, if a flammable gas of low auto ignition
 704 temperature is ingested through the air inlet of an engine with high compression ratio, the engine might continue to
 705 run with the ignition system disabled. The runaway could be prevented by applying externally mounted air inlet shutoff
 706 valve. An ignition hazard assessment should take into account type of the engine, compression ratio and auto ignition
 707 temperature of the gas that might be ingested.

708 The emergency shutdown shall be a separate and fully independent system, designed to well-
 709 known fail-safe principles (see also 5.1.6.2.). The overspeed device shall be reset only by
 710 operator. It shall be possible to operate the emergency shutdown function manually from a local
 711 and remote position. If an engine is not closely monitored by an operator, a manual emergency
 712 shutdown switch shall be in a prominent location on or near the engine and a second emergency
 713 shutdown switch shall be in a place that is constantly monitored (for example a control room).
 714 The manual emergency shutdown switches shall require manual reset before the engine can be
 715 restarted. For further requirements for manual emergency switches, IEC 60204-1:2016, 10.7
 716 applies.

717 For emergency shutdown an inert gas may be injected into the air inlet in conjunction with
 718 operation of the air shut off valve. No other fire extinguishing fluid is permitted in the air inlet.

719 NOTE: An inlet air shut off valve should be installed as close as possible to the inlet valves of the combustion
 720 chamber. The best position is in the inlet gas path after turbo charger, intercooler etc.. If the inlet air shut off valve
 721 is installed before the turbo charger, a safe shut down of the engine might not be given.

722 5.1.6.5.4 Engines equipped with gas detection systems

723 Gas detection systems shall comply to the requirements of IEC 60079-29-1 and shall be
 724 selected and installed in accordance with IEC 60079-29-2. Factors for consideration shall
 725 include, but not be limited to:

- 726 • the characteristics of the flammable gas(es) and vapour(s) which are likely to be present
 727 on site.
- 728 • effective operation of gas detection system depends on its performance and its correct
 729 usage:
 - 730 a) gases for which the apparatus is suitable and the relative response characteristics to
 731 these gases;
 - 732 b) the system to be suitable for the special conditions of use, for example shock, vibration,
 733 weather influences and ingress from foreign bodies and water;
 - 734 c) the system response time, warm-up time, immunity and reliability, self-test and display
 735 of operational readiness;
- 736 • the characteristics of the flammable gas(es) and vapour(s) for which the engine is
 737 designed and later marked for;
- 738 • the possibility of malfunction of the gas detection system due to obstructions preventing
 739 the gas sensor detecting the atmosphere;
- 740 • the (number and) correct position of the gas sensor(s) with respect to the type of gas(es)
 741 to be detected; and
- 742 • the shutdown of the engine shall not give rise to other hazards.

743 NOTE Gas detection systems are synonymous with gas detectors as mentioned in IEC 60079-29-1 and IEC 60079-
 744 29-2 and include sensors (sampling) as well as equipment for measuring, monitoring, indicating, control, and alarm
 745 functions.

746 Gas detection systems using software or digital technologies shall meet the requirements for
 747 SIL 2 in accordance with IEC 60079-29-3.

[Type here]

The gas detection system shall provide an audible and visual alarm at the low concentration level (typically maximum of 25 % lower flammability limit (LFL)) and shall provide an emergency shutdown according to Table 2. Engine start-up shall only be possible after the gas detection system's self-integrity check is confirmed by the system.

Gas sensors shall be suitably protected against mechanical impact. The mechanical protection shall not hinder the detection of the gas.

Gas sensor(s) shall be fitted in or adjacent to the combustion air intake taking due account to the gas behavior, environmental and weather conditions ensuring that it measures the gas concentration in the air.

On engines with more than one inlet duct, the gas sensor(s) shall be fitted for each inlet duct.

Gas detector(s) can be used in addition to engines already designed according to respectively applicable requirements for Mb, Gb, Gc, Db, Dc.

5.1.7 Flame arresters

5.1.7.1 General

Flame arresters shall comply with the requirements of ISO/IEC 80079-49 for design and construction.

In addition, flame arresters in reciprocating internal combustion engine applications shall be tested according to 7.7.

Both the selection of a flame arrester for use in internal combustion engines and the test methods shall take into consideration the geometry and flow specifications of the complete system (internal combustion engine with intake system and exhaust system).

NOTE Flame arrester(s) are used as an integral part of a system of explosion protection measures to meet international guidelines for explosion protection and prevention of explosion propagation.

5.1.7.2 Types, construction and materials for flame arresters used in internal combustion engines

5.1.7.2.1 Types

Flame arresters for combustion engines are classified into the following types:

- Flame arresters of dry types shall be located and defined as in line or end of line flame arresters (intake systems and exhaust systems).
- Liquid seal type flame arresters for exhaust systems are also described in ISO/IEC 80079-49. A liquid seal flame arrester shall be fitted with a liquid level monitoring device as specified in Table 2.

Flameless discharge systems used on engine crankcase or exhaust pipelines to reduce the explosion pressure are excluded from this clause.

5.1.7.2.2 Construction and materials

The material used for the flame arresters shall be suitable for the respective application including operating temperature. ISO/IEC 80079-49 describes the essential construction requirements for flame arresters.

The flame arrester's materials strength, corrosion and abrasion resistance properties should not significantly be reduced at the upper and lower service temperature range

Flame arrester elements of intake flame arresters as well as exhaust flame arresters shall be manufactured with a corrosion resistance that is suitable for the respective conditions in the engine environment in accordance with ISO 15510.

Stainless steel, grade, 316L is appropriate to most of internal combustion engines applications, however, if chemical resistance properties of stainless steel, grade, 316L are not suitable for the application then an alloy with more suitable properties may be selected.

Non-metallic materials and light alloys (for example aluminium) are not permitted for flame arrester elements and exhaust flame arrester housings.

If a liquid seal flame arrester is installed it shall be constructed from materials that are resistant to the seal fluid, the exhaust gases and any chemical compounds formed from gases in the water (for example stainless steel, grade, 316L).

5.1.7.3 Installation / positioning

The position for the installation of a flame arrester in an intake and exhaust system is determined by constructive and operational parameters and shall be installed as close as practicable to a potential internal ignition source. For example, on the intake side, the engine is most likely the ignition source (internal ignition sources through inlet system to atmosphere). The installation of one flame arrester per cylinder, immediately upstream of the cylinder inlet may be a solution.

If the air intake system takes air from hazardous area and if the ignition hazards assessment has identified that a specific part of the intake air system is a potential internal ignition source (for example: engine start aid heater) then a flame arrester shall be installed upstream of such equipment.

On the exhaust side the flame arrester shall be positioned in such a way that it protects the engine exhaust from any flame transmission to the surrounding atmosphere.

5.1.7.4 Design of flame arresters

5.1.7.4.1 General

The inlet flame arrester shall not be interchangeable with the exhaust flame arrester unless the two are identical in all respects.

Each engine system is different even when the same flame arrester design is applied. The design of the inlet and exhaust systems can vary even for the same operating conditions and the same performance parameters.

Any modification in the pipework configuration or run up distance to the flame arrester or a flame arrester design shall be reassessed and tested. An explosive atmosphere can be present in the engine system, or, under the respective operating condition it can penetrate from the outside into the engine system. Safety characteristics can change under non-atmospheric conditions. The knowledge of the pressure and temperature values at the position of installation of a flame arrester is important for the design of a flame arrester.

5.1.7.4.2 Flame arresters for Intake system

- The intake flame arrester shall be designed, specified, and installed to withstand operational pressures and temperatures and maintain its flame arresting integrity including when pressure or temperature is increased by a charge-boosting device. The following type tests shall be performed: Maximum explosion pressure tests shall be in accordance with 7.5 or 7.6.
- Flame propagation tests shall be in accordance with 7.7.

[Type here]

5.1.7.4.3 Flame arresters for exhaust system

The high temperatures in the exhaust system have an influence on the flame arrester suitability for the application.

The selected flame arrester shall be designed and tested for the maximum operating temperature in service in its location within the exhaust system.

A device cannot be used as flame arrester if it can be considered as a potential ignition source.

The following type tests shall be performed:

- Maximum explosion pressure tests shall be in accordance with 7.4, 7.5 or 7.6 and
- Flame propagation tests shall be in accordance with 7.7.

NOTE A flame arrester is only one of the elements in the exhaust system (besides catalytic converter, spark arrester, silencer, explosion relief valve for protection of the catalytic converter, pipe elbows and reducers). All of those elements contribute to the overall backpressure. Backpressure limits are provided in manufacturer's documentation.

5.1.8 Spark arresters**5.1.8.1 General requirements**

The materials used for the construction of spark arresters shall be resistant to corrosion caused by the chemicals within the exhaust gas stream and shall have abrasion resistance and strength properties, equal to or better than, type 316 or 316L stainless steel.

5.1.8.2 Spark arresters – Types

Spark arresters may be:

- a) The dry type including the collection type, the quenching type, the filter type;
- k) The liquid type including water-based, water-spray; or
- l) An alternative design meeting the type test requirements of a recognized standard (for example ASTM F2876).

Diesel Particulate Filters shall not be used as spark arresters unless the conditions of 5.1.8.4.4 are met.

NOTE The spark arrester housing (for example piping, turbocharger, or silencer) is not required to meet the same corrosion resistance as the spark arrester)

5.1.8.3 Spark arresters – Installation

Except when a venturi type fume diluter or a disposable particulate matter filter is fitted, a spark arrester should be the final device installed into the exhaust system before the exhaust gas first meets the atmosphere.

If a disposable particulate matter filter is fitted, then the installation shall include the means to ensure that the exhaust gas entering the particulate matter filter cannot cause an ignition of the filter media or of captured carbon or aerosols causing the transmission of flame or sparks under any condition of operation. Whenever an active or active/passive type particulate matter filter, requiring intermittent regeneration, is included in the exhaust system then a Spark Arrester shall be fitted after the particulate matter filter and before the exhaust gas first meets the atmosphere.

Whenever a passive type particulate matter filter, that is not of the wall-flow type, is included in the exhaust system then a spark arrester shall be fitted after the particulate matter filter and before the exhaust gas first meets the atmosphere.

875 If a type tested spark arrester is used the characteristics of the engine (gas flow, swept volume
876 of the engine, gas temperature) shall be within limits of conditions of use of the spark arrester
877 selected.

878 **5.1.8.4 Exemptions**

879 **5.1.8.4.1 General**

880 Subclauses 5.1.8.4.1 to 5.1.8.4.4 identify exemptions from the design and testing requirements
881 for spark arresters. The following exemptions are spark arresters.

882 **5.1.8.4.2 Turbocharged Engines**

883 Turbocharged engines if all the exhaust gas passes through the turbocharger turbine and no
884 device is fitted between the turbocharger turbine and the external atmosphere that might
885 generate sparks.

886 **5.1.8.4.3 Liquid seal flame arresters**

887 Engines fitted with a liquid seal type flame arrester, meeting the design requirements of
888 ISO/IEC 80079-49 and the testing nominated in this document.

889 **5.1.8.4.4 Particular Matter Filters**

890 If engines are fitted with wall-flow, monolithic, catalytic, passive, particulate matter filters that
891 do not periodically regenerate either manually or automatically and if all of the exhaust gas
892 passes through the filter and no waste-gate valve or similar device is fitted enabling any of the
893 exhaust gas to bypass the filter, then monitoring equipment shall be fitted to provide the
894 operator with a visual or audible warning (for example dashboard light, message centre, or
895 alarm) when the particulate matter filter requires maintenance.

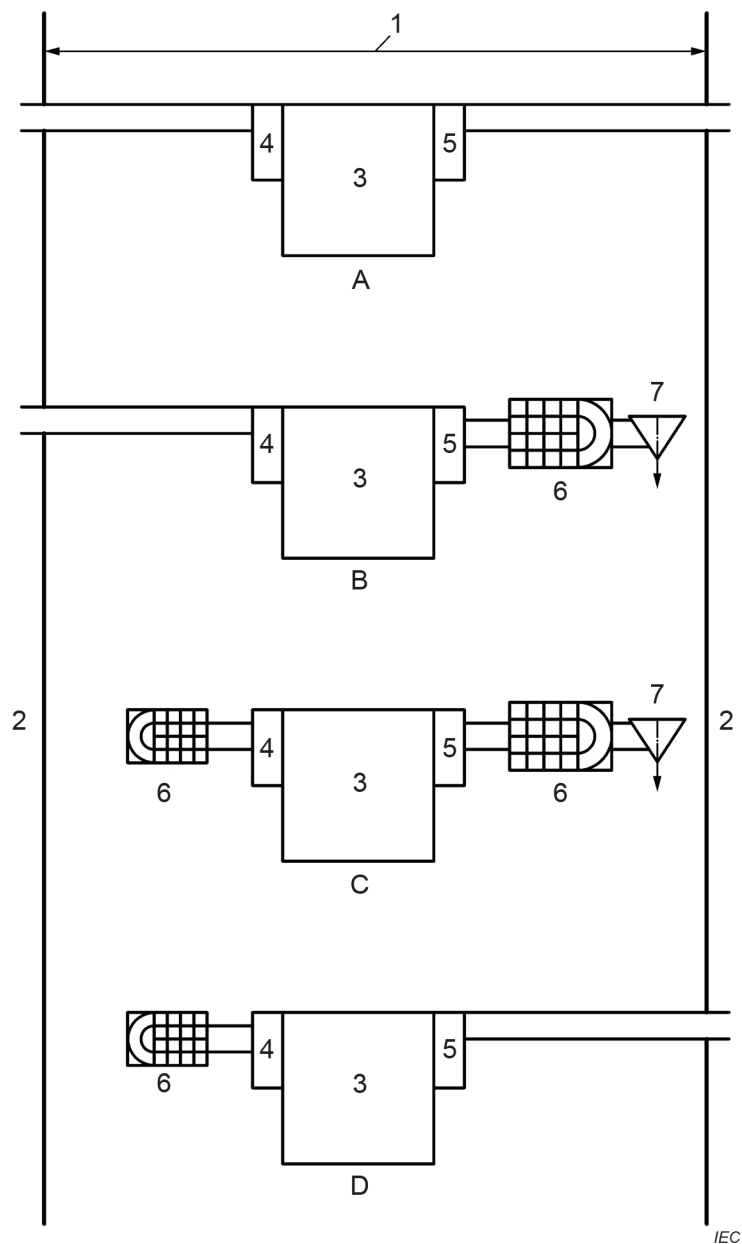
896 The process of regeneration may generate sparks and should be considered during the risk
897 assessment.

898 NOTE Passive particulate matter filter systems including CRT (Continuously Regenerating Traps) and FBC (Fuel-
899 borne catalyst) devices do not regenerate from time-to-time either manually or automatically and are not likely to
900 cause an emission of sparks.

901 **5.1.9 Engine gas path configuration**

902 **5.1.9.1 General**

903 The engine gas path consists of all components from the air intake to the exit point of exhaust
904 gasses to the surrounding atmosphere. These may include: intake and exhaust flame arresters,
905 intake and exhaust ducting, air boosting equipment such as turbochargers or superchargers,
906 intake and exhaust manifolds, air shutoff valves, charge air and exhaust coolers, engine head,
907 and cylinders, and exhaust after treatment.



- Key**
- | | | | |
|---|--------------------|---|----------------|
| 1 | hazardous area | 5 | exhaust |
| 2 | non-hazardous area | 6 | flame arrester |
| 3 | engine | 7 | spark arrester |
| 4 | intake | | |

Figure 1 – Basic gas path configurations

- NOTE 1 Figure 1 is an example and does not include all possible configurations. For more details, see Table 4.
- NOTE 2 Figure 1 is a simplified presentation and does not contain all the items that may be installed in the exhaust line, for example, explosion vent valve, catalytic converter, exhaust silencer.

5.1.9.2 Leak tight

Any portion of the gas path within a hazardous area shall be leak tight and withstand testing outlined in 7.7.

5.1.9.3 Explosion protected

Any portion of the gas path that is fully contained in a hazardous area shall be explosion protected and withstand:

- pressure determination (explosion testing) outlined in 7.4;
- overpressure testing outlined in 7.5; and
- propagation testing outlined in 7.7.

Intake and exhaust systems may be tested separately unless both are within the hazardous area, and there is an operational condition where the gas path is open throughout (for example a 2-cycle engine when both the intake and exhaust ports are open).

NOTE Parts between the flame arrester and cylinder block are included in this test. Components outside these limits are excluded from testing (for example air filters, silencers, and spark arresters are often excluded).

5.1.9.4 Cold start devices

The use of flammable liquid or gaseous fluid at the inlet for cold start is not permitted.

5.1.9.5 Air preheating devices

If air pre-heating devices are provided (such as electric glow plugs, electric grid heaters and pilot flame heaters) they shall be permanently installed downstream of any inlet flame arrester.

The electrical portions of air pre-heating devices shall not be capable of energization when an explosive atmosphere is present.

5.1.9.6 Valves and venting devices

Where valves and venting devices are installed to any part of the gas path they shall be:

- vented within the gas path;
- vented to a non-hazardous area in a leak tight vent tube; or
- fitted with a flame arrester.

Valves and venting devices may include:

- waste gate, valves
- explosion vent valves, with flame retention not meeting the tests for a flame arrester
- pressure relief, bypass, valves

Note: gas path valves and venting devices include turbo waste gate, vent valves, pressure relief valves, and bypass valves.

5.1.9.7 Inlet air pressure boosting devices

Where an air inlet pressure boosting device (for example turbocharger or supercharger) is provided, it shall be selected so that the maximum temperature within the air inlet pressure boosting device cannot produce ignition conditions (see 5.3.1) and it shall be fitted with an air filter to ensure that foreign bodies cannot penetrate inside and damage the air inlet pressure boosting device,

or

the air inlet pressure boosting device shall be part of the gas path and tested in accordance with 7.4, 7.5, 7.6. and 7.7.

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5.1.9.8 Crankcase

The crankcase:

- shall be maintained at a positive pressure while-ever the engine is running; or
- shall be explosion-protected with sufficient mechanical integrity to withstand an internal explosion and if vented, then that venting shall be through one or more flame arresters. (see 7.8).

NOTE 1 Four stroke engines fitted with pressure regulated, positive crankcase ventilation (PCV) and four stroke, positive pressure controlled, dry sump, engines generally maintain a positive pressure while running.

NOTE 2 Many two stroke engines operate with a negative pressure (vacuum) in the crankcase.

5.1.10 Fuel system**5.1.10.1 General**

To reduce the risk of leakage, fuel circuits connections shall be minimised.

5.1.10.2 Fuel lines

Fuel lines shall be:

- a) metal piping or stainless steel mesh reinforced hoses;
- m) resistant to damage from internal and external chemical, heat and mechanical influences;
- n) routed where they are protected against mechanical damage.

Line connections shall be kept to a minimum and shall be made to reduce, the possibility of leakage during operation.

5.1.10.3 Fuel tanks

Fuel tanks shall be fitted with drainage devices which comply with the following requirements.

Liquid fuel tanks shall have a drainage device at their lowest point.

The cap shall be secured to prevent it working loose.

It shall not be possible for any fluid residues to collect in parts of the installation outside the fluid system.

5.1.11 Mechanically generated sparks**5.1.11.1 Metallic materials**

Where the ignition hazard assessment demonstrates that there is a risk of ignition from incendive friction, impact or abrasion sparks then the metallic enclosure requirements of ISO 80079-36, ISO/IEC 80079-38 and IEC 60079-0 apply.

5.1.11.2 Fans and other rotating parts

Fans for cooling shall comply with ISO 80079-36 and ISO 80079-37.

Fans, fan shrouds, coverings for ventilation apertures, etc. shall be constructed and fitted so that under running conditions no spark generating contact occurs between fixed and moving parts.

5.1.11.3 Motor starting systems (for example electrical, air, hydraulic and spring) engaging the flywheel ring gear

Motor starting systems shall be of two-step type, engaging the flywheel ring gear without giving significative torque, and give full torque once they are completely engaged. Starter motors of all kinds, engaging the engine's turning flywheel ring gear, shall have its pinion made of non-sparkling material.

The operation and the pinion material shall be the subject of an ignition hazard assessment (see ISO 80079-36) and should be of the pre-engaging type or, of the initial torque limiting type.

The pinion should be manufactured from non-sparking material (for example beryllium copper, stainless steel) according to the ignition hazard assessment.

5.1.11.4 Compressed air systems

It is recommended that compressors are not installed on the engine. If such a device is provided the precautions below shall be taken.

If the air is taken from the hazardous area then the compressor shall be selected such that the temperatures and pressures within the compressor do not produce ignition conditions. Additionally, for EPL Gb engines, the compressor shall be explosion protected and be protected by flame arresters according to 5.1.7 on both the inlet and outlet. The compressor inlet and outlet flame arrester shall be tested with ignition in the compressor and at the maximum delivery temperature and pressure.

Starters driven by hazardous compressed gas shall be vented to a safe location.

5.2 Specific requirements for EPL Mb

5.2.1 Maximum temperature

Where combustible dust is present, the maximum surface temperature shall not exceed 150 °C.

For underground workings without the likelihood of combustible dust, this maximum surface and exhaust gas temperature shall not exceed the autoignition temperature of potentially explosive atmospheres for the intended location.

If other gases besides firedamp are present, the engine shall be classified in accordance with Table 4 or defined by the actual maximum surface and exhaust temperature.

5.2.2 Gas path

The EPL Mb applications are almost always considered a fully contained in the hazardous area and shall be Ex protected (see Figure 1C) and fitted with intake and exhaust flame arresters complying with 5.1.7, spark arresters complying with 5.1.8 and meet the requirements of 5.1.9 for gas path design and testing.

The number of mechanical connections in the gas path should be minimised.

5.2.3 Connections

Each connection of mechanical parts within the gas path shall be a closed joint, an open joint or protected by liquid immersion (Ex "k").

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1028 5.2.4 Air intake system

1029 When the air intake system takes air from the hazardous area (see Figure 1, part C and D) the
1030 following requirements shall be met:

1031 Each air inlet duct shall be fitted with a flame arrester complying with 5.1.7. High efficiency air
1032 filters with two (or more) stages and meeting the ISO 29463 series of standards shall be used
1033 and fitted with an intake vacuum indicator. These filters should be located as close as possible
1034 to the engine inlet manifold. The first stage should have an efficiency equal to or greater than
1035 85 %. The second stage should have an efficiency equal to or greater than 95 %.

1036 Where a cyclonic air filter is used, the dust disposal from the filter shall not be through the
1037 exhaust system.

1038 The inlet system between air filter and engine shall be dust tight.

1039 5.2.5 Exhaust system

1040 When the exhaust system discharges into the hazardous area (see Figure 1 part B and C) the
1041 following requirements shall be met: Each exhaust system shall be fitted with a flame arrester
1042 complying with 5.1.7 and a spark arrester complying with 5.1.8.

1043 The part of the exhaust system between the flame arrester and the engine shall comply with
1044 5.2.2.

1045 The spark arrester shall be located between the flame arrester and the surrounding atmosphere.

1046 If a type tested spark arrester is used the characteristics of the engine (gas flow, swept volume
1047 gas temperature) and the installation shall be the same as those of the engine used for the type
1048 test of the spark arrester.

1049 5.2.6 Fans and other rotating parts

1050 Fans for cooling shall comply with ISO/IEC 80079-38.

1051 5.2.7 Compressed air systems

1052 The surface temperature of compressors forming parts of an engine shall be less than 150 °C
1053 if coal dust is present or less than 450 °C without coal dust of the engine on the maximum
1054 surface temperature under all conditions of operation

1055 . Compressors should be selected having the lowest reasonable, operating temperature. Intake
1056 filters shall be fitted.

1057 Hoses that are attached to a compressor delivery port shall be of PTFE
1058 (polytetrafluoroethylene), steel-wire reinforced, braided construction or equivalent, smooth bore
1059 and heat-resisting, material.

1060 An unloader valve shall be fitted to control the maximum pressure of the compressor. There
1061 shall be no shut-off valves between the unloader valve and the compressor.

1062 A pressure relieving valve shall be fitted to all connected air receivers.

1063 The compressor shall be fitted with an independent, effective, intake air filter.

1064 If a compressor is driven by vee belts, then the belt shall be fire-resistant and anti-static,
1065 meeting ISO 1813.

1066 A calculation shall be completed to determine the maximum temperature of the compressed air
1067 within the compressor. If the temperature can reach the lowest reasonable auto-ignition
1068 temperature of coal damp, then flame arresters shall be fitted to both the intake and exhaust
1069 side of the compressor.

1070 5.3 Specific requirements for EPL Gb and EPL Gc

1071 5.3.1 Maximum temperature

1072 The maximum surface temperature and exhaust gas temperature (in accordance with
1073 IEC 60079-0) shall not exceed:

- 1074 – the temperature class assigned (see Table 3), or
- 1075 – the maximum surface temperature assigned, or
- 1076 – if appropriate, the ignition temperature of the specific gas for which it is intended.

1077 In addition, if the charge air temperature exceeds the value established above then additional
1078 protection may be required.

1079 **Table 3 – Classification of maximum temperatures**

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

1080

1081 5.3.2 Configuration of flame arresters and spark arresters

1082 Flame arresters and spark arresters shall be installed for EPL Gb and EPL Gc according to the
1083 Table 4. Tests to be performed for the various configurations are also given in Table 4.

1084

1085

Table 4 – Configuration of Gb and Gc flame arresters and spark arresters

Engine location	Air inlet system			Exhaust system			Tests, Clauses 2)
	Air intake from	Protecting Device	Gas path	Exhaust into	Protecting device	Gas Path	
Zone 1 (EPL Gb)	Zone 1	Flame arrester	Ex protected	Zone 1	Flame arrester and Spark arrester	Ex protected	7.6, 7.7, 7.8, 7.12,
				Non hazardous	No device	Leak tight	7.6, 7.7, 7.8 7.12
	Non Hazardous	No device	Leak tight	Zone 1	Flame arrester and Spark arrester	Ex protected	7.6, 7.7, 7.8
				Non hazardous	No device	Leak tight	7.12
Zone 2 (EPL Gc)	Zone 2	Flame arrester	Ex protected	Zone 2	Flame arrester and Spark arrest	Ex protected	7.6, 7.7, 7.8, 7.12,
				Non hazardous	No device	Leak tight	7.6, 7.7, 7.8
	Non hazardous	No device	Leak tight	Zone 2	Spark arrester	Leak tight	7.12
				Non hazardous	No device	Leak tight	7.12
1) Tests 7.10 and 7.11 to be performed for all configurations.							

1086 If the engine is fitted with one of the two flame arresters, it shall be marked “X” in accordance
 1087 with 9.1(k) and the specific condition of use shall specify that no protecting device is included
 1088 in the air intake and/or exhaust system as applicable.

1089 5.3.3 Gas path

1090 The number of mechanical connections in the gas path should be minimised.

1091 Each connection of mechanical parts within the gas path shall be either a closed joint, an open
 1092 joint, or a liquid immersed joint and shall meet the requirements stated in 5.1.9 for gas path
 1093 design and testing.

1094 5.3.4 Air intake system

1095 5.3.4.1 Air intake ducts from a non-hazardous area

1096 The parts of the inlet ducts which pass through the hazardous area shall be leak tight and tested
 1097 as specified in 7.11 (see Figure 1 part A and B).

1098 5.3.4.2 Air intake duct from the hazardous area

1099 Each air inlet duct shall be fitted with a flame arrester complying with 5.3.4 and the part between
 1100 the flame arrester and the engine shall comply with 5.3.2 (see Figure 1 part C and D).

1101 5.3.5 Exhaust system

1102 5.3.5.1 Exhaust system duct into a non-hazardous area

1103 That part of the exhaust duct which passes through the hazardous area shall be leak tight and
 1104 tested as specified in 7.4, 7.5, 7.6 and 7.7 (see Figure 1 part A and D). The installation
 1105 conditions to prevent damage shall be specified by the manufacturer.

5.3.5.2 Exhaust system duct into a hazardous area

Each exhaust system duct shall be fitted with flame arrester and spark arrester or only spark arresters according to Table 4. The flame arrester shall comply with 5.1.7. The spark arrester shall comply with 5.1.8. The part of the exhaust system between the flame arrester and the engine shall comply with 5.1.7. If the exhaust system is fitted with only a spark arrester and no flame arrester, the part of the exhaust system between the spark arrester and the engine shall comply with 5.1.9.2.

The spark arrester shall be located between the flame arrester and the surrounding atmosphere.

5.4 Specific requirements for EPL Db and EPL Dc**5.4.1 Maximum temperature****5.4.1.1 General**

EPL Db and EPL Dc engines shall be defined by the actual maximum surface and exhaust gas temperature and shall be marked accordingly.

5.4.1.2 Maximum surface and exhaust gas temperature determined without a dust layer

The maximum surface and exhaust gas temperature determined shall not exceed the maximum surface temperature assigned.

5.4.1.3 Maximum surface and exhaust gas temperature with respect to dust layers

Unless otherwise specified, documented and marked, the maximum surface and exhaust gas temperatures calculated in 5.4.1.2 should also be determined for a given layer (T_L) of dust surrounding all sides of the engine.

5.4.2 Air intake system**5.4.2.1 Air ducts from a non-hazardous area**

The parts of the inlet ducts which pass through the hazardous area shall be tested as specified in 7.11.

The installation conditions to prevent damage shall be specified by the manufacturer.

5.4.2.2 Air duct from the hazardous area

Each air inlet duct shall be fitted with a two, or more, stage air filter located as close as possible to the engine inlet manifold and with an efficiency better or equal to 85 % (see EN 1822-1:2019, class E 10) for the first stage and 95 % (see EN 1822-1:2019, class E 11) for the second stage and an intake vacuum indicator shall be fitted. Where a cyclonic air filter is used the dust disposal from the filter shall not be through the exhaust system.

The integrity of the inlet system between air filter and engine shall be maintained on EPL Db and EPL Dc engines (see 8.2.3). On EPL Db and EPL Dc engines, the inlet system between air filter and engine shall be tested according to 7.11.

5.4.3 Exhaust system**5.4.3.1 Exhaust system duct into a non-hazardous area**

That part of the exhaust duct which passes through the hazardous area shall be tested as specified in 7.11.

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