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Reciprocating internal combustion engines — Fire protection

Moteurs alternatifs à combustion interne — Protection contre l'incendie

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*.

This third edition cancels and replaces the second edition (ISO 6826:1997), which has been technically revised.

The main changes are as follows:

— additional applied fields, including engines used to propel agricultural tractors, road construction and earth-moving machines, have been covered;

— referenced standards have been updated;

— additional requirements on flammable gases have been added;

— additional requirements on flame-retardant characteristics of non-metal components, including hose and plastic components, have been added:

— additional requirements on ground connection as well as protection of electrical components have been added;

— additional requirements on after-treatment system for exhaust gas have been added;

— requirements of piping for flammable liquids or gases are included in basic class;

— detailed requirements for marine engines have been added.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Reciprocating internal combustion engines — Fire protection

1 Scope

This document establishes requirements for reciprocating internal combustion engines to minimize the risk of fire caused by the engine, its components and the auxiliaries fitted to it. Where necessary, special requirements can be given for particular engine applications.

This document applies to reciprocating internal combustion engines for land and marine use, excluding engines used in an explosive atmosphere, road vehicles and aircraft.

This document can also apply to engines used to propel small craft and for other applications where no suitable International Standard for fire protection on reciprocating internal combustion engines exists.

For engine applications excluded above, this document can be used as the basis for engine application standards.

2 Normative references

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

ISO 7840, *Small craft — Fire-resistant fuel hoses*

ISO 8846, *Small craft — Electrical devices — Protection against ignition of surrounding flammable gases*

ISO 10088, *Small craft — Permanently installed fuel systems*

ISO 15540, *Ships and marine technology — Fire resistance of non-metallic hose assemblies and non-metallic compensators — Test methods*

ISO 15541, *Ships and marine technology — Fire resistance of non-metallic hose assemblies and non-metallic compensators — Requirements for the test bench*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
fire resistance
ability of a test specimen to withstand fire or give protection from it for a period of time

Note 1 to entry: Typical criteria used to assess fire resistance in a standard fire test are fire integrity, fire stability and thermal insulation.

4 Other regulations and requirements

4.1 For engines used on board ships and offshore installations which are subject to the rules of a Classification Society, it is presupposed that the additional requirements of the Classification Society are observed. The Classification Society shall be stated by the customer prior to placing the order.

For non-classed engines, additional requirements shall in each case be subject to agreement between the engine manufacturer and customer (AMC).

4.2 If special requirements from regulations of any other authorities, such as inspecting and/or legislative authorities, apply, the authority shall be stated by the customer prior to placing the order.

Any additional requirements shall be subject to agreement between the engine manufacturer and customer (AMC).

5 General

This document provides one means of conforming with essential safety requirements and helps to facilitate communication and understanding between the engine manufacturer and the customer. Application of this document shall be subject to agreement between the engine manufacturer and the customer (AMC).

The measures required for fire protection are very different depending on the type and application of the engine. It is therefore neither necessary nor desirable for all these measures to be applied to every engine.

For this reason, an engine delivered according to this document shall conform with at least the basic class (see Clause 6) of this document. The fire protection of the engine in this case shall be designated by:

Fire protection ISO 6826

Where additional requirements are applied in order to provide the essential safety requirements for a specific application (i.e. special requirements specified in Clause 7), these shall be specified by adding the appropriate feature codes to "ISO 6826". In this case, an engine would have all the basic class measures applied and additionally the protection measures specified in the selected feature codes.

The selection of special requirements according to feature codes A, B and so on shall be subject to agreement between the engine manufacturer and the customer (AMC). For this purpose, the format given in Annex A, Table A.1 should serve for communicating special requirements. Cross reference of special requirements is given in Annex A, Table A.2.

An example of the designation of fire protection for a specific application of an engine, conforming with the basic class and additionally the special requirements (feature codes C, K and P) selected from this document is:

Fire protection ISO 6826-C-K-P

Feature codes, such as C-K-P, shall be stated in alphabetical order.

6 Engine basic class

6.1 General

The methods and the design details used to conform with the basic class features are the responsibility of the engine manufacturer.

6.2 Instructions

The manufacturer shall provide instructions for the installation, operation and maintenance of the engine. The instructions shall include inspection procedures to maintain the integrity of engine systems containing flammable liquids or gases, the features of the basic class and all applicable special requirements. Particular attention shall be given to inspecting hoses, pipes and their associated connections for signs of material cracking, deterioration, corrosion and thermal or vibration-induced damage.

Gasoline and gas engines shall be operated in well-ventilated spaces to avoid explosions in the event of fuel leakage. Flammable vapours due to flammable gases and liquids leakage and/or spillage shall not cause explosions.

6.3 Engine fill provisions

The arrangements for filling engines with flammable liquids or gases shall be such that no flammable liquids or gases can come into contact with high-temperature surfaces, electrical components or rotating parts.

6.4 Stop, drain and vent valves

Stop, drain and vent valve fittings shall be positioned to enable easy access for operation and service.

6.5 Piping for flammable liquids or gases

6.5.1 Pipe design and installation

The design or installation of pipes shall prevent flammable liquids from dripping or spraying leakage on to high-temperature (higher than 220 °C) surfaces, rotating parts and electrical components or into the air inlet system of compression ignition engines.

Fuel gas piping installed on the engine shall be double-walled or ducted, such that a single failure shall not lead to release of fuel gas into the machinery space.

Materials used in any part of piping systems installed on the engine shall be compatible with the working fluid at the appropriate working temperature and pressure.

No leakage from the piping systems of flammable liquids and gasses, such as fuel, lubricating oil or hydraulic oil, is permitted.

Hoses should be constructed to a recognized standard as suitable for the intended service, taking into consideration fire resistance, pressure, temperature, fluid compatibility and mechanical loading, including impulse where applicable.

EXAMPLES

a) location of fuel and lubricating oil pipes, particularly pipe joints, away from the vicinity of high-temperature surfaces, electrical components or air inlets;

b) local protection, shielding or reinforcement of pipes, especially small pipes such as those for pressure signal transmission;

c) suitable locking of drain or vent valves fitted on pipes or components containing flammable liquids or gases to prevent accidental opening.

6.5.2 Pipe fittings

The use of flexible hoses should be limited to locations where necessary because of relative movements. The length should, where possible, be limited to 1,5 m. The number of detachable pipe fittings shall be

limited to the necessary minimum. Flexible hoses and pipe joints shall be installed in clearly visible and readily accessible locations.

7 Special requirements for engines

7.1 Fire resistance

7.1.1 30-min fire-resistance test (feature code: A)

All installed components which contain flammable liquids shall withstand exposure to flame without leaking. Flexible pipes and hoses shall be tested when transporting water at 80 °C ± 5 °C at the maximum service pressure to check that they can withstand exposure to flame with a temperature of 800 °C ± 50 °C for 30 min without leaking. For marine engines, the non-metallic hose assemblies and non-metallic compensators shall be tested by the methods and test bench specified by ISO 15540 and ISO 15541.

7.1.2 2,5-min fire-resistance test (feature code: B)

All installed components which contain flammable liquids shall withstand exposure to free-burning fuel for 2,5 min without leaking. The test shall be subject to the typical test procedures specified by ISO 7840 and ISO 10088.

7.1.3 Flame-retardant characteristics of plastic components (feature code: C)

Flame-retardant hoses (other than those in 7.1.1) shall withstand exposure to flame with a temperature of 800 °C ± 50 °C for 5 s and remain constantly burning for no longer than 5 s after putting out the flame.

All plastic components located close to high-temperature surfaces shall be subject to a test. Samples shall be tested five times and remain burning for no longer than 30 s after 5 s of exposure to fire. Particles dripping after exposure to fire shall not ignite cotton. Plaque samples after exposure to fire shall not have any burn-through point.

7.2 Protection of electrical components (feature code: D)

Electrical components for spark ignition engines shall be designed so that during operation they do not ignite surrounding flammable gases. Electrical components shall be tested by the procedures and requirements specified by ISO 8846.

For fire-resistance or flame-spreading characteristics of plastics and insulation materials for electrical conductors and wires, refer to ISO 21367, IEC 60331 and IEC 60332.

7.3 Electrostatic protection (feature code: E)

Electrical components shall be grounded reliably. Equipment installed on natural gas engines shall be grounded through an electrostatic strip.

7.4 Protection of high-pressure fuel systems (feature code: F)

High-pressure (higher than 150 bar[1)] for liquids, and higher than 10 bar for gases) fuel injection pipes shall be located and/or protected so that leakage does not come into contact with high-temperature surfaces, rotating parts, electrical components or the air inlet system. Means shall be provided for the detection of liquids or gases and their related drainage or venting.

The position of supports should be given special consideration in order to minimize vibration and ensure that excessive bending moments are not imposed on the pipes.

1) 1 bar = 0,1 MPa = 10^5 Pa; 1 MPa = 1 N/mm^2.

High-pressure fuel injection pipes shall be executed as double-wall pipes to avoid fuel spreading out in the case of high-pressure pipe damage.

7.5 Protection of high-pressure hydraulic systems (feature code: G)

Hydraulic pipes with a pressure of over 60 bar shall be located and/or protected so that leakage does not come into contact with high-temperature surfaces, rotating parts, electrical components or the air inlet system. Means shall be provided for the detection and drainage of leaks.

The position of supports should be given special consideration in order to minimize vibration and ensure that excessive bending moments are not imposed on the pipes.

7.6 Drain and vent valves (feature code: H)

Valves for the draining of systems containing flammable liquids or venting gases shall open manually and shall be located so that liquids or gases can be drained or vented so the liquid or gas does not come into contact with high-temperature surfaces, rotating parts, electrical components or the air inlet system, as applicable.

7.7 Filters for flammable liquids or gases

7.7.1 Filter location (feature code: J)

Filters for flammable liquids or gases shall be located and/or protected so that in the case of leaks no flammable liquids or gases shall be in contact with high-temperature surfaces, rotating parts, electrical components or the air inlet system, as applicable.

7.7.2 Filter trays (feature code: K)

Filter locations shall be fitted with trays made of a suitable material and/or gutters to conduct flammable liquids or gases spilled during servicing, away from high-temperature surfaces, rotating parts, electrical components and the air inlet system, as applicable.

7.8 High-temperature surfaces (feature code: L)

7.8.1 The exhaust system and all other parts of the engine shall be cooled and/or insulated so that no external surface shall reach a temperature at which leaking flammable liquids or gases ignite (auto-ignition temperature).

Examples of auto-ignition temperatures:

— diesel fuel: 220 °C;

— lubricating oil: 380 °C;

— hydraulic oil: 380 °C;

— gasoline: 260 °C (evaporates at 225 °C);

— natural gas: 650 °C.

7.8.2 Insulating materials shall be non-flammable and protected against intrusion of flammable liquids or gases by suitable means, such as sheet metal, hard sheeting or other impermeable materials. Insulating materials shall be applied in such a way that in the case of leakage of flammable liquids or gases these are prevented from reaching the heated surface underneath.

7.9 Protection from engine exhaust gas (feature code: M)

The engine exhaust system shall be fitted with a spark arrester or otherwise be suitably designed to act as a spark arrester.

NOTE A turbocharger is considered to be a spark arrester.

7.10 Protection from after-treatment system of exhaust gas (feature code: N)

For the after-treatment system of exhaust gas, the alarm system shall initiate a warning in the case of exhaust gas temperatures over 550 °C, except when the diesel particulate filter system is regenerating. A cooling device using, for example, exhaust gas dilution or hydrocooling, shall be installed. When the cooling device is not suitable, a load control strategy for exhaust gas temperature control shall be included in the engine control system.

7.11 Inlet system flame control

7.11.1 Inlet system flame prevention (feature code: P)

The engine induction system shall be designed or equipped with a flame arrester to ensure that a fire or explosion within it does not propagate into the atmosphere surrounding the engine.

7.11.2 Inlet system fire warning (feature code: Q)

For spark ignition and four-stroke trunk piston compression ignition engines, the engine air inlet system shall be fitted with a device to set off an alarm if there is a fire in the inlet system.

7.11.3 Inlet system drains (feature code: R)

Two-stroke crosshead engines shall provide the means to drain or vent flammable liquids or gases from the engine air inlet system if a flammable mixture can be formed in this system.

On marine engines (two- and four-stroke engines), generally charge air pressure systems are fitted with drain valves for draining the water condensate.

7.12 Crankcase flame control

7.12.1 Crankcase breather flame control (feature code: S)

Crankcase breathers shall be designed or equipped with flame arresters to ensure that a crankcase fire or explosion does not propagate into the atmosphere surrounding the engine.

7.12.2 Crankcase explosion relief valve flame control (feature code: T)

Crankcase explosion relief valves are fitted to many large engines having cylinders of more than 300-mm bore to restrict the damage caused by crankcase explosions.

Where it is essential to reduce the risk of fire resulting from crankcase explosions, crankcase explosion relief valves shall have a fire-resistance function or flame arresters shall be fitted.

The installation of crankcase explosion valves is required depending on the volume of the crankcase. Internal combustion engines having a cylinder bore of 200 mm and above or a crankcase volume of 0,6 m^3 and above shall be provided with crankcase explosion relief valves. For two-stroke engines, additional explosion relief valves should be installed on the under-piston buffer space closing covers. Scavenge spaces in open connection to the cylinders shall be fitted with explosion relief valves.

7.12.3 Oil mist detection arrangements against marine engine crankcase explosions (feature code: U)

The oil mist detector arrangements (or engine-bearing temperature monitors or equivalent devices) are required for the automatic shut-off arrangements in the case of medium- and high-speed diesel engines of 2,250 kW and above or having cylinders of more than 300 mm bore.

7.13 Indicator cock flame control (feature code: V)

Indicator cocks shall be fitted with screw-in blind plugs to avoid flame emission in the case of self-opening of the indicator valve during engine running.

7.14 Flexible connections in engines started by admitting air directly into the cylinders (feature code: W)

Flexible connections (bellows, flexible hoses) in pipe lines which are permanently under starting air pressure shall withstand the movements and vibrations caused by internal engine explosions.

In order to protect starting air mains against explosions arising from improper functioning of starting valves, the following devices should be fitted:

a) an isolation non-return valve or equivalent at the starting air supply connection to each engine;

b) a bursting disc or flame arrester either in the way of the starting valve of each for direct reversing engines having a starting air manifold or at the supply inlet to the starting air manifold for non-reversing engines.

Devices in b) may be omitted for engines having a bore not exceeding 230 mm.

NOTE On marine two-stroke engines the under-piston spaces can be fitted with CO_2 or steam fire-extinguishing systems.

For crosshead-type engines, scavenge spaces in open connection to the cylinder shall be connected to an approved fire extinguishing system, which shall be entirely separate from the fire extinguishing system of the engine room.

Annex A
(informative)

Format for communicating special requirements

Table A.1 — Protection features for specified engine applications

Engine applications	Feature codes																						
	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W		