

Reciprocating internal combustion engines — Safety requirements for design and construction of engines for use in potentially explosives atmospheres —

Part 1: Group II engines for use in flammable gas and vapour atmospheres

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ICS 13.230; 27.020

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National foreword

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The UK participation in its preparation was entrusted by Technical Committee MCE/14, RIC engines, to Subcommittee MCE/14/-/1, Engines to be used in potentially explosive atmospheres, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 36, an inside back cover and a back cover.

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This British Standard, having been prepared under the direction of the Sector Committee for Engineering, was published under the authority of the Standards Committee and comes into effect on 15 April 2000

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ISBN 0 580 34474 6

Amendments issued since publication

Amd. No.	Date	Comments

English version

**Reciprocating internal combustion engines - Safety
requirements for design and construction of engines for use in
potentially explosive atmospheres - Part 1: Group II engines for
use in flammable gas and vapour atmospheres**

Moteurs alternatifs à combustion interne - Prescriptions de
sécurité pour la conception et la construction des moteurs
fonctionnant en atmosphère explosible - Partie 1: Moteurs
du groupe II utilisés dans des atmosphères de gaz et de
vapeurs inflammables

Hubkolben-Verbrennungsmotoren -
Sicherheitsanforderungen für die Konstruktion und den Bau
von Motoren zur Verwendung in explosionsgefährdeten
Bereichen - Teil 1: Motoren der Gruppe II für Bereiche mit
explosionsfähigen Gasen und Dämpfen

This European Standard was approved by CEN on 8 July 1999.

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COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This European Standard has been prepared by Technical Committee CEN/TC 270, Internal combustion engines, 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 July 2000, and conflicting national standards shall be withdrawn at the latest by July 2000.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

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

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

The standards prepared by CEN/TC 270 are specific to internal combustion engines and supplement those A and B standards concerned with safety.

Normative and informative annexes to this standard are indicated in the contents list. General Safety requirements for internal combustion engines are given in EN 1679-1:1998.

0 Introduction

This European Standard has been prepared to be a harmonized standard to provide one means of conforming with the essential safety requirements of the Machinery (98/37/EEC) and ATEX (94/9/EEC) Directives, and associated EFTA regulations. This European standard is a type C standard as defined in EN 292:1991.

The extent to which hazards are covered are indicated in the scope of this standard. In addition, machinery shall comply as appropriate with part 1 and 2 of EN 292:1991 for hazards which are not covered by this standard.

The requirements of this standard apply to designers, manufacturers, suppliers and importers of reciprocating internal combustion engines.

This standard also contains the information to be provided by the manufacturer to the user of reciprocating internal combustion engines.

1 Scope

This European Standard specifies the safety requirements and/or measures to remove the hazards and limit the risks on reciprocating internal combustion compression ignition engines hereinafter referred to as 'engines' of group II categories 2 and 3 for use in potentially explosive atmospheres of flammable gas and vapour.

This European Standard does not apply to flammable gas and vapour atmospheres containing carbon disulphide (CS₂).

This European Standard does not define requirements relating to the driven machinery. These requirements can be found in the appropriate application standards.

This European standard does not apply to engines used in premises for the processing manufacture or storage of explosives.

The safety requirements for engines for use in potentially explosive atmospheres for underground applications are given in EN 1834-2:2000.

The safety requirements for engines for used in explosive atmospheres with combustible dust are given in EN 1834-3:2000.

This European Standard does not apply to spark ignition engines.

The hazards applicable are listed in clause 4 and relate to the additional hazards of operation in an atmosphere that may become explosive. The tests which the engine and its ancillary fittings are required to undergo to verify compliance with this specification are detailed in this standard.

General safety requirements i.e. those common to all RIC engines, are covered in EN 1679-1:1998.

This European Standard is applicable to engines which are manufactured after the date of issue of this standard.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of, any of these publications apply to this European standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies.

EN 292-1	1991	Safety of machinery - Basic concepts, general principles for design - Part 1: Basic terminology, methodology
EN 292-2:1991/+A1:1995		Safety of machinery - Basic concepts, general principles for design - Part 2: Technical principles and specifications
EN 1050	1996	Safety of machinery – Principles for risk assessment
EN 1127-1	1997	Explosive atmospheres - Explosion prevention and protection – Part 1: Basic concepts and methodology
EN 1679-1	1998	Reciprocating internal combustion engines - Safety - Part 1: Compression ignition engines
EN 1834-3	2000	Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosive atmospheres - Part 3: Group II engines for use in flammable dust atmospheres

EN 50014	1997	Electrical apparatus for potentially explosive atmospheres – General requirements
EN 50015	1994	Electrical apparatus for potentially explosive atmospheres – Oil immersion ‘o’
EN 50016	1995	Electrical apparatus for potentially explosive atmospheres – Pressurized apparatus ‘p’
EN 50017	1994	Electrical apparatus for potentially explosive atmospheres – Powder filling ‘q’
EN 50018	1994	Electrical apparatus for potentially explosive atmospheres – Flameproof enclosures ‘d’
EN 50019	1994	Electrical apparatus for potentially explosive atmospheres – Increased safety ‘e’
EN 50020	1994	Electrical apparatus for potentially explosive atmospheres – Intrinsic safety ‘i’
prEN 50021	1998	Electrical apparatus for potentially explosive atmospheres – Type of protection ‘n’
EN 50028	1987	Electrical apparatus for potentially explosive atmospheres – Encapsulation ‘m’
EN 50039	1980	Electrical apparatus for potentially explosive atmospheres – Intrinsic safety systems ‘l’
prEN 50154	1993	Electrical installations in potentially explosive gas atmospheres (other than mines)
ISO 1813	1979	Antistatic endless V belts - Electrical conductivity - Characteristics and method of test
ISO 2710	1978	Reciprocating internal combustion engines - Vocabulary
ISO 3046-3	1989	Reciprocating internal combustion engines - Performance - Part 3: Test measurements
ISO 7967-1	1987	Reciprocating internal combustion engines - Vocabulary of components and systems - Part 1: Structure and external covers
ISO 7967-2	1987	Reciprocating internal combustion engines - Vocabulary of components and systems - Part 2: Main running gear
ISO 7967-3	1987	Reciprocating internal combustion engines - Vocabulary of components and systems - Part 3: Valves, camshaft drive and actuating mechanisms
ISO 7967-4	1988	Reciprocating internal combustion engines - Vocabulary of components and systems - Part 4: Pressure charging and air/exhaust gas ducting systems
ISO 7967-8	1994	Reciprocating internal combustion engines - Vocabulary of components and systems - Part 8: Starting systems
ISO 9563	1990	Belt drives - Electrical conductivity of antistatic endless synchronous belts - Characteristics and test method
IEC 60243-1	1996	Methods of test for electric strength of solid insulating materials - Part 1: Tests at power frequencies

3 Definitions

For the purposes of this standard, the definitions in ISO 2710:1978 and ISO 7967-1:1987, ISO 7967-2:1987, ISO 7967-3:1987, ISO 7967-4:1988 and ISO 7967-8:1994 and the following definitions apply:

3.1 Explosive atmosphere

A mixture with air, under atmospheric conditions of combustible material in the form of gas, vapour, mist or dust, in which after ignition, combustion spreads throughout the unconsumed mixture

NOTE: See 3.15 in EN 1127-1:1997. For the purposes of this standard dust is excluded.

3.2 Zones for gas and vapour

The definitions given in 6.4.2 of EN 1127-1:1997 apply

3.3 Potentially explosive atmosphere

An atmosphere which could become explosive due to local and operational conditions

3.4 Categories

Category 2 and 3 of equipment group II are defined in annex 1 of the ATEX Directive. In the meaning of ATEX directive RIC engines are equipments.

NOTE: The letter G is included to identify engines designed according to this European Standard

3.5 Temperatures

3.5.1 Ignition temperature of an explosive atmosphere

The definition is given in 3.28 of EN 1127-1:1997

3.5.2 Maximum surface temperature

The highest temperature attained under the most adverse operating conditions of the external surfaces to which the surrounding atmosphere has access. This includes the engine, its fittings, its ancillary equipments including flameproof enclosure, flame arrester, spark arrester, ducts, etc

3.5.3 Maximum temperature

The maximum temperature is the greatest under the most adverse operating conditions of:

- a) the maximum surface temperature as defined in 3.5.2,
- b) the maximum gas temperature of:
 - the exhaust gas emitted into the atmosphere immediately after the flame arrester;
 - the charge air at the outlet of the boosting device.

3.6 Flameproof enclosure

A gas permeable enclosure which can withstand the pressure developed during an internal explosion and which prevents the ignition of the surrounding atmosphere

3.7 Flame arrester

A device fitted to the opening of an enclosure or to the connecting pipework of a system of enclosures to permit the transmission of a gas/air mixture but to prevent the passage of a flame. A flame arrester consists of the flame arrester element and the flame arrester housing

3.8 Joints

3.8.1 Closed joint

Any assembly between two parts without open path leading to the surrounding atmosphere

3.8.2 Open joint

Any continuous open path through a joint or opening excluding flame arrester (example: valve guide)

4 List of hazards

Only the specific hazards for engine applications in potentially explosive atmospheres are listed below according to EN 1050:1996.

- hazards generated by materials and substances processed, used, exhausted or ejected by machinery including fire or explosion hazards (see 5.2, 5.10);
- hazards caused by failure or malfunction of the control system (see 5.15);
- hazards caused by incorrect position or absence of guards or safety related devices including starting and stopping devices, also including safety signs and signals, warning devices or information (see 5.5, 5.6, 5.7).

The main sources of ignition are:

Hot surfaces,
Flames and hot gases,
Mechanically generated sparks,
Electrical apparatus and systems,
Static electricity.

The potential sources of ignition likely to ignite the surrounding explosive atmosphere are listed in annex A2.

5 Safety requirements and/or measures

5.1 General

Engines of group II shall meet the requirements of EN 1679-1:1998.

No ignition of the explosive atmosphere outside the flameproof enclosure by hot surfaces, hot gases, flames, sparks or electrical apparatus shall occur.

The relation between the classification of hazardous zones and conformity categories is given in table C.1 (see 6.3.2 of prEN 1127-1:1997).

For the category 3 G engines, only normal operating conditions need to be taken into account. Malfunctions need not be considered (see annex A.1.1).

For the category 2 G engines, normal operating conditions and reasonably foreseeable malfunctions shall be taken into account. Rare malfunctions and catastrophic failures need not be considered (see annex A.1.1 and A.1.2).

All safety requirements and/or measures apply to both categories 2 G and 3 G unless otherwise specified.

Engines for use in flammable gas and vapour atmospheres including flammable dust shall fulfil the requirements of EN 1834-3:2000 in addition to the requirements of this standard.

5.2 Gas grouping subdivision

Engines intended for use in areas with potentially explosive atmospheres are defined as group II engines. Engines of group II may be subdivided according to the nature of the potentially explosive atmosphere for which they are intended.

These subdivisions are IIA, IIB and IIC.

NOTE 1: These subdivisions come from annex A of EN 50014:1997 and correspond to the subdivision of gases, vapours and mists according to their maximum experimental safe gap (MESG).

NOTE 2: Engines marked IIB are suitable for applications requiring group IIA engines. Engines marked IIC are suitable for applications requiring group IIA and IIB engines.

5.3 Maximum temperature

The maximum temperature as defined in 3.5.3 shall not exceed the autoignition temperature of the explosive atmosphere.

This is achieved if the maximum temperature does not exceed the maximum temperature of the temperature class (see table1) or the maximum temperature declared by the engine manufacturer under the conditions of 6.3.

Table 1: Classification of maximum temperatures

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

NOTE : Equipment is normally designed for use in the ambient temperature range between – 20°C and + 40°C.

5.4 Engine designation

Internal combustion engines for use in potentially explosive atmospheres of gases and vapour shall be designated by:

- 'engine group II',
- the category (2 G or 3 G),
- the gas group subdivision IIA, IIB or IIC given in annex A of EN 50014:1997,
- the temperature class given in table 1 or the maximum temperature declared by the engine manufacturer.

5.5 Flameproof enclosure

The flame proof enclosure shall withstand:

- the pressure of an internal explosion when tested according to 6.2.1;
- the overpressure when tested according to 6.2.2;

and prevent

- transmission of an internal explosion when tested according to 6.2.3.

The number of mechanical connections in the flameproof enclosure shall be minimized.

Each connection of mechanical parts within the flameproof enclosure shall be either a closed joint, or an open joint.

Any open joint in the flameproof enclosure leading to the surrounding atmosphere shall be within the ratio of length versus gap shown in EN 50018:1994 for the relevant gas group subdivision.

Threaded joints shall be designed in accordance with table 3 or 4 of EN 50018:1994.

5.6 Air intake system

5.6.1 Air ducts from a non-hazardous area

The parts of the inlet ducts which pass through the hazardous area shall be leak tight when tested as specified in 6.5 (see figure 1A and 1B).

5.6.2 Air duct from the hazardous area

Each air inlet duct shall be fitted with a flame arrester complying with 5.9 and the part between the flame arrester and the engine shall comply with 5.5 (see figure 1C and 1D).

5.7 Exhaust system

5.7.1 Exhaust system duct into a non-hazardous area

That part of the exhaust duct which passes through the hazardous area shall:

- be leak tight and tested as specified in 6.5 (see figure 1A) if the combustion air is taken from a non hazardous area ;
- comply with 5.5 if the combustion air is taken from the hazardous area (see figure 1D).

5.7.2 Exhaust system duct into a hazardous area

Each exhaust system shall be fitted with a flame arrester complying with 5.9, unless tests have proved (see annex B) it is not necessary, and a spark arrester complying with 5.10 (see figure 1B and 1C).

The part of the exhaust system between the flame arrester and the engine shall comply with 5.5.

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

If a type tested spark arrester is used the characteristics of the engine (gas flow, swept volume of the engine, gas temperature) and the installation shall be the same as those of the engine used for the type test of the spark arrester (see 6.4.2).