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# Design of fans working in potentially explosive atmospheres

## National foreword

This British Standard is the UK implementation of EN 14986:2017. It supersedes BS EN 14986:2007 which is withdrawn.

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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 Atmosphären

This European Standard was approved by CEN on 30 October 2016.

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# Contents

Page

European foreword ........ 4
Introduction ........ 5
1 Scope ........ 6
2 Normative references ........ 7
3 Terms and definitions ........ 7
4 Requirements for all fans ........ 8
4.1 Ignition hazard assessment ........ 8
4.1.1 General ........ 8
4.1.2 Normal operating conditions ........ 8
4.1.3 Expected malfunction ........ 8
4.1.4 Rare malfunction ........ 8
4.2 Assignment of categories ........ 8
4.3 Temperatures ........ 9
4.3.1 General ........ 9
4.3.2 Maximum surface temperature ........ 9
4.3.3 Temperature of the conveyed atmosphere (flammable or not) ........ 10
4.4 Mechanical design criteria ........ 10
4.4.1 General ........ 10
4.4.2 Clearance between rotating elements and the fan casing ........ 10
4.5 Casing ........ 11
4.5.1 General ........ 11
4.5.2 Gas tightness ........ 11
4.6 Impellers ........ 11
4.7 Materials for rotating and stationary parts of fans ........ 11
4.7.1 General ........ 11
4.7.2 Permissible material pairings ........ 12
4.8 Linings and tip extensions ........ 22
4.9 Vibration ........ 22
4.10 Earthing conducting parts ........ 23
4.11 Electrostatic charges ........ 23
4.12 Electrical equipment ........ 23
4.13 Prevention of deposits inside the fan ........ 23
4.14 Shaft seals ........ 24
4.15 Bearings ........ 24
4.16 Power transmission systems ........ 24
4.17 Clutches and couplings ........ 24
4.18 Brakes and braking systems ........ 24
4.19 Impeller-shaft attachment ........ 24
4.20 Corrosion of fan components ........ 28
4.21 Fire resistance ........ 28
4.22 Protection against foreign particles ........ 28
5 Additional requirements for category 2 ........ 28
5.1 General ........ 28
5.2 Impeller-shaft attachment ........ 28
5.3 Vibration ........ 29

5.4 Material pairings ... 29
6 Category 1 fans for specific use with a gaseous explosive atmosphere as a conveyed atmosphere (flammable or not) ... 29
6.1 General requirements ... 29
6.2 Flame arresters ... 29
6.2.1 General ... 29
6.2.2 Stabilized burning ... 29
6.3 Casings ... 30
6.3.1 General ... 30
6.3.2 Gas tightness ... 30
7 Information for use ... 30
7.1 General ... 30
7.2 Accompanying documentation ... 30
7.3 Markings ... 32
Annex A (normative) Additional requirements for category 1 G fans ... 33
A.1 General ... 33
A.2 Flame transmission test ... 33
A.3 Pressure test ... 34
Annex B (informative) Classification of requirements for the different categories ... 35
Annex C (informative) Checklist for verification of the safety requirements and/or protective measures ... 39
C.1 General ... 39
C.2 All categories ... 39
C.3 Category 2 – Gas and dust ... 40
C.4 Category 1 – Gas ... 40
Annex D (informative) Examples of types of fans showing ignition minimizing features ... 41
Annex E (normative) List of significant hazards ... 46
Annex ZA (informative) Relationship between this European Standard and the Essential Requirements of EU Directive 2014/34/EU ... 50
Bibliography ... 51

# European foreword

This document (EN 14986:2017) 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 document supersedes EN 14986:2007.

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 2017, and conflicting national standards shall be withdrawn at the latest by July 2017.

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 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 2014/34/EU.

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

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, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

# Introduction

This European Standard is a type C standard as stated in EN ISO 12100.

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

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 European Standard 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 1 Operation conditions for the different categories of fans used in this European Standard are defined in Clause 4.

NOTE 2 Technical requirements for category 1 D fans are not given in this document. Where explosive dust atmospheres are regularly conveyed, explosion protection measures as described in EN 1127–1 are required if this specific us is needed.

**1.2** This European Standard does not apply to group I fans (fans for mining), cooling fans or impellers on rotating electrical machines, cooling fans or impellers on internal combustion engines.

NOTE 1 Requirements for group I fans are given in EN 1710.

NOTE 2 The requirements for electrical parts are covered by references to electrical equipment standards.

**1.3** This European Standard 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 may exist inside (the conveyed atmosphere (flammable or not)), outside, or inside and outside of the fan.

**1.4** This European Standard 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 European Standard may 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, should clearly demonstrate and indicate the equipment's suitability for the conditions the fan may encounter.

This European Standard should not apply to integral fans as a part of Diesel engines, vehicles or electric motors.

NOTE 2 Where undated references are used in the body of the standard the latest edition applies.

## 2 Normative references

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

EN 1127-1:2011, *Explosive atmospheres - Explosion prevention and protection - Part 1: Basic concepts and methodology*

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)*

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

EN ISO 5801, *Industrial fans - Performance testing using standardized airways (ISO 5801)*

EN ISO 11925-2, *Reaction to fire tests - Ignitability of products subjected to direct impingement of flame - Part 2: Single-flame source test (ISO 11925-2)*

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

EN ISO 16852:2010, *Flame arresters - Performance requirements, test methods and limits for use (ISO 16852:2008, including Cor 1:2008 and Cor 2:2009)*

EN ISO 13349:2010, *Fans - Vocabulary and definitions of categories (ISO 13349:2010)*

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

ISO 14694:2003/AMD1, *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 1127-1:2011, EN ISO 80079-36:2016 and the following apply.

**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**
diameter of a rotating part at the point where it can contact a stationary part

# 4 Requirements for all fans

## 4.1 Ignition hazard assessment

### 4.1.1 General

A list of hazards considered is given in Annex D. These include hazards inside and outside the fan. Where additional hazards could occur an ignition hazard assessment according to EN ISO 80079-36 shall be carried out.

For the purposes of fans made according to this European Standard 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 4.3.

### 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.)

For the purposes of fans made according to this European Standard 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 made according to this European Standard 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) release of the impeller blade by vibrations over an extended period.

### 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 ignition hazard but which, in combination, do create an ignition hazard, are regarded as a single rare malfunction.

## 4.2 Assignment of categories

A fan may have a different category for the inside and outside. 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.

Fans, especially their shaft seals and flexible connections at the inlet and outlet, may not be absolutely gas tight, and connected ducts may not be leak proof. The hazardous atmosphere may 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. Therefore the manufacturer shall consider these aspects in the ignition hazard assessment. The manufacturer shall give information about the possible leakage rates of the fan 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) 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.

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 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 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.

In the absence of detailed information from the end user on expected fault conditions and maximum and minimum flow, pressure rise and density, 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. 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 components 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.

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 the clearance is also possible if the fan is installed with inlet ductwork and the pressure drops below atmospheric when the inlet is closed.

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 60079-0.

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 may change with rotation, temperature, and due to vibrations and belt drive tension.

## 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.

If the fan is intended to convey fluid above UEL (upper explosion limit) the manufacturer shall state the leakage rate to provide the information in the instruction for use.

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

## 4.6 Impellers

Impellers shall be of a rigid design and shall be able to withstand a test run at a minimum of 1,15 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.

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.

## 4.7 Materials for rotating and stationary parts of fans

### 4.7.1 General

In view of possible friction, due to malfunctions or even rare malfunction, potential areas of contact between the rotating elements and fixed components shall be manufactured from materials in which the risk of ignition through friction and friction-impact sparks, hot spots or hot surfaces is minimized. Consideration should be given to the fact that layers of combustible or non-combustible materials may cause increased ignition risks. See Annex C.

Where the gap between fixed and moving parts can be checked, as part of routine maintenance, on a fan once it is installed and any ducting fitted to inlet and outlet, the manufacturer shall include in the instructions for use how this should be done, and the acceptable minimum gap. Recommendations for the frequency of checking this gap shall also be included.

For category 3 fans there are no requirements for material pairings as outlined in 4.7.2 if one of the following requirements is fulfilled:

1) the power input is less than 5,5 kW; and/or

2) relative speed < 40 m/s; or

3) the conditions for verifying the critical gap as described above can be met during service.

All alloys except aluminium alloys (sheet or cast) shall contain not more than a mass fraction of 15 % aluminium and shall have a homogenous structure. Paints and coatings shall contain not more than a mass fraction of 10 % aluminium.

### 4.7.2 Permissible material pairings

One of the material pairings given in Table 1 for gas explosion groups IIA and IIB, dust applications or in Table 2 for hydrogen for the different categories shall be used in the construction of ignition protected fans

The pairings shown are for the stationary rubbing part and the rotating rubbing part. Either material (1) or material (2) may be chosen for the rotation part subject to satisfactory mechanical stress performance over the design life of the fan.

For category 1 fans this European Standard requires additional protective measures, thus rotating and stationary parts of fans acceptable for category 2 fans are also suitable for category 1.

NOTE Many of the material pairings given in Table 1 can cause ignition of sensitive explosive atmospheres if there is a high degree of friction for a long enough time. These pairings have been chosen as a represent a gradation of the ignition risk for different applications. The other constructional measures detailed in this European Standard are essential to ensure the appropriate level of safety of the fan.

**Table 1 — Permissible material pairings for gas explosion groups IIA and IIB and dust applications**

<table>
<tr><th>Item</th><th>Material (1)</th><th>Material (2)</th><th colspan="2">Requirements</th><th>Footnotes</th></tr>
<tr><td>1</td><td>Leaded brass CuZn39Pb or naval brass CuZn39Sn or tin bronze</td><td>Carbon or stainless steel<br>or nickel base or cast iron</td><td></td><td rowspan="3">- Paint containing aluminium shall not be used because of the risk of thermite sparks (EN 1127–1).<br>- Nickel based alloys shall contain a minimum mass fraction 60 % nickel. Nickel based alloys and nickel based steel alloys shall contain a maximum mass fraction of 4 % in total of magnesium, titanium and zirconium. All alloys shall have a homogeneous structure.<br>- Even if these alloys are non-sparking, they can easily form hot spots due to friction and low heat conductivity</td><td>a f</td></tr>
<tr><td>2</td><td>Copper</td><td>Carbon or stainless steel<br>or nickel base or cast iron</td><td></td><td></td></tr>
<tr><td>11</td><td>CuNi10Fe1.6Mn (CW352H)</td><td>Any steel alloy or nickel base</td><td>- This pairing can cause ignition of explosive atmospheres when rubbing occurs. This shall be included in the technical documentation provided to the user.<br>- In category 1 or 2 fans these pairings shall be limited to fans having a motor power not exceeding 11 kW and a relative rubbing speed between stationary and rotating parts not exceeding 40 m/s, provided the clearances at all possible points of contact specified in 4.5.2 are ensured by design or checks during service. Where greater motor powers or relative rubbing speeds</td><td></td></tr>
</table>

| Item | Material (1) | Material (2) | Requirements | | Footnotes |
|---|---|---|---|---|---|
| | | | occurs additional measures are required to control the clearance (e.g. vibration control, see 5.3). | | |
| 7 | Nickel based alloy | Nickel based alloy | - Nickel based alloys shall contain a minimum mass fraction 60 % nickel. Nickel based alloys and nickel based steel alloys shall contain a maximum mass fraction of 4 % in total of magnesium, titanium and zirconium. All alloys shall have a homogeneous structure.<br>- Even if these alloys are non-sparking, they can easily form hot spots due to friction and low heat conductivity. | - These pairings can cause ignition of explosive atmospheres when rubbing occurs. This shall be included in the technical documentation provided to the user.<br>- In category 1 or 2 fans these pairings shall be limited to fans having a motor power not exceeding 5,5 kW and a relative rubbing speed between stationary and rotating parts not exceeding 40 m/s, provided the clearances at all possible points of | |

| Item | Material (1) | Material (2) | Requirements | | Footnotes |
|---|---|---|---|---|---|
| | | | | contact specified in 4.5.2 are ensured by design or checks during service. Where greater motor powers or relative rubbing speeds occurs additional measures are required to control the clearance (e.g. vibration control, see 5.3).<br>- In this material pairing austenitic steel shall have a mass fraction of at least 16,5 % chrome (see [1], [2]), to minimize the probability of mechanically generated sparks in case of friction.<br>- Even if this alloy generates no sparks it can in case of friction easily generate hot surfaces because of the low thermal conductivity. | |
| 8 | Stainless steel | Stainless steel | | | |
| 9 | Any other steel alloy or cast iron | Any other steel alloy or cast iron | - Paint containing aluminium shall not be used because of the risk of thermite sparks (EN 1127–1). | | |
| 10 | Any steel alloy | Brass CuZn37 | **Only category 3 allowed**<br>- Paint containing aluminium shall not be used because of the risk of thermite sparks | | |

| Item | Material (1) | Material (2) | Requirements | | Footnotes |
|---|---|---|---|---|---|
| | | | (EN 1127–1).<br>- Paint containing iron oxides shall not be used because of the risk of thermite sparks (EN 1127–1).<br>- This combination shall only be used when the Brass CuZn37 is employed as the stationary part. | | |
| 4 | Aluminium alloy | Aluminium alloy | | - Steps shall be taken to ensure that no flying rust particles or flakes can be deposited on surfaces that may come into contact with each other.<br>- Paint containing iron oxides shall not be used because of the risk of thermite sparks (EN 1127–1). | c |
| 5 | Aluminium alloy | Naval brass CuZn39Sn | | | c f |
| 6 | Aluminium alloy | Leaded brass CuZnPb3 / CuZn39Pb | | | a c |
| 12 | Plastic | Plastic | | - Plastic components shall fulfil the requirements of EN ISO 80079-36. The manufacturer shall give details of the material specification, thermal endurance and electrostatic properties in the technical documentation. Plastic materials for category 2 and category 1 fans | d |
| 17 | Plastic | Any steel alloy or cast iron | | | d |
| 18 | Plastic | Stainless steel | | | d |
| 13 | Plastic | Naval brass CuZn39Sn | - Paint containing aluminium shall not be used because of the risk of thermite sparks (EN 1127–1).<br>- Paint containing iron oxides shall not be used because of the risk of thermite sparks | | d |
| 14 | Plastic | Aluminium alloy | | | c d |
| 16 | Plastic | Leaded brass CuZnPb3 | | | a d |

| Item | Material (1) | Material (2) | Requirements | | Footnotes |
|---|---|---|---|---|---|
| | | | (EN 1127–1). | shall withstand short-term exposure to flames without burning, when tested according to 4.21.<br>- In fans plastic or rubber can be used to produce linings, rings or contact strips, or as extension to metallic parts (e.g. a tip extension to a metallic blade), or to manufacture entirely the impeller, the casing or both. | |
| 15 | Plastic | Nickel based alloy<br>or nickel based steel alloy | - Nickel based alloys shall contain a minimum mass fraction 60 % nickel. Nickel based alloys and nickel based steel alloys shall contain a maximum mass fraction of 4 % in total of magnesium, titanium and zirconium. All alloys shall have a homogeneous structure.<br>- Even if these alloys are non-sparking, they can easily form hot spots due to friction and low heat conductivity. | | c d |
| 3 | Tin or lead | Carbon or stainless steel<br>or cast iron | | - Paint containing aluminium shall not be used because of the risk of thermite sparks (EN 1127–1). | a b |
| 19 | Rubber or rubber coated metal | Any steel alloy or cast iron or nickel base or | - Nickel based alloys shall contain a minimum mass | - If the impeller is rubber coated the tip speed shall be limited to 70 m/s. | c e |

| Item | Material (1) | Material (2) | Requirements | | Footnotes |
|---|---|---|---|---|---|
| | | aluminium alloy | fraction 60 % nickel. Nickel based alloys and nickel based steel alloys shall contain a maximum mass fraction of 4 % in total of magnesium, titanium and zirconium. All alloys shall have a homogeneous structure.<br>- Even if these alloys are non-sparking, they can easily form hot spots due to friction and low heat conductivity. | - In fans plastic or rubber can be used to produce linings, rings or contact strips, or as extension to metallic parts (e.g. a tip extension to a metallic blade), or to manufacture entirely the impeller, the casing or both. | |
| 20 | Rubber coated metal | Rubber coated metal | | | e |

[a] Use of alloys containing lead may be prohibited or limited by national or local authorities if this may not be acceptable from an environmental point of view.

[b] The use of tin may be the only permissible combination when explosive dust is present (see below) in order to fulfil the temperature requirements given in EN 1127–1. It will melt before dangerous hot surface temperatures are reached. On the other hand, a low melting temperature may represent a risk to touch underlying materials.

[c] Aluminium alloys containing approximately 12 % silicon e.g. silumin are appropriate from an anti-sparking and corrosion viewpoint because the alloy is brittle and breaks on contact and thus prevents rubbing.

[d] Where plastic is chosen, it should be noted that not all grades are automatically permissible, as they have a low heat conductivity leading relatively easily to hot surfaces. It should be noted that the mechanical properties of plastic may limit its use for impellers (see 4.12).

[e] Rubbers may be natural or synthetic. The minimum thickness of the rubber layer shall be in accordance with Table 3.

[f] Naval brass is sometimes designated CuZn38Sn1 as well as CuZn39Sn.

**Table 2 — Permissible material pairings for gas mixtures containing hydrogen for category 1G and 2G**

| Item | Material (1) | Material (2) | Requirements | | Footnotes according to Table 1 |
|---|---|---|---|---|---|
| 1 | Steel or steel alloy | Tin or lead | Paint containing aluminium shall not be used because of the risk of thermite sparks (EN 1127–1). | | a b |
| 3 | Cast iron | Tin or lead | | | a b |
| 2 | Nickel or nickel alloy | Tin or lead | Nickel based alloys shall contain a minimum mass fraction 60 % nickel. Nickel based alloys and nickel based steel alloys shall contain a maximum mass fraction of 4 % in total of magnesium, titanium and zirconium. All alloys shall have a homogeneous structure.<br>NOTE 1 Even if these alloys are non-sparking, they can easily form hot spots due to friction and low heat conductivity. | | a b |
| 4 | Aluminium alloys | Tin or lead | - Steps shall be taken to ensure that no flying rust particles or flakes can be deposited on surfaces that may come into contact with each other<br>- Paint containing iron oxides shall not be used because of the risk of thermite sparks (EN 1127–1) | | a b c |

| Item | Material (1) | Material (2) | Requirements | | Footnotes according to Table 1 |
|---|---|---|---|---|---|
| 5 | any of the above | Plastic or rubber coated metal | | - Plastic components shall fulfil the requirements of EN ISO 80079-36. The manufacturer shall give details of the material specification, thermal endurance and electrostatic properties in the technical documentation.<br>Plastic materials for category 2 and category 1 fans shall withstand short-term exposure to flames without burning, when tested according to 4.22.<br>- If the impeller is rubber coated the tip speed shall be limited to 70 m/s. | d e |

| Item | Material (1) | Material (2) | Requirements | | Footnotes according to Table 1 |
|---|---|---|---|---|---|
| 6 | Steel alloys, nickel based alloys, cast iron | Soft brass alloys, copper, plastic or rubber | - Steps shall be taken to ensure that no flying rust particles or flakes can be deposited on surfaces that may come into contact with each other. | | a c d |
| 7 | Aluminium or aluminium alloy | Soft brass alloys, copper, plastic or rubber, aluminium or aluminium alloy | - Paint containing aluminium shall not be used because of the risk of thermite sparks (EN 1127–1).<br>- Paint containing iron oxides shall not be used because of the risk of thermite sparks (EN 1127–1).<br>- Nickel based alloys shall contain a minimum mass fraction 60 % nickel. Nickel based alloys and nickel based steel alloys shall contain a maximum mass fraction of 4 % in total of magnesium, titanium and zirconium. All alloys shall have a homogeneous structure.<br>NOTE 2 Even if these alloys are non-sparking, they can easily form hot spots due to friction and low heat conductivity. | | a c d e |
| 8 | Plastic | Plastic | If the impeller is rubber coated the tip speed shall be limited to 70 m/s. | | d |

### 4.8 Linings and tip extensions

If linings or tip extensions are used, then the material combination shall correspond to one of the pairings specified in 4.7.2.

For linings the minimum thickness is given in Table 3.

**Table 3 — Minimum thickness of linings**

| **Motor power, P** kW | **Thickness for category 1 and 2** mm | | **Thickness for category 3** mm | |
|---|---|---|---|---|
| | **Metallic linings** | **Non-metallic linings** | **Metallic linings** | **Non-metallic linings** |
| $P \leq 11$ | 2 | 3 | 1 | 2 |
| $11 < P \leq 90$ | 3 | 5 | 2 | 4 |
| $90 < P \leq 250$ | 4 | 6 | 3 | 5 |
| 250 < P | 5 | 8 | 4 | 7 |

Tip extensions shall have a length of at least 3 % of the relevant contact diameter, but shall not be smaller than 5 mm in axial or radial direction and need not to be greater than 40 mm.

For category 2 and 1 fans, using rubber or plastic as a tip extension on one/or both of the possible contact surfaces, the distance between any metallic rotating and metallic stationary parts shall never be less than 20 mm.

Linings shall be securely attached to the base material e.g. welded, riveted or vulcanised using compatible materials. Care shall be taken that no galvanic reactions occur between the lining and the base material.

Care shall also be taken in the use of plastics, as these have low heat conductivity, leading relatively easily to hot surfaces. Mechanical or electrostatic sparks may depend on the filler used. Where plastic materials are used they shall comply with the requirements in 4.11.

NOTE 1 See 7.2, Item f) for how these requirements can be met.

NOTE 2 The use of linings may only give protection for a limited time.

NOTE 3 Further information on this topic is contained in CLC/TR 60079–32–1.

Any coating shall consider the nature of fluid handled and/or externally present able to reduce the original characteristics of the material.

The application of coating shall be detailed as a part of the design and quality requirements.

### 4.9 Vibration

The rotating assembly shall have a balance quality grade according to ISO 14694.

The completed fan shall meet the vibration levels recommended in ISO 14694 as appropriate for its size and application (see ISO 14694:2003, 8.3 and 8.4).

The manufacturer shall inform the user of those parts of the fan characteristic curve and the fan's rotational speed which shall not be used. Characteristics can be measured using EN ISO 5801.

Where special methods of installation e.g. specific inlet and outlet ducting connections can effect the degree of vibration, the manufacturer shall include information on acceptable methods of installation in the information for use.

For fans with variable speed drives, any known speeds which may induce resonance shall be identified in the instructions for use.

NOTE 1 Stable operation can be achieved by ensuring that there is a pressure margin between the operating point and the stall point or by means of suitable monitoring methods.

NOTE 2 Manufacturers' performance figures are based on tests to a recognized standard such as EN ISO 5801 and EN ISO 5802. These standards specify ducting, which ensures a uniform velocity profile at the fan inlet.

## 4.10 Earthing conducting parts

The requirements of CLC/TR 60079-32-1 should apply, including equipotential bonding and an assessment of the hazard due to the conveyed atmosphere.

NOTE It is normally sufficient to ground the static parts of the fan. If there is a voltage build-up in the rotating parts, this is sufficiently grounded through metallic antifriction bearings to prevent ignition by electric sparks, but this may lead to premature bearing failure (see Annex B).

## 4.11 Electrostatic charges

The fans shall be designed to eliminate the risk of ignitions due to electrostatic discharges.

The relevant requirements of CLC/TR 60079-32-1 should apply, including equipotential bonding and an assessment of the hazard due to the conveyed atmosphere.

## 4.12 Electrical equipment

All electrical equipment, (i.e. drive motors and any monitoring equipment supplied as part of the fan assembly by the fan manufacturer) shall comply with an equipment category according to EN 60079-0 that is appropriate for the fan it is driving/monitoring and is appropriate for the specific environmental conditions (pressure and temperature) at the place of installation.

Drive motors, or if not supplied by the fan manufacturer, their mounting arrangement, shall be positioned to ensure adequate cooling air is available, that ventilation openings cannot be blocked and the motor’s declared maximum surface temperature cannot be exceeded. If the motor depends on thermal protective devices to prevent its maximum surface temperature being exceeded the instructions for use shall include instructions as to how they shall be connected into the control circuit.

Selection of the fan and electrical equipment associated with it shall take account of the requirements in EN 60079–14:2014, 5.6.

## 4.13 Prevention of deposits inside the fan

Many types of dust, mist and droplets may be in suspension in the air stream. Even small quantities of impurities may in time form layers of combustible or non-combustible material within the fan and adhere to rotating parts. Even normal ambient air may contain sufficient airborne particles to form layers, which may increase the risk of ignition.

Casings shall allow for easy inspection and cleaning as appropriate (see also EN 1127-1).

The impeller and housing shall be of a design that will minimize dust from attaching or settling under normal conditions. In this sense the selection of an appropriate shape of blade is particularly important. Suitable facilities (e.g. easily accessible inspection doors) shall be provided so that inspection and cleaning operations can be easily carried out.

## 4.14 Shaft seals

Sealing elements may be of contact or non-contact type.

For contact type the sealing element contacts permanently the rotating shaft. Sealing material and design shall be suitable according the ignition hazard assessment.

Non-contact seals and seal housings shall comply with 4.4.2 and 4.7.

NOTE 1 If the seal is purged or encapsulated (Type of protection k – see EN ISO 80079-37) and the function of the purge is monitored, deviations from 4.4.2 and 4.7 are acceptable.

These issues should be covered in the ignition hazard assessment.

NOTE 2 Purging can influence the explosive atmosphere within the seal.

## 4.15 Bearings

Bearings shall comply with the requirements of EN ISO 80079-37.

## 4.16 Power transmission systems

Power transmission systems shall comply with the requirements of EN ISO 80079-37.

## 4.17 Clutches and couplings

Clutches and couplings shall comply with the requirements of EN ISO 80079-37.

## 4.18 Brakes and braking systems

Brakes and braking systems shall comply with the requirements of EN ISO 80079-37.

NOTE It is normal practise that fans working in explosive atmospheres do not have mechanical brakes as they create an unnecessary risk.

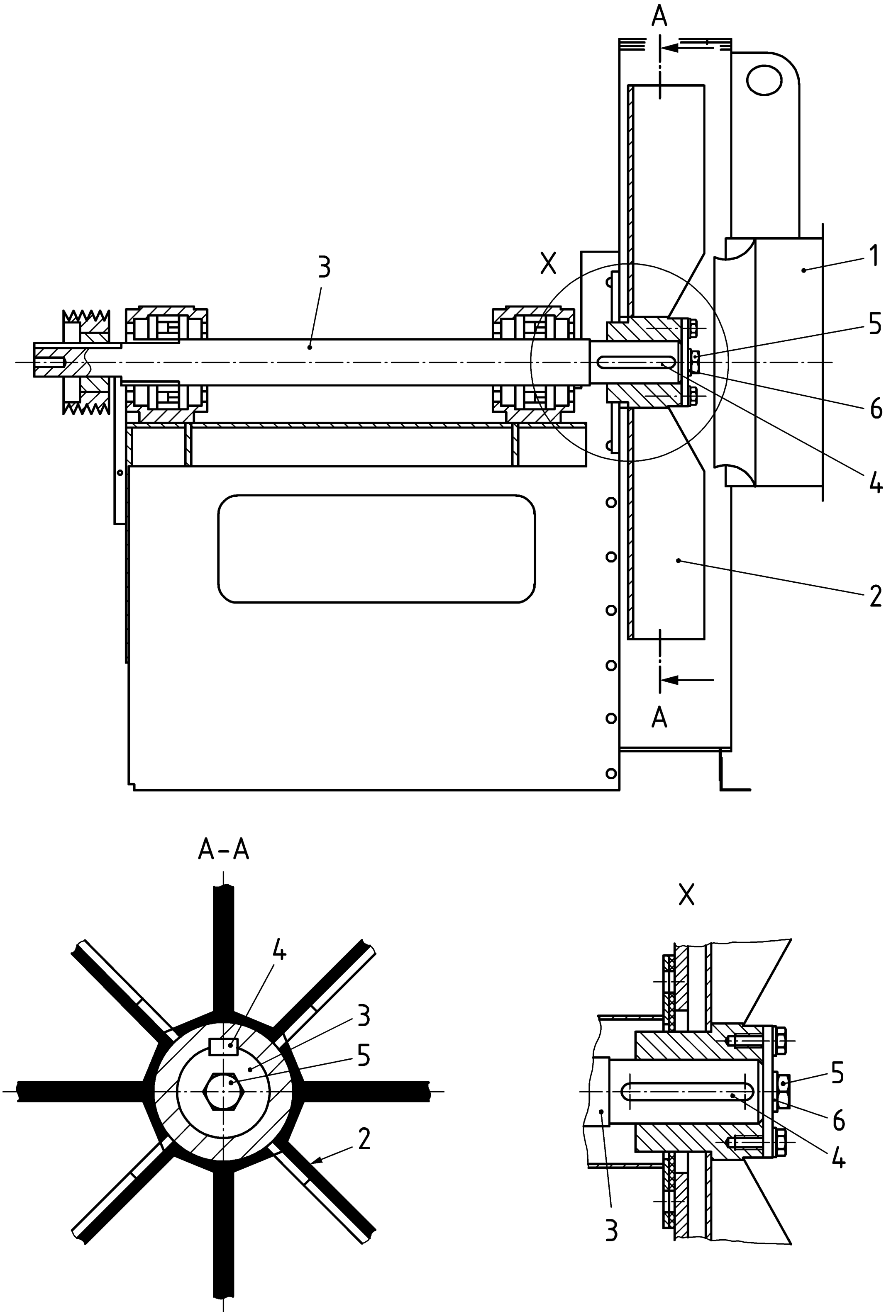
## 4.19 Impeller-shaft attachment

Attachment of the impeller to shaft, if not a single component, shall give a means of both positive location and drive.

The following examples show how this requirement can be fulfilled.

EXAMPLE 1 A simple bush fixed in correct position by means of a lockable or self-locking screw or nut at the shaft end in combination with a parallel key and a shaft with a shoulder. The impeller bush shall locate against the shoulder and be fixed axially by the screw/ nut at the shaft end. Washers may be included to compensate for different shaft end length and to allow clearance adjustment axially.

NOTE 1 This fixing method is considered applicable for heavy duty applications i.e. with large particles in the airflow and/or frequent operation with unbalance. Exchange of the impeller is often difficult. Accurate clearance adjustment is difficult resulting in reduced efficiency / increased power consumption. Change to another motor with a different power output, on direct driven fans, is often not possible with fixed bush types as the motor shaft size often changes with motor power. Furthermore, this type of impeller is not suited for production to stock as motor shaft diameter range is very large and the same impeller will fit several motor sizes.



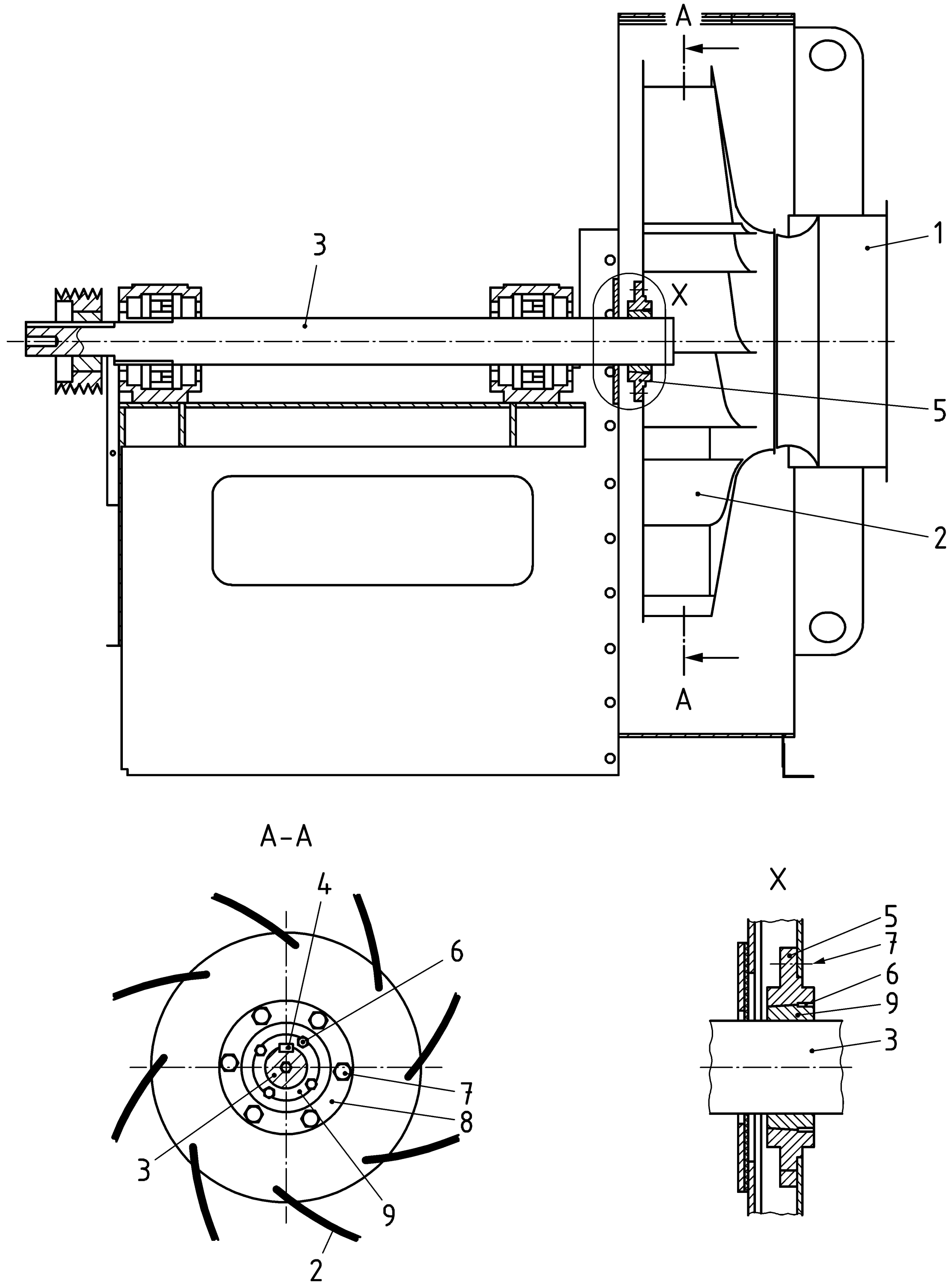

**Key**

| | | | | | |
|---|---|---|---|---|---|
| 1 | fan inlet | 2 | impeller blade | 3 | fan shaft |
| 4 | key (rotational fixation) | 5 | locking screw shaft end | 6 | washer shaft end |

**Figure 1 — Fixed bush**

EXAMPLE 2 An impeller fixed in correct position by means of a taper bush in combination with a parallel key. The impeller bush part of the taper bush shall contain a flange of appropriate diameter for mounting of the impeller to ensure uniform strength of the complete impeller. The manual shall include information on correct torque for screw tightening.

NOTE 2 This fixing method is considered applicable for normal applications. Exchange of the impeller is easy. Accurate clearance adjustment is possible resulting in optimal efficiency / minimized power consumption. Change to another motor power, on direct driven fans, is possible with taper bush types as the inner part of the taper bush can be changed. Further this type of impeller is suited for production to stock as the inner part of the taper bush is selected later when fan shaft diameter is known. The taper lock bush is a clamped joint of two conical parts. By tightening of the screws in the joint area the parts are moved against each other and pretensioned. Forces and torques are transmitted by friction.




**Key**

1 fan inlet
2 impeller blade
3 fan shaft
4 key (rotational fixation)
5 taper bush
6 taper bush locking screws (2 in this example and an un-locking hole)
7 screw for mounting taper bush to impeller (6 in this example)
8 outer part of taper bush
9 inner part of taper bush

**Figure 2 — Taper bush**

### 4.20 Corrosion of fan components

Corrosion of fan components can in several ways lead to an ignition risk.

The materials of construction shall therefore be corrosion protected from the ambient atmosphere and the specified fluid handled, by an appropriate paint or other finish. Galvanic and other chemical reactions between construction materials and the gas shall also be considered. Where dust particles can be present, the possibility of abrasion shall be considered.

### 4.21 Fire resistance

The materials used for the impeller and fan casing shall withstand short-term exposure to flames.

This requirement is met if the components or material samples are only partly destroyed without burning through and without the onset of a self-sustaining combustion when exposed to a (propane) Bunsen burner flame approximately 150 mm long for 30 s without additional air supply. Alternatively the samples or components can be tested according to EN ISO 11925-2 for a period of 30 s

The full procedure of EN ISO 11925-2 is not applicable, because that standard describes a test more appropriate to essentially flat products. Detailed requirements from that test should be followed where practicable.

### 4.22 Protection against foreign particles

Where a fan is intended to be installed with an open inlet or outlet protection shall be provided to prevent ingress of unintended particles or objects which can cause an ignition.

Where a fan is intended to be fitted with inlet ducting as part of a larger system, instructions for use shall make clear that the ingress of particles or objects which can cause ignition shall be prevented in other ways. Normally this would be the responsibility of the installer and/or end user.

## 5 Additional requirements for category 2

### 5.1 General

All the requirements of Clause 4 for category 3 shall be met by category 2 fans (inside and/or outside) with the additions and/or alterations detailed below.

These requirements apply to fans that may be category 2 on the inside, outside or both. The marking and the instructions for use shall specify if the fan is category 2 on the inside, outside or both.

In addition the requirements specified in 5.2, 5.3 and 5.4 shall be applied.

### 5.2 Impeller-shaft attachment

Impeller-shaft attachments shall be designed in a way so that even in the event of expected malfunction no drift can occur and that the joint is secured against loosening.

This can be achieved as shown in the following example:

EXAMPLE For category 2 fans with motor powers in excess of 5,5 kW positive locking is recommended, where the impeller is fixed between a shoulder on the shaft and a locking device or a tapped shaft with locking screw and washer. In this case a parallel key between the impeller hub and shaft should also be fitted. A taper-bushed connection of an impeller to a shaft of a double inlet fan should be located axially by circlips or similar means for motor powers in excess of 5,5 kW.

NOTE A self-locking nut at the shaft end in combination with a parallel shaft and bore is also acceptable provided that the shaft incorporates a shoulder against which the impeller will locate.

### 5.3 Vibration

The requirements in 4.9 shall apply. In addition for Category 2G fans inside, vibration which could lead to contact between the impeller and housing caused by expected malfunctions including those listed in 4.1.3 shall be avoided.

NOTE This can be achieved by vibration monitoring.

In addition for Category 2D fans inside, as the presence of dust can cause imbalance in the impeller, vibration monitoring is mandatory. The alarm and shutdown levels shall meet the requirements of ISO 14694. The manufacturer shall inform the user of those parts of the fan characteristic curve which shall not be used. See also EN ISO 80079-37 for specification of requirements for the control of ignition sources.

### 5.4 Material pairings

4.7.2 also applies to category 2 fans where the gap can be checked.

## 6 Category 1 fans for specific use with a gaseous explosive atmosphere as a conveyed atmosphere (flammable or not)

### 6.1 General requirements

The requirements of this section apply to category 1 G fans (category 1 G with respect to their inlet and outlet connections coming into contact with the conveyed atmosphere). Such fans shall have casings which are explosion-pressure-resistant and the inlet and outlet shall be protected by flame arresters. Where they come into contact with the conveyed atmosphere, such fans shall meet all the requirements for category 2 G fans with the additions and/or alterations detailed below.

The requirements for other parts of the fan depend on the category chosen for these parts.

### 6.2 Flame arresters

#### 6.2.1 General

Fans shall be fitted with either integrated or externally mounted flame arresters.

For construction and materials of flame arresters the requirements of EN ISO 16852:2010, 6.1 to 6.4 shall apply.

Both the integrated and externally mounted flame arresters shall be tested for flame transmission according to Annex A.

#### 6.2.2 Stabilized burning

A risk of stabilized burning exists on the flame arrester located on fan inlet.

The inlet flame arrester shall be tested for short time burning according to EN ISO 16852:2010, 7.3.4 with connected pipe.

Temperature sensors shall be installed to indicate a flame on the flame arrester element and shall comply with EN ISO 16852:2010, 7.3.4.

The integrated temperature sensor shall produce a signal that may be used to activate counter measures within a burning time of 50 % of the manufacturer's specified burning time:

a) switch off the driving motor of the fan and

b) stop the flow of the flammable atmosphere (e.g. by closing a valve upstream of the fan, by-passing, sufficient diluting or inerting are measures equivalent to stop the flow).

### 6.3 Casings

#### 6.3.1 General

The casing shall be explosion-pressure-resistant. This requirement is fulfilled if the casing shows no permanent deformation after the flame transmission test according to Annex A.

In addition all fans shall be routinely tested by the manufacturer in accordance with A.3.

#### 6.3.2 Gas tightness

A pressure test to verify air tightness shall be carried out according with EN ISO 13349:2010 category E, with the inlet, outlet and shaft seals blanked off. No measurable leaks are allowed.

## 7 Information for use

### 7.1 General

In addition to the information required by EN ISO 80079-36 the following additional information shall be supplied:

a) information on how to connect any monitoring devices into the motor control circuit;

b) where appropriate information on the leakage rates;

c) special lifting points if required.

### 7.2 Accompanying documentation

Further to the general requirements specified above, the supplier shall furnish his customer with the following documents:

a) **Shipping instructions.** In some cases this shall include recommendations on special lifting arrangements designed to minimize equipment distortion.

b) **Storage instructions.** Special instructions associated with equipment storage.

c) **Fan erection and commissioning manual.** This shall be comprehensive and detail all the stages involved in installing the fan correctly. The manual shall at least cover the following topics/rubrics where appropriate:

   1) general installation notes and information;

   2) checks prior to installation;

   3) information on the maximum loads that should be transmitted from connecting ductwork to the fan, to avoid distortion of the fan casing, and if flexible couplings are required;

   4) erection procedure (including bonding/earthing);

   5) commissioning checks;

   6) table of recommended bolt tightening torques;

   7) information and instruction related to additional items fitted to the fan;

8) minimum and maximum air flow rates which are required to maintain the maximum surface temperature rating;

9) specific information to ensure the required clearance for material pairings according to 4.7.2.

A description of the procedure to ensure the required clearance is maintained where the user should do this during the commissioning and the service life of the fan.

The manual shall contain a series of forms specifically designed to focus the installer/end user attention towards key items. These forms should form the basis of a check sheet quality system and should insist that the erection-team measure and record key dimensions to allow a direct comparison with the design requirements.

d) **Operation and maintenance manual.** This shall be comprehensive and detail all the stages involved in operating and maintaining the fan. The manual shall at least cover the following categories where appropriate:

1) performance data, including the recommended replacement interval of the bearings and seals;

2) detail description;

3) health and safety;

4) operation of the fan;

5) maintenance, including preventative and corrective;

6) fault finding and rectification;

7) sub-suppliers information;

8) fan application category (BV-1 to BV-5) according to ISO 14694, considering the vibration level (see 4.9);

9) information whether the fan casing is substantially leak-proof;

10) specific information to ensure the required clearance for material pairings according to 4.7.2.

e) **Particle limitations.** The fan manufacturer shall inform the user of any limitations with regard to the ingress of foreign particles.

f) **Routine inspections, service and cleaning.** The operation and maintenance manual shall inform the user that the ignition minimizing properties of fans and fan accessories can only be retained if routine inspections, services and cleaning are carried out. The manual shall at least address the following:

1) it shall request that the intervals between routine inspections shall be chosen to take the specific operating conditions into account. For example, the time between inspection may need to be reduced if the fan is exposed to dust and corrosive atmospheres. Unexpected noise, temperatures and vibrations should especially be taken into account. Due to the appearance of noticeable problems the fan shall be taken out of service and inspected;

2) it shall contain a list of recommended spare parts together with the necessary service information and recommended intervals of (visual) inspection;

3) it shall inform that special care shall be devoted to wear and tear of components such as bearings, belts in belt drives and flexible joints. Correct tension in a belt drive shall be checked, to avoid slippage, or excessive forces on the driven parts;

4) it shall request that fan blades shall be inspected for damage which could cause the moving parts to become unbalanced;

5) it shall request that, where the fan has different categories inside and out, seals forming part of the casing shall be inspected for damage, and replaced if necessary;

6) it shall request that installed monitoring devices (such as temperature, vibration and bearing temperature monitoring systems or similar devices) shall be checked regularly, thereby allowing to do this in accordance with a user's plan if this has shown the need for more frequent checks. The required maintenance checks may depend on local operating conditions;

7) it shall request regular cleaning operations at appropriate intervals in all applications, where non combustable or conbustable dust may be expected to form layers on surfaces of the fan proper and its components.

## 7.3 Markings

The marking shall be according to EN ISO 80079-36.

Additionally the nameplate shall include the following fan details:

a) rating information (casing pressure and temperature), where applicable;

b) maximum inlet temperature taking into account temperature of conveyed atmosphere (flammable or not);

c) for variable speed fans, the speed according to 4.3.3.

# Annex A
(normative)

# Additional requirements for category 1 G fans

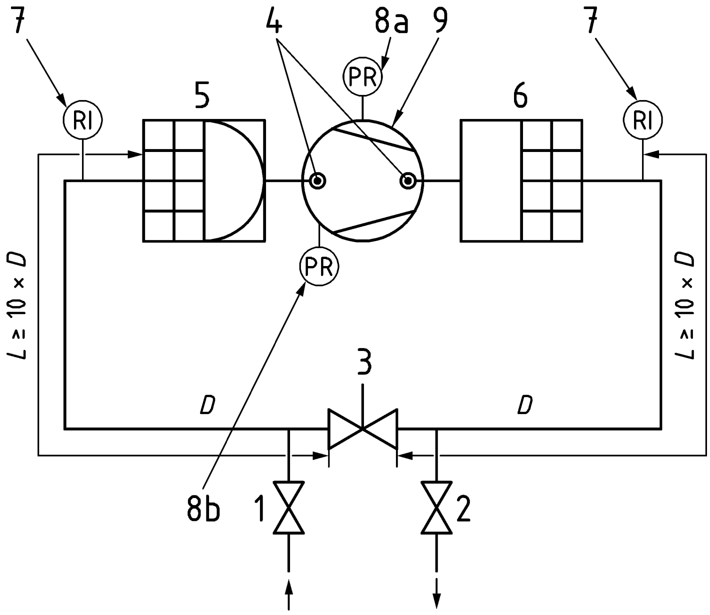
## A.1 General

In addition to meeting the requirements for category 2 G fans, category 1 G fans shall meet the requirements in this annex.

The flame transmission test according to A.2 is a type test. The pressure test according to A.3 is a routine test (to be carried out on all samples manufactured).

## A.2 Flame transmission test

The fan with externally mounted or integrated flame arrester shall be tested in accordance with the following test procedure. The test apparatus is shown in Figure A.1.




**Key**

1 mixture inlet
2 mixture outlet
3 throttling valve
4 ignition positions
5 inlet flame arrester
6 outlet flame arrester
7 flame detector (RI)
8a pressure transducer – operational pressure (PR)
8b pressure transducer – explosion pressure (PR)
9 equipment to be tested

**Figure A.1 — Test apparatus for the flame transmission test**

The nominal duct diameter *D* shall not be larger than the diameter of the flame arrester connection.

Ignition devices shall be provided at the inlet and the outlet of the fan as near as possible to the moving parts.

The test shall be carried out with gas/air test mixtures as specified in EN ISO 16852:2010, 6.8.2.

The following twelve tests shall be carried out at maximum rotational speed of the fan, allowing the mixture to circulate by opening the throttle valve.

The test apparatus shall be filled with the gas/air mixture until the maximum permissible pressure is achieved in the fan's suction socket.

Then the mixture supply shall be disconnected and it shall be ignited.

The following tests shall be carried out, with every test being done for each case with ignition in the suction socket and ignition in the outlet socket:

— Three tests with throttle valve fully opened, mixture temperature and fan being warmed up that the temperature profile in the fan is steady (steady-state condition with 60 °C or the maximum allowed temperature given by the manufacturer at the inlet as a general rule), maximum gas temperature measured in the outlet socket;

— Three tests with throttle valve closed so far (ca. 80 %) so that the maximum permissible pressure rise is achieved in the fan, but a sufficient air flow is remaining to avoid overheating of the fan, mixture temperature and fan being warmed up that the temperature profile in the fan is steady (steady-state condition with 60 °C at the inlet as a general rule), maximum gas temperature measured in the outlet socket.

Additional the following six tests shall be carried out on a stationary fan.

The test apparatus shall be filled with the gas/air mixture until the maximum permissible pressure is achieved in the fan's suction socket. The fan and the gas mixture shall have the actual ambient temperature.

Then the mixture supply shall be disconnected and it shall be ignited.

This test shall be carried out three times with every test being done for each case with ignition in the suction socket and ignition in the outlet socket.

No flame transmission shall occur in the inlet or exhaust sections in any of the eighteen tests to be carried out.

## A.3 Pressure test

Fans with integrated flame arresters shall be tested as a complete unit with connected flame arrester elements.

Fans with externally mounted flame arresters shall be tested as a complete unit with connected flame arrester, or without the flame arrester. If the fan is tested without the flame arrester then the flame arrester which is intended to be mounted on the fan shall be tested in accordance with EN ISO 16852.

The test shall be done on the casing which may or may not contain the impeller/shaft components.

The inlet and outlet and all other joints and gaps of the fan enclosure shall be closed by blanking plates or in another way. Pressure testing of fan enclosures shall be carried out with water or other suitable liquid for not less than 3 min. The maximum test pressure shall be 1,25 times of the maximum explosion pressure measured during type tests but not less than 10 times of the maximum operation pressure at the outlet (the pressure which is in total the maximum absolute pressure in the inlet of 1,1 bar plus the nominal pressure rise up).

NOTE See EN 14460 for this information.

No permanent deformation and no leakage shall occur during the test.

# Annex B
(informative)

## Classification of requirements for the different categories

**Table B.1 — Classification of requirements for the different categories**

| **Property** | | **Cat 3** | **Cat 2** | **Cat 1** |
|---|---|---|---|---|
| **Design** | | | | |
| **General** | Rigid design (4.5.1) | x | x | x |
| | Securely fixed position of all moving parts (4.4.1) | x | x | x |
| | Minimum clearance between rotating elements and the fan casing (4.4.2) | x | x | x |
| **Casing** | Rigid design of the fan casing (4.5.1) | x | x | x |
| | Gas tightness<br>- Information to the user (4.5.2) | x | x | x |
| | Gas tightness<br>- EN ISO 13349:2010; Cat E (6.2.2) | | | x |
| | explosion-pressure-resistant casing (6.1)<br>- Test acc. to Annex A (6.2.1)<br>- Routine test acc. to A3 (6.2.1) | | | x |
| **Impellers (4.6)** | 15 % more than the max. operational rotation speed for 60 s | x | x | x |
| | Or: Primary stress calculation based on 2/3 of the yield stress | x | x | x |
| **Material pairings (4.7)** | | | | |
| **General (4.7.1)** | Minimization of potential areas of contact, which can lead to friction, sparks or hot surfaces as result of foreseeable or rare malfunctions | x | x | x |

| Property | | Cat 3 | Cat 2 | Cat 1 |
|---|---|---|---|---|
| **Design** | | | | |
| | If it is possible to check the minimum gap than explanations in the information for use are necessary | x | x | x |
| | Material requirements acc. to Table 1 or Table 2 | (x) only if there are no possibilities to check the minimum gaps | X (5.4) | X (5.4) |
| | All alloys except aluminium alloys shall contain not more than a mass fraction of 15 % aluminium | x | x | x |
| | Paints and coatings shall contain not more than a mass fraction of 10 % aluminium | x | x | x |
| **Linings and tip extensions (4.8)** | | x | x | x |
| **Vibrations (4.9)** | | | | |
| | ISO 14694 | x | x | x |
| | Information to the user about those parts of the fan characteristic curve and the fan's rotational speed which shall not be used | x | x | x |
| | Information for use shall include installation requirements resonance conditions | x | x | x |
| | **Vibration which could lead to contact between the impeller and housing caused by expected malfunctions shall be avoided (5.3)** | | x | x |
| | **Cat 2D: Vibration monitoring -** ISO 14694, EN ISO 80079-37 | | x | ––– |

| **Property** | | **Cat 3** | **Cat 2** | **Cat 1** |
|---|---|---|---|---|
| **Design** | | | | |
| **Earthing conducting parts (4.10)** | | x | x | x |
| **Electrostatic charges (4.11)**<br>CLC/TR 60079–32–1 | | x | x | x |
| **Electrical equipment (4.12)** | | | | |
| | Drive motors and any monitoring equipment supplied as part of the fan assembly: EN 60079–0 acc. to Category | Gc | Gb | Ga |
| | Mounting arrangement of drive motors:<br>- Adequate cooling<br>- Not exceeding of maximum surface temperature | x | x | x |
| | Instructions how thermal protective devices shall be connected into the control circuit | x | x | x |
| **Prevention of deposits inside the fan (4.13)** | | x | x | x |
| **Shaft seals (4.14)** | | | | |
| | Contact type seals<br>- ignition hazard assessment | x | x | x |
| | Non-contact seals<br>- 4.4.2 and 4.7<br>- ignition hazard assessment | x | x | x |
| **Bearings (4.15), Power transmission systems (4.16), Clutches and couplings (4.17), Brakes and braking systems (4.18)** | | | | |
| | EN ISO 80079-37 | x | x | x |
| **Impeller-shaft attachment (4.19)** | | | | |
| | No drift and guard against loosening | x | x | x |
| | No drift and guard against loosening in the event of expected malfunction (5.2) | | x | x |

| **Property** | | **Cat 3** | **Cat 2** | **Cat 1** |
|---|---|---|---|---|
| **Design** | | | | |
| **Corrosion (4.20)** | | | | |
| | Resistance against corrosion from the ambient atmosphere and the specified fluid handled | x | x | x |
| **Fire resistance (4.21)** | | | | |
| | 30 s test or EN ISO 11925-2 | x | x | x |
| **Protection against foreign particles (4.22)** | | | | |
| | protection for open inlet or outlet<br>or<br>if the inlet is fitted to a larger system - > Information for use | x | x | x |
| **Flame arresters (6.2)** | | | | |
| | EN ISO 16852:2010 Construction and materials (6.2.1)<br>- stabilized burning (6.2.2) | | | x |
| | Testing acc. to Annex A | | | x |
| **Information for use** | | | | |
| | Information on the maximum loads that should be transmitted from connecting ductwork to the fan, to avoid distortion of the fan casing | x | x | x |

# Annex C
(informative)

# Checklist for verification of the safety requirements and/or protective measures

## C.1 General

The following checklists (see C.2 to C.4) are provided to help manufacturers check that they have complied with all relevant parts of this European Standard.

## C.2 All categories

a) Temperature limitations, see 4.3.

b) Impact test (moving parts contact with casing), see EN ISO 80079-36.

c) Casing tightness, see 4.5.

d) Impellers, see 4.6.

e) Permissible material pairings, see 4.7.

f) Limitation of vibration, see 4.8.

g) Prevention of deposits or layers inside fan casings and on the surface of motors, see 4.13, and easy inspection and cleaning of casing, see also EN 1127-1.

h) Clearance between rotating elements and fan casing, see 4.4.2.

NOTE Centrifugal fans in arrangements 3–6–7–11–14–17–18–19 of EN ISO 13349:2010, Tables 4 and 5 (impeller mounted on shaft running in bearings on each side of casing) handling hot gases, which are erected in cold conditions, will produce in operation an axial movement of the wheel from the fixed bearing to the free bearing due to shaft elongation. This is important when gaps are fixed in cold conditions.

i) Shaft seals, see 4.14.

j) Bearings, see 4.15.

k) Power transmissions, clutches, brakes and couplings, see 4.16, 4.17 and 4.18.

l) Impeller-shaft attachment see 4.19.

m) Belt drives, see 7.2 f), item 3).

n) Corrosion, see 4.20.

o) Fire resistance, see 4.21.

p) Protection against foreign particles, see 4.22.

q) Electrical installation, see EN 60079-14.

r) Motors and other electrical equipment, including adequate cooling air for the motor and suitable ventilation openings, see 4.12, for the relevant category.

s) Electrostatic charges, see 4.11.

## C.3 Category 2 – Gas and dust

a) Documentation, see Clause 7.

b) Casings, shaft and bearings, see Clause 5.

c) Belt drives, see 7.2 f), item 3).

d) Gas tightness, see 4.5.2.

## C.4 Category 1 – Gas

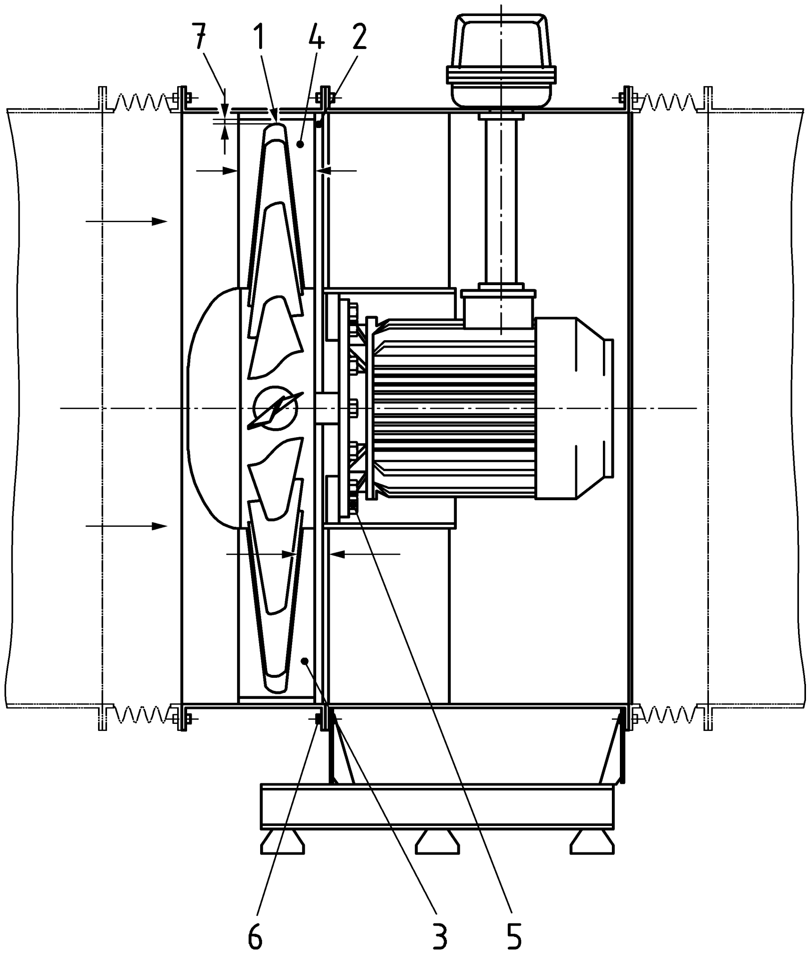
In addition to C.2 and C.3:

a) flame arresters, see 6.2 and Annex A;

b) casings, see 6.3.

# Annex D
(informative)

## Examples of types of fans showing ignition minimizing features




**Key**

1 blade tips

2 hub to internal circular motor support housing running clearance. Potential rubbing (spark-generating) zone

3 blade operating clearance to fan internal motor support struts. Potential spark-generating zone

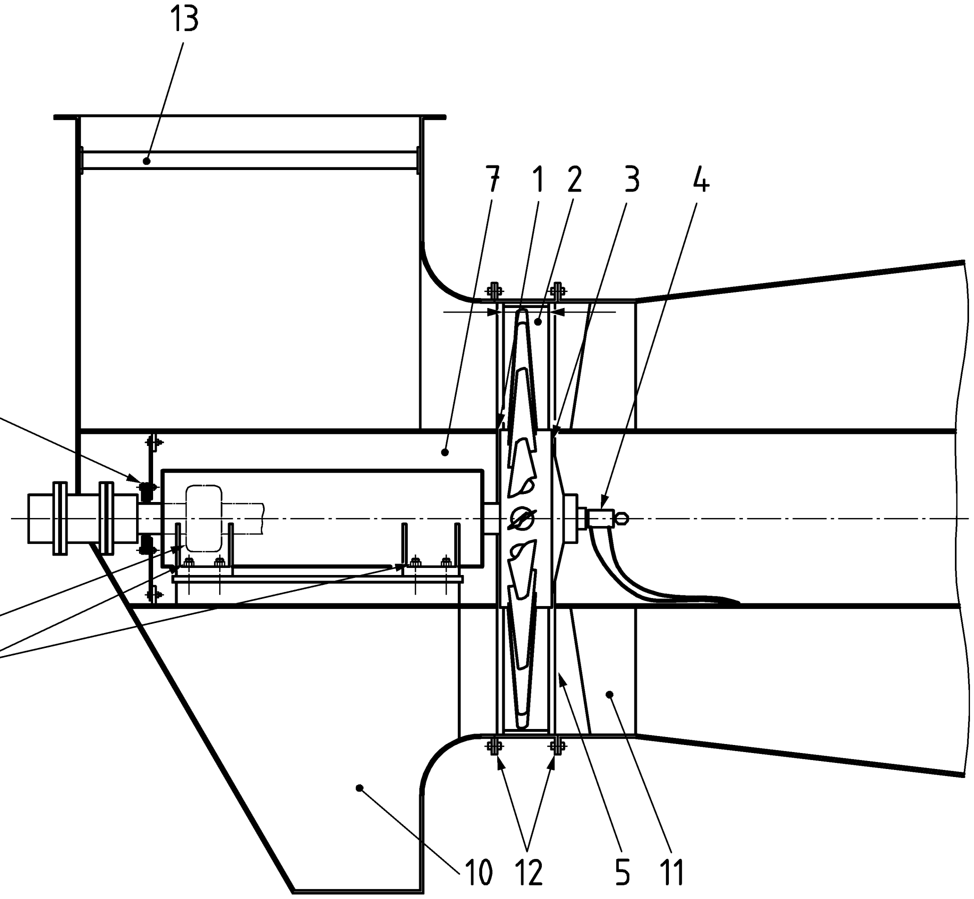
4 internal anti-sparking impeller housing liner shown wider than the blade axial tip dimension (category 2 only)

5 motor spigot located on mounting flange plus fasteners adequately torqued and mechanically locked

6 impeller housing should be securely fastened to the upstream and downstream casings with fasteners adequately torqued. In addition dowels are provided to prevent movement and to ensure repeatability of its positional datum

7 clearance between impellor and casing

**Figure D.1 — Axial fan with fixed pitch blades and ducted inlet for categories 2 and 3**




**Key**

1 impeller hub to casing axial running clearance (inlet side)

2 impeller hub to casing axial running clearance (discharge side)

3 anti-spark liner fitted internally to the impeller blade housing

4 rubbing (hot-spot) potential at the rotating union on the impeller hub

5 rubbing (spark generating) potential between the blades and the downstream guide vanes. Adequate clearance should be provided

6 rubbing (hot-spot) potential between the shaft seal and the main fan rotor shaft

7 rubbing (hot-spot) potential between the impeller hub and the rotor-bearing unit

8 bearing unit fasteners adequately torqued and mechanically locked. Bearing housing bracket to casing support plinth should also be fitted with dowels

9 precautions to be taken at the rotor guide or thrust bearing to ensure that the axial position of the rotor is adequately controlled

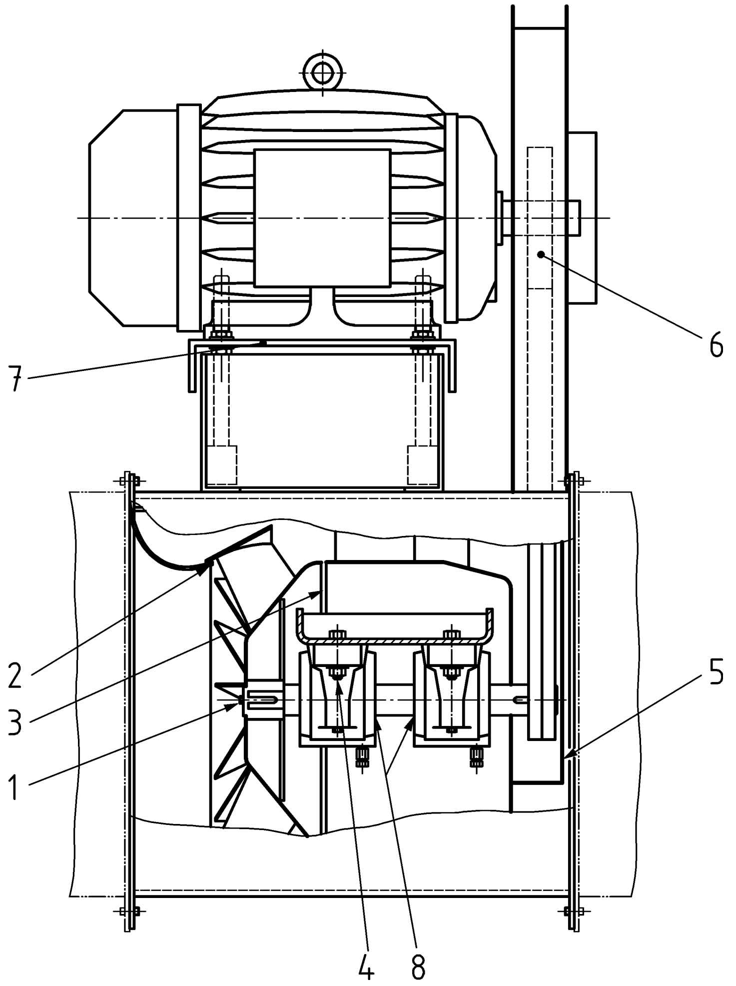
10 rubbing potential between the upstream bearing support struts and or inlet guide vanes. Adequate clearance should be provided

11 down stream guide vanes

12 impeller housing should be securely fastened to the upstream and downstream casings with fasteners adequately torqued. In addition dowels are provided to prevent movement and to ensure repeatability of its positional datum

13 any upstream cross-duct stiffeners should be adequately stiff to prevent damaging vibrations resulting from fluid flow. In addition particular attention should be paid to how they are connected at the duct wall to ensure a high integrity connection is achieved

**Figure D.2 — Axial fan with variable pitch in-motion ducted inlet-box arrangement**




**Key**

1 impeller positively locked on the fan shaft

2 rubbing potential between the inlet flow-guide and the impeller. Shown here with an ignition minimizing brass tip on the flow-guide

3 rubbing potential between the impeller and the central down-stream flow guide. Shown here with an ignition minimizing strip mounted on the static component

4 rotor bearings secured with adequately torqued fasteners. Fasteners to be mechanically locked and where possible dowels used to prevent rotor misalignment. Where it is impractical to fit dowels due to space restrictions then attention needs to be given to the bolt clearance in the bearing housings and support plate

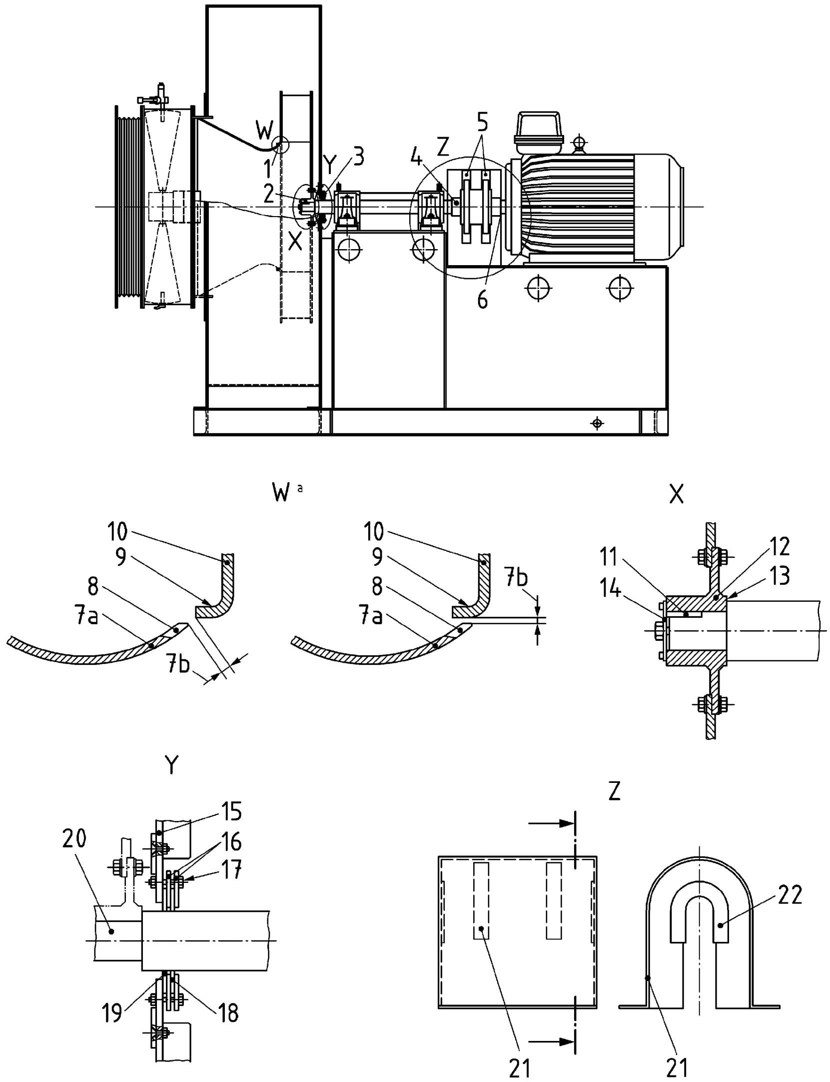
5 belt cover to be manufactured from ignition minimizing material such as brass or lined with anti-sparking material

6 the belt guard to be manufactured or lined with ignition minimizing material

7 the motor feet should be secured with fasteners adequately torqued together with a mechanical locking feature. If possible the motor is to doweled in position to restrict potential movement

8 attention to be given to spark minimizing features at the bearing shaft seals

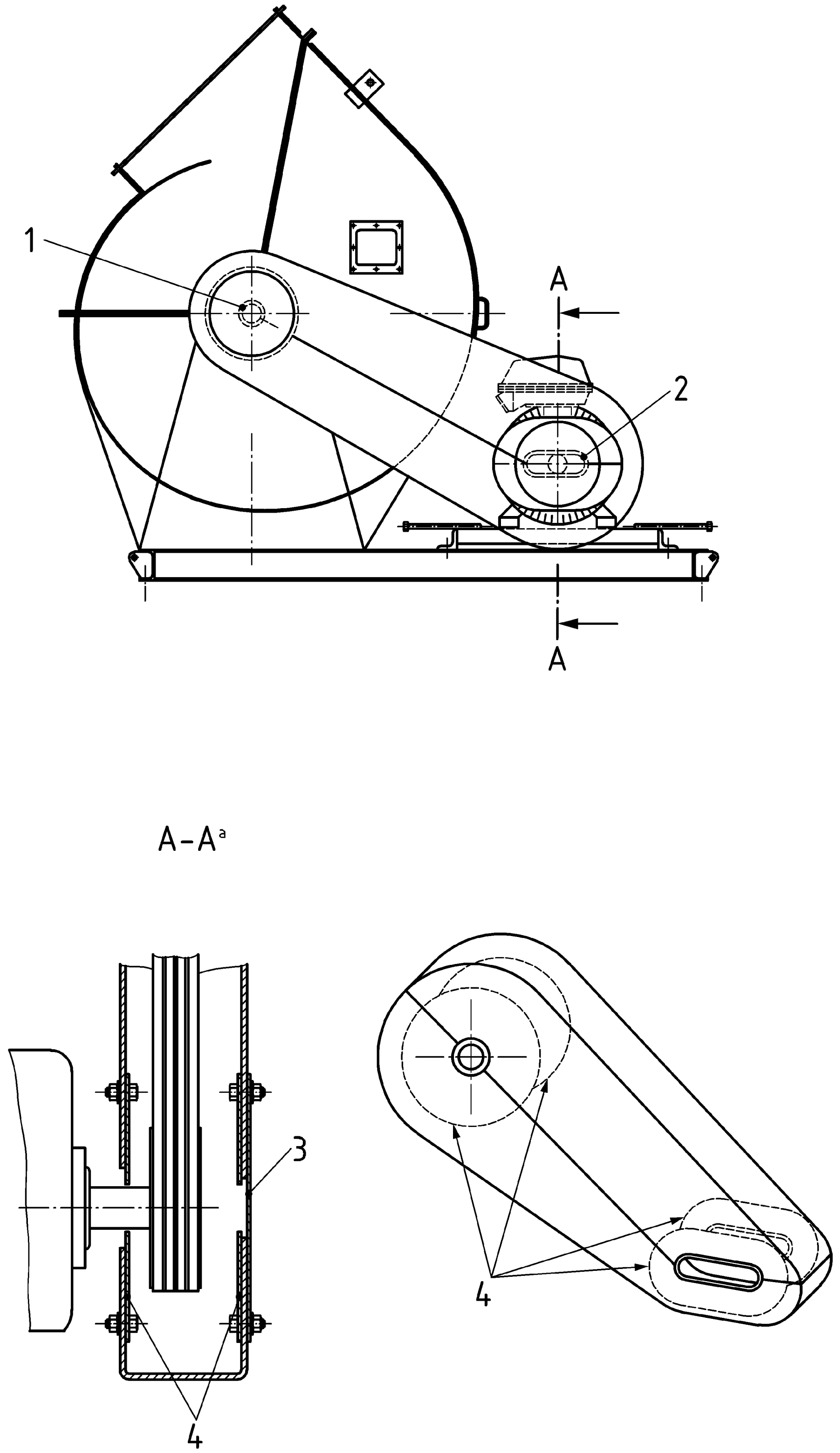
**Figure D.3 —Mixed flow belt driven ducted fan**




**Key**

1 rubbing (spark-generating) potential between the inlet flow-guide and the impeller
2 impeller connection
3 shaft to casing seal zone
4 bearing shaft zone
5 coupling guard anti-sparking feature
6 motor shaft zone
7a impeller upstream inlet flow guide
7b clearance between impeller and stationary housing
8 tip extension – anti-sparking feature on the inlet flow guide; e.g. copper insert
9 impeller inlet ring
10 impeller side plate or shroud
11 impeller hub keyed to the shaft
12 impeller shaft connection hub
13 shoulder on shaft to positively locate the impeller hub
14 impeller locking device
15 fan discharge casing
16 shaft seal plates manufactured from anti-sparking material, for example copper
17 seal retaining fasteners
18 shaft to casing sealing elements manufactured from non-sparking material for example thin pressure vessel fibrous gasket material, carbon etc.
19 ample running clearance provided between the casing sidewall and the shaft
20 impeller hub
21 internal anti spark strip positioned to align with the outside diameter of the drive coupling flange (two required with spacer type couplings)
22 anti spark copper end plates to be fitted to provide a minimum of 3 mm extension from the carbon steel

**Figure D.4 — Centrifugal fan - ducted arrangement**




**Key**

1 shaft penetration at fan

2 shaft penetration at motor

3 cover plate fitted to outside of fan drive belt guard

4 internal surfaces, in way of drive pulleys, fitted with an anti-sparking material such as copper

**Figure D.5 — Typical fan drive belt guard details**

# Annex E
(normative)

## List of significant hazards

This clause contains most of the significant hazards, hazardous situations and events, as far as they are dealt with in this European Standard, identified by risk assessment as significant for this type of machinery and which require action to eliminate or reduce the risk. When carrying out the risk assessment the designer, manufacturer or supplier, will have to check whether the list of hazards is complete and applicable with respect to the particular fan.

In accordance with EN ISO 12100 and EN 1127-1 the following points shall be considered:

a) that the equipment shall be appropriate to the intended mechanical and thermal stresses and capable of withstanding attack by existing or foreseeable aggressive substances;

b) that any misuse, which can reasonably be expected, is taken into account;

c) that safe operation throughout the foreseeable lifetime shall be possible;

d) that foreseeable conditions of overload or deviations from the intended operation shall not give rise to dangerous situations;

e) that the ignition hazard may be considerably increased if the temperature of the fluid is higher than + 60 °C, if the oxygen content is higher than a volume fraction of 21 % or if the absolute pressure is higher than 1,1 bar (under such conditions the list of hazards shall be checked and/or revised, as the measures listed below may be insufficient);

f) that fans may be of very different design, as axial fans, mixed flow fans, centrifugal fans, roof fans or window fans. They may come in a large variety of sizes, cast or made of plate of different thickness, with different impeller speeds, absorbed power, pressure difference to the surroundings, construction material, direct or indirect drives, different prime movers, manufacturing methods. It shall be checked if all hazards are listed here or if additional hazards may require additional protective methods for the specific fan concerned.

Hazards, which will exist for most fans within the scope of this European Standard, are listed in Table E.1.

NOTE For other hazards see also prEN 14461.

**Table E.1 — Identification of hazards and required countermeasures**

| No. | Potential ignition source | Clause or annex | Measures applied to prevent the source becoming effective |
|---|---|---|---|
| 1 | **All categories** | | |
| 1.1 | Transportation damage | **7.2** | Manufacturer's instructions for transport |
| 1.2 | Storage damage | **7.2** | Manufacturer's instructions for storage |
| 1.3 | General environmental influences | **7.2** | Manufacturer's instructions for erection concerning:<br>a) Environmental temperatures (Comment: Special requirements may apply for electric components if they can become exposed to temperatures in access of 40 °C)<br>b) Environmental humidity (Comment: Especially for electric components)<br>c) Environmental pollution<br>d) Environmental corrosivity<br>e) Nature of conveyed atmosphere including electrostatic charges hazard |
| 2 | **Category 3 G and 3 D**<br>(Hazards and measures in order to reach a normal level of protection) | | |
| 2.1 | Explosive atmosphere with low ignition temperature due to dust deposits forming clouds or thick layers | **7.2** | Manufacturers instruction concerning inspection, cleaning<br>Limitation of dust quantities<br>Easy inspection |
| 2.2 | Bridging of gap between static and moving components due to sticky dust or other non-metallic material | **7.2** | Maintenance instructions |
| 2.3 | Excessive fluid temperature | **4.3** | Inlet temperature and heating limitation of the gas handled |
| 2.4 | Contact between static and moving components caused by housing deformation | **4.4**<br>**4.5** | Rigid housing design and separation of ductwork by flexible joints |
| 2.5 | Contact between static and moving components caused by impeller deformation or fault | **4.6** | Rigid impeller design |
| 2.6 | Contact between static and moving components caused by | **4.19** | Select acceptable impeller-shaft attachment |

| No. | Potential ignition source | Clause or annex | Measures applied to prevent the source becoming effective |
|---|---|---|---|
| | loosening impellers | | |
| 2.7 | Contact between static and moving components caused by foreseeable misalignment and wear and tear | **4.4.2**<br>**4.7**<br>**4.8** | Minimum clearance<br>Suitable material pairings<br>Suitable linings and tip extensions |
| | Contact between casing and moving parts caused by closing of inlet ducting, and distortion of casing by reduced internal pressure | **4.4.1** | Testing with blanked inlet at full speed |
| 2.8 | Contact between static and moving components due to shafts gliding in bearings | **4.15** | Shaft fixation in bearing |
| 2.9 | Bearing failure | **4.15** | Bearing specification and recommended lifetime (replacement interval) |
| 2.10 | Seal failure | **4.14** | Shaft seal friction |
| | | **4.11** | Shaft seal charging |
| 2.11 | Weakening of materials and bridging of gaps due to corrosion | **4.20** | Corrosion protection |
| 2.12 | Electrostatic discharges in connection with belts | **4.11** | Belt drive requirements |
| 2.13 | Contact between rotating and static fan parts caused by predictable loss of gap caused by creeping materials | **4.7.1** | Material pairings |
| 2.14 | Contact between rotating and static components caused by thermal deformation | **4.4**<br>**4.7.1**<br>**4.6**<br>**4.7** | Rigid house design<br>Suitable materials<br>Rigid impeller design<br>Material pairings |
| 2.15 | Mechanical faults and fatigue, non-acceptable vibration | **4.9**<br>**4.13** | Vibration control<br>Prevention against dust layers |
| 2.16 | Contact with foreign particles | **4.22**<br>**4.7.1** | Protection against foreign particles<br>Material pairings |
| 2.17 | Electrical parts | **4.12** | Electric installation |

| No. | Potential ignition source | Clause or annex | Measures applied to prevent the source becoming effective |
|---|---|---|---|
| | | **4.12** | Electric equipment |
| 2.18 | Electrostatic ignition | **4.11** | Electrostatic discharges |
| 2.19 | Burning of fan components and smoke poisoning | **4.21** | Fire resistance of plastic |
| 2.20 | Different electrical potential | **4.10** | Earthing of conducting parts |
| 3 | Category 2 G and 2 D as well as 3 G and 3 D<br>(Hazards and measures in addition to those already listed for all categories and for category 3 G and 3 D [Item 1 and 2] in order to reach a high level of protection) | | |
| 3.1 | Stray or unsymmetrical currents | **no** | See EN 1127-1:2011, 5.5 |
| 3.2 | Lightning | **no** | See EN 1127-1:2011, 5.7 |
| 3.3 | Radio frequency, electromagnetic waves | **no** | See EN 1127-1:2011, 6.4.9 and 6.4.10 |
| 3.4 | Ionising radiation | **no** | See EN 1127-1:2011, 6.4.11 |
| 3.5 | Ultrasonic | **no** | See EN 1127-1:2011, 6.4.12 |
| 3.6 | Adiabatic compression and shock waves | **no** | See EN 1127-1:2011, 6.4.13 |
| 3.7 | Exothermic reactions | **no** | See EN 1127-1:2011, 6.4.14 |
| 4 | Category 1 G<br>(Hazards and measures in order to reach a very high level of protection. In addition to the hazards and methods referred to for all categories and categories 3 G, 3 D, 2 G, 2D [Items 1, 2 and 3] | | |
| 4.1 | Internal fire or explosion due to rare and unlikely ignition process. Spreading of fire or an explosion inside the fan to the outside environment | **6.1, 6.3 and A.1** | Explosion resistant casing to contain an internal explosion. No elastic connection to ducts. |
| 4.2 | Spreading a fire or an explosion inside the fan along supply or exhaust ducts | **6.2 and A.2** | Flame arresters with short time stabilised burning function as an integral part of the fan at both inlet and outlet side of the fan able to contain the fire or explosion |

# Annex ZA
# (informative)

## Relationship between this European Standard and the essential requirements of Directive 2014/34/EU aimed to be covered

This European Standard has been prepared under a Commission's standardization request M/BC/CEN/92/46 to provide one voluntary means of conforming to essential requirements of Directive 2014/34/EU "Directive 2014/34/EU Of The European Parliament And Of The Council of 26 February 2014 on the harmonisation of the laws of the Member States relating to equipment and protective systems intended for use in potentially explosive atmospheres (recast)".

Once this standard is cited in the Official Journal of the European Union under that Directive compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

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

| **Essential Requirements of Directive 2014/34/EU** | **Clause(s)/sub-clause(s) of this EN** | **Remarks/Notes** |
|---|---|---|
| all requirements are covered | all clauses | |

**WARNING 1** — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

**WARNING 2** — Other Union legislation may be applicable to the product(s) falling within the scope of this standard.

# Bibliography

[1] EN ISO 13857, *Safety of machinery - Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857)*

[2] EN 1710, *Equipment and components intended for use in potentially explosive atmospheres in underground mines*

[3] EN 1755, *Industrial Trucks - Safety requirements and verification - Supplementary requirements for operation in potentially explosive atmospheres*

[4] EN 1652, *Copper and copper alloys - Plate, sheet, strip and circles for general purposes*

[5] EN 13237, *Potentially explosive atmospheres - Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

[6] EN 13463-2, *Non-electrical equipment for use in potentially explosive atmospheres - Part 2: Protection by flow restricting enclosure 'fr'*

[7] EN 13463-3, *Non-electrical equipment for use in potentially explosive atmospheres - Part 3: Protection by flameproof enclosure 'd'*

[8] EN 14460, *Explosion resistant equipment*

[9] prEN 14461, *Industrial fans - Safety requirements*

[10] EN 60034-1, *Rotating electrical machines - Part 1: Rating and performance*

[11] EN 60079-1, *Explosive atmospheres — Part 1: Equipment protection by flameproof enclosures 'd'*

[12] EN 60079-2, *Explosive atmospheres — Part 2: Equipment protection by pressurized enclosure 'p'*

[13] EN 60079-5, *Explosive atmospheres — Part 5: Equipment protection by powder filling 'q'*

[14] EN 60079-6, *Explosive atmospheres — Part 6: Equipment protection by liquid immersion 'o'*

[15] EN 60079-7, *Explosive atmospheres — Part 7: Equipment protection by increased safety 'e'*

[16] EN 60079-11, *Explosive atmospheres — Part 11: Equipment protection by intrinsic safety 'i'*

[17] EN 60079-14, *Explosive atmospheres — Part 14: Electrical installations design, selection and erection*

[18] EN 60079-15, *Explosive atmospheres - Part 15: Equipment protection by type of protection 'n'*

[19] EN 60079-18, *Explosive atmospheres — Part 18: Equipment protection by encapsulation 'm'*

[20] EN 60335-2-80, *+6Household and similar electrical appliances - Safety - Part 2-80: Particular requirements for fans*

[21] EN ISO 2409, *Paints and varnishes - Cross-cut test (ISO 2409)*

[22] EN ISO 13351, *Fans - Dimensions (ISO 13351)*

[23] IEC 60167, *Methods of test for the determination of the insulation resistance of solid insulating materials*

[24] ISO 281, *Rolling bearings — Dynamic load ratings and rating life*

[25] 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*

[26] ISO 1925, *Mechanical vibration — Balancing — Vocabulary*

[27] ISO 1940-1, *Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances*

[28] EN ISO 5802, *Industrial fans - Performance testing in situ (ISO 5802)*

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

[30] ISO 14695, *Industrial fans — Method of measurement of fan vibration*

[31] CLC/TR 60079-32-1, *Explosive atmospheres - Part 32-1: Electrostatic Hazards - Guidance (IEC/TS 60079-32-1)*

[31] EUROVENT 1/5, *Prescriptions for spark resistant fan construction (1999)*

[32] EUROVENT 1/8, *Prevention of explosions in fans (1996)*

[33] EUROVENT 1/9, *Guidlines for gas tight fans (2002)*

[34] TRAC 201:1990, *Acetylene developers*[1]

[35] Pollak/Mohr – *Untersuchungen zum Zündrisiko bei Reibvorgängen an Ventilatoren (1987)*

[36] Westphalian Mine Owners Association Fund – *Examination to the ignition risk by grinding by fans (1987)*

[37] Voigtsberger, *Zündfähigkeit von Schleiffunken gegenüber explosiblen Gas- und Dampf-Luft-Gemischen, Arbeitsschutz,* Bundesarbeitsblatt Nr. 6/1955

[38] Grunewald, *Die Zündquelle mechanisch erzeugter Funken, Technische Überwachung*, Springer VDI Verlag, 3/2001

[1] TRAC = Technical Rules Acetylene Installations and Carbide Storages.

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