SLOVENSKI STANDARD
SIST EN 14986:2024

01-december-2024

Načrtovanje ventilatorjev za delovanje v potencialno eksplozivnih atmosferah

Design of fans working in potentially explosive atmospheres

Konstruktion von Ventilatoren für den Einsatz in explosionsgefährdeten Bereichen

Conception des ventilateurs pour les atmosphères explosibles

Ta slovenski standard je istoveten z: EN 14986:2024

ICS:

23.120	Zračniki. Vetrniki. Klimatske naprave	Ventilators. Fans. Air-conditioners
29.260.20	Električni aparati za eksplozivna ozračja	Electrical apparatus for explosive atmospheres

SIST EN 14986:2024 **en,fr,de**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14986

April 2024

ICS 23.120

Supersedes EN 14986:2017

English Version

Design of fans working in potentially explosive atmospheres

Conception des ventilateurs pour les atmosphères explosibles

Konstruktion von Ventilatoren für den Einsatz in explosionsgefährdeten Bereichen

This European Standard was approved by CEN on 16 March 2024.

This European Standard was corrected and reissued by the CEN-CENELEC Management Centre on 8 May 2024.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Ref. No. EN 14986:2024 E

Contents

European foreword

This document (EN 14986:2024) has been prepared by Technical Committee CEN/TC 305 “Potentially explosive atmospheres — Explosion prevention and protection”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2024, and conflicting national standards shall be withdrawn at the latest by October 2024.

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

This document supersedes EN 14986:2017.

The significant changes with respect to EN 14986:2017 are listed in Annex F.

This document has been prepared under a standardization request addressed to CEN by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

For the relationship with EU Legislation, see informative Annex ZA, which is an integral part of this document.

Any feedback and questions on this document should be directed to the users’ national standards body. A complete listing of these bodies can be found on the CEN website.

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

Introduction

This document is a type C standard as stated in EN ISO 12100:2010.

The machinery concerned and the extent to which hazards, hazardous situations and events are covered and indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

1 Scope

1.1 This document specifies the constructional requirements for fans constructed to Group II G (of explosion groups IIA, IIB and hydrogen) categories 1, 2 and 3, and Group II D categories 2 and 3, intended for use in explosive atmospheres.

NOTE Operation conditions for the different categories of fans used in this document are defined in Clause 4.

1.3 This document specifies requirements for design, construction, testing and marking of complete fan units intended for use in potentially explosive atmospheres in air containing gas, vapour, mist and/or dusts. Such atmospheres can exist inside (the conveyed atmosphere (flammable or not)), outside, or inside and outside of the fan.

This document covers mechanical equipment, in particular fans. The “type of protection” as specified in EN ISO 80079-37:2016 is constructional safety.

1.4 This document is applicable to fans working in ambient atmospheres and with normal atmospheric conditions at the inlet, having

— absolute pressures ranging from 0,8 bar to 1,1 bar,

— and temperatures ranging from −20 °C to +60 °C,

— and maximum volume fraction of 21 % oxygen content,

— and an aerodynamic energy increase of less than 25 kJ/kg.

NOTE 1 25 kJ/kg is equivalent to 30 kPa at inlet density of 1,2 kg/m^3.

This document can also be helpful for the design, construction, testing and marking of fans intended for use in atmospheres outside the validity range stated above or in cases where other material pairings need to be used. In this case, the ignition risk assessment, ignition protection provided, additional testing (if necessary), manufacturer's marking, technical documentation and instructions to the user, clearly demonstrate and indicate the equipment's suitability for the conditions the fan can encounter.

NOTE 2 Temperatures below −20 °C can be considered. Material suitability can require specific evaluation for these temperatures. With lower temperature the explosion pressure increases, which leads to increased test pressures (see A.3) and can require specific testing. Although the standard atmospheric conditions in EN ISO 80079-36:2016 give a temperature range for the atmosphere of −20 °C to +60 °C the normal ambient temperature range for the equipment is −20 °C to +40 °C unless otherwise specified and marked.

1.5 This document does not apply to:

— group I fans (fans for mining);

— explosion group IIC (other than hydrogen);

— category 1D fans;

— cooling fans or impellers on rotating electrical machines;

— cooling fans or impellers on internal combustion engines, vehicles or electric motors.

NOTE 1 Measures for category 1D fans are given in EN 1127-1:2019.

NOTE 2 Measures for explosion group IIC (other than hydrogen) are given in EN 1127-1:2019.

NOTE 3 Measures for explosion group I are given in EN ISO/IEC 80079-38:2016 and EN 1127-2:2014.

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.

EN 1127-1:2019, *Explosive atmospheres — Explosion prevention and protection — Part 1: Basic concepts and methodology*

EN 60079-14:2014, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection (IEC 60079-14:2013)*

EN IEC 60079-0:2018, *Explosive atmospheres — Part 0: Equipment — General* requirements (IEC 60079-0:2017)

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13349-1:2022, *Fans — Vocabulary and definitions of categories — Part 1: Vocabulary (ISO 13349-1:2022)*

EN ISO 16852:2016, *Flame arresters — Performance requirements, test methods and limits for use (ISO 16852:2016)*

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

EN ISO 80079-37:2016, *Explosive atmospheres — Part 37: Non-electrical equipment for explosive atmospheres — Non-electrical type of protection constructional safety "c", control of ignition sources "b", liquid immersion "k" (ISO 80079-37:2016)*

CLC/TR 60079-32-1:2018, *Explosive atmospheres — Part 32-1: Electrostatic hazards, guidance*

ISO 14694:2003, *Industrial fans — Specifications for balance quality and vibration levels*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1127-1:2019, EN ISO 80079-36:2016 and the following 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
externally mounted flame arrester
flame arrester consisting of a flame arrester housing and flame arrester elements mounted as a separate equipment on the fan

3.2
integrated flame arrester
flame arrester consisting of a flame arrester housing and flame arrester elements where the flame arrester housing is part of the fan housing

3.3
contact diameter
dimension of a rotating part at the point where it can hit a stationary part

4 Requirements for all fans

4.1 Ignition hazard assessment

4.1.1 General

An ignition hazard assessment according to EN ISO 80079-36:2016 shall be carried out. A list of main hazards identified is given in Annex E. These include hazards inside and outside the fan. Additional hazards may need to be considered.

For the purposes of fans designed and made according to this document the following operational conditions shall be used as a basis for the ignition hazard assessment and for the assignment of a fan to a particular category.

Release of flammable material shall be considered in the ignition hazard assessment for the outside of the fan, see 4.2.3.

4.1.2 Normal operating conditions

Normal operating conditions shall be considered to occur in situations where the fan performs its intended use within its design parameters. This includes conditions during start up and shut down (see also EN ISO 12100:2010).

For the purposes of fans designed and made according to this document, failures (such as a breakdown of seals, flange gaskets or releases of substances caused by accidents) which involve repair or shut-down are not considered to be part of normal operation.

4.1.3 Expected malfunction

An expected malfunction shall be considered to be a failure or fault in a fan which normally occurs in practice. In addition, an expected malfunction shall be considered to occur when a fan or its components do not perform their intended functions.

For the purposes of fans designed and made according to this document this can happen for a variety of reasons, including:

a) variation in the properties or dimensions of the fan assembly (e.g. warping of the casing);

b) disturbance to or failure of the power supply or other services;

c) unnoticed long time operation with defective bearing and leading to contact between impeller and housing;

d) running for an extended period with high vibrations.

4.1.4 Rare malfunction

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

4.2 Assignment of categories

4.2.1 General

A fan may have a different category for the inside and outside or none at one side. Fans which may be used both to convey an explosive gas, vapour, mist or dust atmosphere and/or are located in an explosive gas, vapour, mist or dust atmosphere are assigned categories internally and externally depending on the likelihood of them acting as an effective ignition source.

Category 3 fans shall not create an effective ignition source in normal operation, see 4.1.2.

Category 2 fans shall meet category 3 fans requirements, and in addition not create an effective ignition source with expected malfunctions, see 4.1.3. Category 1 fans shall meet category 2 fans requirements, and in addition not create an effective ignition source with rare malfunctions, see 4.1.4.

4.2.2 Influence of external parts on internal hazards and vice-versa

For all external parts used for fans with an internal category, the effects of external faults on the interior shall be considered in the ignition hazard assessments.

NOTE 1 An example is fans that use an external drive to support the impeller. Errors in the bearing of the drive can lead to ignition sources in the interior of the fan housing.

The effects of internal faults on the exterior shall be considered in ignition hazard assessments for fans with an external category.

NOTE 2 An example is an unbalanced impeller that results in overheating of an external bearing.

External parts which are in contact with the atmosphere inside the fan, and can create a potential ignition source, shall have the same equipment category as is required for the interior of the fan. If the equipment category is achieved by the use of additional instrumentation e.g. a temperature monitoring, then the overall system shall be evaluated as part of the conformity assessment.

NOTE 3 For a configuration shown in Figures D.4 and D.5 or Figure D.6 the motor can be considered external to the fan casing. For configuration shown in Figure D.7 with a flange mounted motor the motor can be considered as an internal part which can create a potential ignition source and is in contact with the atmosphere inside the fan.

4.2.3 Leakage

The manufacturer shall consider leak aspects in the ignition hazard assessment.

Fans, especially their shaft seals and flexible connections at the inlet and outlet, are possibly not absolutely gas tight, and connected ducts are possibly not leak proof. The hazardous atmosphere can leak either from the inside of the fan into the adjacent environment, or from a hazardous environment around a fan, and into the fan casing through a leakage path e.g. a shaft seal when this is below atmospheric pressure.

NOTE 1 A leak is possible in either direction, depending on for example the installation configuration or/and on whether the fan is operating.

The ignition hazard assessment shall evaluate leaks under all operating conditions that are specified in the instructions for use as required in Clause 7.

NOTE 2 Example situations include a fan which is category 1G or 2G outside and 3G or non-hazardous inside, which on start-up can contain flammable material due to leaks into the fan housing; and fans which normally convey gas above the UFL (Upper Flammability Limit), where in-leaks of air can result in the mixture becoming flammable.

NOTE 3 In normal operation, leakage of flammable material into the fan (gas or dust) is not a hazard as this would be immediately dissipated by air/gas flow within the fan. Leakage of dust from inside the fan to the external surroundings would not be sufficient to require the outside of the fan to be additionally rated for dust.

The manufacturer shall give information about possible leakage rates relevant for the actual application in the information for use. Where the leakage rates are not known, the manufacturer shall construct the fan so that there is no more than one category difference between the inside and the outside.

Where the fan has an open inlet and/or outlet (installation modes A, B, C according to EN ISO 13349-1:2022) the inside and the outside of the fan shall have the same category.

4.3 Temperatures

4.3.1 General

Both the temperature of potentially hot surfaces and the temperature of the conveyed atmosphere (flammable or not) and/or of the atmosphere surrounding the fan shall be considered.

4.3.2 Maximum surface temperature

The maximum surface temperature of the fan characterizes the hottest part of the equipment that can come in contact with the explosive atmosphere or the maximum temperature of the conveyed atmosphere (flammable or not) which can act as an ignition source.

The maximum surface temperatures of both the inside and outside parts of the fan that can come in contact with the explosive atmosphere shall be determined in accordance with EN ISO 80079-36:2016.

In addition to that, the maximum surface temperature marked for the inside of the fan shall be the greater of either:

— the maximum surface temperature determined in accordance with EN ISO 80079-36:2016 including the appropriate safety margins for the different categories; or

— the maximum temperature of the conveyed atmosphere (flammable or not) at the outlet with a safety margin of 20 % (with temperatures measured in °C).

These temperatures are determined considering the highest inlet temperature specified in 4.3.3.

NOTE This safety margin of 20 % has been chosen because of the enhanced ignition risk at higher gas temperatures.

The maximum surface temperature of the equipment is used – after the application of the above safety margins – for marking of the equipment with a defined temperature, a temperature class of the equipment or an appropriate explosive atmosphere.

EXAMPLE A fan with the following parameters: The maximum surface temperature of the inside, measured according to EN ISO 80079-36:2016 with the appropriate safety margin is 90 °C, the temperature of the conveyed atmosphere (flammable or not) measured at the outlet is 80 °C for an inlet temperature of 60 °C. With a 20 % safety margin the maximum outlet temperature is 96 °C. Therefore, the maximum temperature marked for the inside of the fan is 96 °C.

4.3.3 Temperature of the conveyed atmosphere (flammable or not)

While it is only the ambient and the inlet temperature which is generally known by the user, it is the normally higher outlet temperature which determines the suitability of the fan for the intended use.

As well as temperature increases during normal service, extraordinary temperature increases shall be considered.

The fan manufacturer shall ensure that the appropriate temperature limits are maintained between −10 % or +20 % of nominal gas flow, and at maximum and minimum expected densities. The manufacturer may specify a wider operating range where the temperature limits are maintained. Generally maximum temperature rise will occur at minimum flow and maximum density. For variable speed fans the calculation shall be carried out at maximum fan speed and/or the speed which gives maximum fluid outlet temperature. For fans with motor mounted in conveyed atmosphere (flammable or not) consideration shall be given to the heating effect from the motor. The manufacturer's instructions shall include the minimum and maximum air flow rates which are required to maintain the temperature rating.

The manufacturer shall measure or calculate the maximum gas temperature for an inlet gas temperature of 60 °C within the gas flow limits or −10 % to +20 % of nominal gas flow.

Where the maximum inlet temperature is below 60 °C, the above calculation shall be made with this lower maximum temperature and the manufacturer shall mark the fan appropriately.

Electric motors and other temperature sensitive elements shall receive special attention as they generally are designed for a maximum ambient temperature of 40 °C.

4.4 Mechanical design criteria

4.4.1 General

Fans for operation in potentially explosive atmospheres shall be of rigid design. This requirement is considered as fulfilled for casings, supporting structures, guards, protective devices and other external parts if the deformation resulting from an impact test at the most vulnerable point is so small that the moving parts do not come into contact with the casing. The test shall be carried out in accordance with EN ISO 80079-36:2016.

NOTE Foreseeable causes of reducing the clearances between the casing and the moving parts include distortion of the casing caused by connection to ductwork with no flexible joints, or by damage to the casing during installation. Reduction of clearance is also possible if the fan is installed, and the inlet is blanked off subjecting fan case and ducting to a negative pressure equal to maximum produced by the fan at its maximum speed

All impellers, bearings, pulleys, cooling disks etc. shall be securely fixed in position.

This requirement shall not apply to the bearings incorporated within electric motors which shall be subject to the requirements specified in EN IEC 60079-0:2018.

The manufacturer shall specify the maximum forces and torques in each direction that may be imposed on the casing from connecting ductwork.

The fan shall be capable of withstanding the lowest inlet pressure that can be generated by the fan itself when the inlet is closed, without causing contact between the casing and the moving parts.

4.4.2 Clearance between rotating elements and the fan casing

The clearance between rotating elements and the fan casing is the most important safety feature of ignition minimizing fans. The minimum clearances between rotating parts such as the impeller and fixed parts e.g. the fan casing shall be at least 0,5 % of the relevant contact diameters (diameter of a rotating part at the point where it can contact a stationary part) of the finished component, but shall not be less than 2 mm in the axial or radial directions nor need be more than 13 mm. The design and construction shall ensure that the clearances are maintained under all conditions covered by the intended use. Non-contact seals and seal housings shall comply with these criteria. For other seals see 4.14. The manufacturer's instructions shall include where necessary the appropriate maintenance instructions to maintain the clearance.

NOTE 1 Minimum clearance is defined as taking into account all possible tolerances due to manufacture and fitting.

NOTE 2 The clearance can change with rotation, temperature, and due to vibrations and belt drive tension.

NOTE 3 See Annex D for examples on position of critical clearances.

4.5 Casing

4.5.1 General

The fan casing shall be of a substantially rigid design, to satisfy the mechanical design requirements specified in 4.4.

Inspection doors and other openings are permitted, but shall be designed to have a similar level of leak tightness as the rest of the casing.

4.5.2 Gas tightness

The manufacturer shall consider the possibility of leakage in the selection of components and equipment.

Gas leakage can come from the shaft seal, or joints in the casing. The manufacturer shall provide information about maintenance requirements for the seals as the shaft seal leakage rate may increase over time.

4.6 Impellers

Impellers shall be of a rigid design. An impeller design that enables a primary stress calculation based on 2/3 of the yield stress shall be deemed to satisfy the requirements for a rigid design without testing.

Impeller designs validated by testing shall be able to withstand a test run at a minimum of X times the maximum operational rotating speed for at least 60 s without causing an ignition risk, i.e. the impeller shall not contact the casing. The factor X shall be as follows:

$$X = 1{,}15$$

where the run test is carried out at the maximum operating temperature or

$$X = 1{,}15 \times \sqrt{(R\mathrm{p}20/R\mathrm{pT})}$$

Where the run test is carried out at 20 °C and where

$R\mathrm{pT}$ is the yield strength at maximum operating temperature or the creep rupture strength at maximum operating temperature whatever is smaller;

$R\mathrm{p}20$ is the yield strength at 20 °C.

The above factors are based on a type test principle for series production of identical units. If individual testing of all fan units is employed, a factor of 1,1 shall be used rather than 1,15 in the above calculations.

An impeller either overspeed tested or shown by design to meet the above will satisfy the requirement of not creating an ignition source in expected malfunction d in 4.1.3.