



BSI Standards Publication

Requirements for design and testing of vacuum cleaners for use in potentially explosive atmospheres

National foreword

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The UK participation in its preparation was entrusted to Technical Committee EXL/23/-/3, Design of fans working in potentially explosive atmospheres.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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© The British Standards Institution 2022
Published by BSI Standards Limited 2022

ISBN 978 0 539 02834 8

ICS 97.080

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2022.

Amendments/corrigenda issued since publication

Date

Text affected

English Version

Requirements for design and testing of vacuum cleaners for use in potentially explosive atmospheres

Exigences relatives à la conception et aux essais des
aspirateurs destinés à être utilisés en atmosphère
explosible

Anforderungen an die Konstruktion und Prüfung von
Staubsaugern zur Verwendung in
explosionsgefährdeten Bereichen

This European Standard was approved by CEN on 20 April 2022.

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European foreword

This document (EN 17348:2022) 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of an identical text or by endorsement, at the latest by November 2022, and conflicting national standards shall be withdrawn at the latest by November 2022.

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 Standardization Request given to CEN by the European Commission and the European Free Trade association and supports essential requirements of EU Directive(s) / Regulation(s).

For relationship with EU Directive(s) / Regulation(s), see informative Annexes ZA and ZB, which are 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.

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Introduction

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

This document is of relevance, in particular, for the following stakeholder groups representing the market players with regard to machinery safety:

- machine manufacturers (small, medium and large enterprises);
- health and safety bodies (regulators, accident prevention organizations, market surveillance, etc.).

Others can be affected by the level of machinery safety achieved with the means of the document by the above-mentioned stakeholder groups:

- machine users/employers (small, medium and large enterprises);
- machine users/employees (e.g. trade unions, organizations for people with special needs);
- service providers, e.g. for maintenance (small, medium and large enterprises);
- consumers (in case of machinery intended for use by consumers).

The machinery concerned and the extent to which hazards, hazardous situations and events are covered, are 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

This document specifies requirements for design, construction, testing and marking of hand-held, portable and transportable vacuum cleaners, including their accessories, constructed to Group II, categories 2G or 3G (of explosion groups IIA, IIB, IIB plus hydrogen), and to Group II, categories 2D or 3D (of explosion groups IIIA, IIIB and IIIC), intended for the collection of combustible or non-combustible dusts and flammable or non-flammable liquids in potentially explosive atmospheres. A potentially explosive atmosphere could be generated by the equipment during its intended use.

NOTE 1 The accumulation of 1 mm or more of combustible dust on surfaces in a working area can create an explosive atmosphere (see reference to 1/32 in. of Depth of Dust Accumulation for Guidance for Area Electrical Classification in NFPA 654, 2017 Edition).

This document applies to equipment driven by electric power and by pneumatic power.

This document gives guidelines for dealing with significant hazards, hazardous situations and/or events relevant to vacuum cleaners when they are used as intended and under conditions of misuse which are reasonably foreseeable by the manufacturer.

Typical applications for the concerned equipment are:

- collection of dust produced by machinery at the point of generation;
- general housekeeping around machinery and of working areas; and/or
- collection of spills;
- cleaning of equipment during maintenance operations; and/or
- collection of specific waste.

For the collection of dust in the presence of flammable liquids or vapours, a specific risk assessment is performed if this is part of the vacuum cleaners intended conditions of use and additional precautions beyond what is described in this document can be required.

NOTE 2 The passage of dust through a vacuum cleaner will generate high levels of electrostatic charge which, in most situations, will be a potential source of ignition to a flammable gas or vapour atmosphere.

For the collection of low-conductivity flammable liquids, a specific risk assessment is performed if this is part of the vacuum cleaners intended conditions of use and additional precautions beyond what is described in this document can be required.

NOTE 3 The resulting liquid velocities are likely to be in excess of the limits required to maintain electrostatic charge generation at a non-hazardous level according to CLC/TR 60079-32-1:2018.

This document does not apply to equipment used to collect toxic dusts where there is a health risk if dust passes through the filter elements. This document does not apply to the collection of dusts which have explosive and unstable properties (UN transport class 1, class 4.1 and class 5.2).

NOTE 4 Hazards related to the use of vacuum cleaners for the collection of hazardous dusts are the subject of other standards.

This document applies to vacuum cleaners with an internal dirty air volume of maximum 250 l.

NOTE 5 250 l is the volume above which it is recognized a vacuum cleaner might not be considered as transportable by an operator, and above which additional explosion protections can be required.

The present version of the document does not apply to battery operated equipment.

NOTE 6 Battery operated equipment might be part of the scope of this document in a subsequent version.

This document does not apply to vacuum trucks.

This document applies to vacuum cleaners of canister and back-pack types. This document does not apply to upright vacuum cleaners.

This document does not apply to motorized cleaning head accessories.

NOTE 7 This document does not apply to household appliances which are the subject of other standards.

This document does not apply to applications where the substances are conveyed into a separate receiving container.

This document does not apply to equipment intended for use in underground parts of mines as well as those parts of surface installations of such mines endangered by firedamp and/or combustible dust.

For an easier readability, all types of equipment concerned by this document are referred as a “vacuum cleaner”.

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.

CEN/TR 16793:2016, *Guide for the selection, application and use of flame arresters*

CLC/TR 60079-32-1:2018, *Explosive atmospheres — Part 32-1: Electrostatic hazards, guidance (IEC TS 60079-32-1:2013, IEC/TS 60079-32-1:2013/A1:2017)*

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

EN 1149-1:2006, *Protective clothing — Electrostatic properties — Part 1: Test method for measurement of surface resistivity*

EN 13237:2012, *Potentially explosive atmospheres — Terms and definitions for equipment and protective systems intended for use in potentially explosive atmospheres*

EN 14797:2006, *Explosion venting devices*

EN 14986:2017, *Design of fans working in potentially explosive atmospheres*

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

EN 60079-31:2014, *Explosive atmospheres — Part 31: Equipment dust ignition protection by enclosure “t” (IEC 60079-31:2013)*

EN 60204-1:2018, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2016, modified)*

EN 60335-1:2012¹, *Household and similar electrical appliances — Safety — Part 1: General requirements (IEC 60335-1:2010, modified)*

¹ As impacted by EN 60335-1:2012/A1:2019, EN 60335-1:2012/A2:2019, EN 60335-1:2012/A11:2014, EN 60335-1:2012/A13:2017, EN 60335-1:2012/A14:2019 and EN 60335-1:2012/A15:2021.

EN IEC 60079-0:2018², *Explosive atmospheres — Part 0: Equipment — General requirements (IEC 60079-0:2017)*

EN ISO 3744:2010, *Acoustics — Determination of sound power levels and sound energy levels of noise sources using sound pressure — Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)*

EN ISO 4126-2:2019, *Safety devices for protection against excessive pressure — Part 2: Bursting disc safety devices (ISO 4126-2:2018)*

EN ISO 4871:2009, *Acoustics — Declaration and verification of noise emission values of machinery and equipment (ISO 4871:1996)*

EN ISO 8031:2020, *Rubber and plastics hoses and hose assemblies — Determination of electrical resistance and conductivity (ISO 8031:2020)*

EN ISO 11201:2010, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions in an essentially free field over a reflecting plane with negligible environmental corrections (ISO 11201:2010)*

EN ISO 11203:2009, *Acoustics — Noise emitted by machinery and equipment — Determination of emission sound pressure levels at a work station and at other specified positions from the sound power level (ISO 11203:1995)*

EN ISO 11688-1:2009, *Acoustics — Recommended practice for the design of low-noise machinery and equipment — Part 1: Planning (ISO/TR 11688-1:1995)*

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

EN ISO 13849-1:2015, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2015)*

EN ISO 13849-2:2012, *Safety of machinery — Safety-related parts of control systems — Part 2: Validation (ISO 13849-2:2012)*

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

EN ISO 20643:2008, *Mechanical vibration — Hand-held and hand-guided machinery. Principles for evaluation of vibration emission (ISO 20643:2005)*

EN ISO 80079-36:2016³, *Explosive atmospheres — Part 36: Non-electrical equipment for explosive atmospheres — Basic method and requirements (ISO 80079-36:2016)*

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

ISO 22883:2004, *Castors and wheels — Requirements for applications up to 1,1 m/s (4 km/h)*

² As impacted by EN IEC 60079-0:2018/AC:2020-02.

³ As impacted by EN ISO 80079-36:2016/AC:2019.

ISO 22884:2004, *Castors and wheels — Requirements for applications over 1,1 m/s (4 km/h) and up to 4,4 m/s (16 km/h)*

ISO 29463-1:2017, *High efficiency filters and filter media for removing particles from air — Part 1: Classification, performance, testing and marking*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 1127-1:2019, EN ISO 12100:2010, EN IEC 60079-0:2018², EN 13237:2012 and EN ISO 80079-36:2016³ and the following apply.

ISO and IEC maintain terminological 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

vacuum cleaner

suction device for the collection of solid debris, dust and liquids

3.2

vacuum cleaner type

type based on the substances the vacuum cleaner is designed to collect

Note 1 to entry: There are three types of vacuum cleaners: “dry type dust collector”, “wet type dust collector” and “liquid collector”.

3.3

dry type dust collector

device designed for the collection of dry dust of all types, combustible or non-combustible, in any mix except where self-heating dust and/or chemical aggressive substances result from the mixing, unless specific exclusions are detailed in the information for use

Note 1 to entry: The dust is collected in a collection bag or directly in the collection tank.

3.4

wet type dust collector

device designed for the collection of dust of all types, combustible or non-combustible, in any mix including where chemical aggressive and/or self-heating substances result from the mixing

Note 1 to entry: The collection device is designed to precipitate the collected dust into a neutralizing liquid.

3.5

liquid collector

device designed for the collection of liquids of all types, flammable or non-flammable, in any mix excluding where self-heating substances result from the mixing

Note 1 to entry: The liquids are collected directly in the collection tank.

3.6

transportable vacuum cleaner

vacuum cleaner not intended to be carried by a person nor intended for fixed installation and which can be moved when energized

3.7

portable vacuum cleaner

vacuum cleaner intended to be carried by a person and which can be moved when energized

3.8

canister vacuum cleaner

vacuum cleaner which power source, collection tank and filter chamber are placed on a cart with wheels

Note 1 to entry: The suction nozzle, placed at the end of a wand which is connected to a suction hose attached to the collection tank or filter chamber, allows the operator to collect substances at distance from the power source.

3.9

back-pack vacuum cleaner

vacuum cleaner designed to have the power source and collector carried on the operator's back by means of a supporting device

3.10

powerhead

upper part of the vacuum cleaner containing the motor or power system which creates the vacuum

Note 1 to entry: The powerhead can be detached from the filter chamber or from the collection tank.

Note 2 to entry: See Figure B.1 and Figure B.2.

3.11

motor cabinet

enclosure which is a part of the vacuum cleaner assembly and which contains the motor

Note 1 to entry: See Figure B.3 and Figure B.4.

3.12

collection tank

part of the vacuum cleaner where the substances collected are contained

Note 1 to entry: See Figure B.1, Figure B.2, Figure B.3 and Figure B.4.

3.13

filter chamber

part of the vacuum cleaner containing filters

Note 1 to entry: See Figure B.2, Figure B.3 and Figure B.4.

3.14

through flow motor

motor where the working air travels through the fan system and is discharged directly over the motor windings as it exits, so the working air also provides cooling for the motor

3.15

bypass motor

motor where the working airflow is independent from the cooling airflow

Note 1 to entry: The working air does not come into contact with motor windings. A separate fan is used for the cooling air.

Note 2 to entry: See Figure C.1 and Figure C.3.

3.16**motor enclosure**

enclosure which is part of the motor and which is designed to protect the motor from damages and from contaminants present in the environment it operates

Note 1 to entry: Motor enclosures are categorized as either open (see Figure B.1) or totally enclosed (see Figure C.1 and Figure C.3) and have an impact on how the cooling air circulate.

3.17**open enclosure bypass motor**

bypass motor in which the cooling airflow circulates through the windings

3.18**totally enclosed bypass motor**

motor in which the cooling airflow circulates on the outside of the frame of the motor

Note 1 to entry: See examples on Figure C.1 and Figure C.3.

3.19**side channel fan**

non-positive displacement, high volume, pressure fan that can operate as either a compressor or a vacuum pump

Note 1 to entry: It is also known as other names such as side channel blower, regenerative blower or vortex blower. The fan or blower typically consists of an impeller mounted directly on a motor shaft and is rotated at a high speed.

3.20**non-electrical vacuum cleaner**

vacuum cleaner using a non-electrical power source to operate

Note 1 to entry: Electrical monitoring equipment can be associated in some design.

3.21**electrical vacuum cleaner**

vacuum cleaner using an electrical power source to operate

3.22**high-efficiency particle air filter**

filter certified in conformance with applicable standards for having a minimum filtration efficiency of 99,95 % as specified in EN 1822-1:2019 (H13) or in ISO 29463-1:2017 (ISO 35H)

3.23**coalescing filter**

filter specifically designed to filter a humidified air flow and to remove liquid and droplets from the air flow

3.24**mist filtration system**

filtration system used as main filter in wet type dust collectors to filter airflow from droplets

3.25**most penetrating particle size**

particle size at which the minimum of the particle size efficiency curve occurs under test conditions

[SOURCE: ISO 29464:2017, 3.2.136, modified – Note 1 to entry has been deleted.]

3.26

main filter

filter element filtering the air flow upstream of the motor or power system in order to prevent the majority of collected substances from entering the power system or fan, and to get released into the environment

Note 1 to entry: A main filter is designed for dust or liquid collectors.

3.27

collection bag

bag into which the collected substances are accumulated

3.28

pre-filter

air filter fitted upstream of another filter to reduce the challenge on that filter

[SOURCE: ISO 14644-4:2001, 3.8]

3.29

suction inlet

air intake placed on the vacuum cleaner to which the suction hose is connected

3.30

filter blockage indicator

device indicating the blockage of the filters installed in the vacuum cleaner

3.31

working air

air allowing to collect dusts and/or liquids in the vacuum cleaner

Note 1 to entry: See Figure B.1 for illustration.

3.32

cooling air

air used to cool off the motor of the vacuum cleaner

Note 1 to entry: See Figure B.1 for illustration.

3.33

upstream airflow

flow of air which is located before the motor or power system

Note 1 to entry: See cooling air intake and working air intake on Figure B.1 for illustration.

3.34

downstream airflow

flow of air which is located after the motor or power system

Note 1 to entry: See cooling air exhaust and working air exhaust on Figure B.1 for illustration.

3.35

self-heating dust

dust which, by reaction with air and without energy supply, is liable to self-heat

3.36**degassing vent**

safety feature preventing the build-up of gas in the collection tank by allowing it to be vented out when the vacuum cleaner is switched off

3.37**dirty side of the vacuum cleaner**

internal part of the vacuum cleaner located between the suction inlet and the first stage of filtration

3.38**clean side of the vacuum cleaner**

internal part of the vacuum cleaner located after the last stage of filtration

Note 1 to entry: At this point, the concentration of combustible substances in the airflow is designed to be below the lower explosive limit.

3.39**vacuum relief valve**

valve placed on the power system (s.a. motor) to relieve vacuum created inside the vacuum cleaner while the vacuum cleaner is in operation

3.40**machine control system**

system which responds to input signals from parts of machine elements, operators, external control equipment or any combination of these and generates output signals causing the machine to behave in the intended manner

Note 1 to entry: The machine control system can use any technology or any combination of technologies (e.g. electrical/electronic, hydraulic, pneumatic, mechanical).

[SOURCE: ISO 13849-1:2015, 3.1.32]

3.41**control device**

device which is part of the control system and which detect input signals given by the operator, usually by means of hand

Note 1 to entry: There are many different kinds of control devices including, for example, push-buttons, levers, switches, knobs, sliders, joy-sticks, hand wheels, pedals, keyboards and tactile screens.

3.42**wheel**

circular structure able to rotate on an axle, either directly or with the use of bearing(s), with the external part in contact with the ground

[SOURCE: EN 12526:1998, 2.1.1.1, modified – Reference to Figure 1 has been deleted.]

3.43**castor**

assembly comprising a housing, one or more wheels, an axle and, if required, accessories

[SOURCE: EN 12526:1998, 2.3.1]

3.44

tyre

outer part of a wheel, produced from different material from the wheel centre

[SOURCE: EN 12526:1998, 2.1.1.6]

3.45

service temperature

maximum or minimum temperature reached at specific points of the equipment when the equipment is operating at rated conditions, including ambient temperature and any external sources of heating or cooling

Note 1 to entry: Equipment may reach different service temperatures in different parts.

[SOURCE: EN ISO 80079-36:2016³, 3.8]

3.46

continuous operating temperature

COT

maximum temperature which ensures the stability and integrity of the material for the expected life of the equipment, or part, in its intended application

[SOURCE: IEV ref 426-04-26]

4 Safety requirements and protective measures

4.1 General

All vacuum cleaners shall comply with the requirements contained in EN ISO 80079-36:2016³ for non-electrical equipment or non-electrical part(s) of electrical equipment unless otherwise stated in this document. EN ISO 80079-36:2016³ specifies the requirements for the design and construction of equipment intended for explosive atmospheres in conformity with all Equipment Protection Levels (EPLs) of Group II and III. It supplements and modifies the general requirements of EN IEC 60079-0:2018², as shown in Table 1 of EN ISO 80079-36:2016³. Where a requirement of EN ISO 80079-36:2016³ conflicts with a requirement of EN IEC 60079-0:2018², as far as applicable for non-electrical equipment, the requirement of EN ISO 80079-36:2016³ takes precedence, unless otherwise stated in this document.

All vacuum cleaners, within the scope of this document, shall comply with the safety requirements and protective measures of Clause 4, Clause 5 and Clause 6.

NOTE Annex A presents a methodological approach to identify the applicable safety requirements and protective measures for the vacuum cleaner.

4.2 Risk assessment

An ignition hazard assessment according to EN 1127-1:2019 and EN ISO 80079-36:2016³ shall be carried out and documented (see Annex D). Where, due to the specific intent of use, additional hazards could occur a further risk assessment shall be carried out according to EN 1127-1:2019 due to nature of substances to collect. An electrical power source will contain generally at least some potential ignition hazards due to non-electrical parts, as a consequence, application of EN ISO 80079-36:2016³ is required

A list of significant hazards, hazardous situations and events according to EN ISO 12100:2010, identified by a risk assessment as significant for the machines specified in the scope and which require action to eliminate or reduce the risk, is given in Annex E. A risk assessment for significant hazards, hazardous

situations and/or events according to EN ISO 12100:2010 shall be carried out and documented where, due to the specific intended use, such as the collection of hybrid mixtures, additional hazards could occur.

The air loaded, with the dust or liquid and gas collected, and drawn into the vacuum cleaner from the hazardous atmosphere, is released in the adjacent environment around the equipment through the air path. Release of flammable substances shall therefore also be considered in the ignition hazard assessment for the external part of the vacuum cleaner.

NOTE Refer to EN 1127-1:2019 for further information about hybrid mixture.

4.3 Assignment of categories

Vacuum cleaners which are used to collect and convey dusts or liquids in an explosive atmosphere are assigned a category depending on the likelihood of them acting as an effective ignition source. The category assignment concerns the part of the vacuum cleaner in contact with the explosive atmosphere.

NOTE 1 For definitions of equipment Categories 2 and 3, see EN 1127-1:2019.

Normal operating conditions shall be considered to occur in situations where the vacuum cleaner performs its intended use within its design parameters. This includes conditions where stones, metal particles and other solid or liquid substances could be drawn into the machine. This also includes conditions during start up, shut down and emptying the collection tank.

Foreseeable malfunctions (such as a breakdown of seals, flange gaskets or releases of substances caused by accidents or lack of maintenance observance) which involve repair or shut down are not considered to be part of normal operation.

NOTE 2 For further information regarding relationship between categories and Equipment Protection Levels (EPLs), see EN ISO 80079-36:2016³.

4.4 Assignment of types and applicable requirements

Vacuum cleaners have either an electrical or a non-electrical power source. The power sources can be combined with 3 different collectors as shown in Table 1 based on the substances the vacuum cleaners are designed to collect. Instructions for safe use need to identify the proper selection of equipment according to the application, the characteristics of the flammable substances and potential external influences

Vacuum cleaners are assigned a type based on the power source and the collector.

Table 1 — Vacuum cleaner collectors

Vacuum cleaner collectors for all categories	Substances to be collected
Dry type dust collector	Non-combustible dust
	Combustible dust
Wet type dust collector	Combustible and/or self-heating dust
Liquid collector	Non-flammable liquids
	Flammable liquids

Table 2 — Applicable requirements for vacuum cleaner types

Vacuum cleaner types for all categories	Ignition hazards Safety requirements	Significant hazards Safety requirements
All vacuum cleaners	5.1	6.1
Non-electrical parts of vacuum cleaner	5.1	6.4
Electrical parts of vacuum cleaner	5.2	6.1
Dry type dust collector	5.3	6.2
Wet type dust collector	5.4	6.1
Liquid collector	5.5	6.3
Portable hand-held vacuum cleaner	5.1	6.5
NOTE Annex C shows examples of vacuum cleaner types.		

5 Safety requirements regarding ignition hazards

5.1 Requirements applicable to all types of vacuum cleaners

5.1.1 Hot surfaces

5.1.1.1 Maximum surface temperature

The maximum surface temperature of the vacuum cleaner is characterized by the hottest part of the equipment that can come into contact with the explosive atmosphere or the maximum temperature of the airflow which can act as an ignition source.

The maximum surface temperature of the vacuum cleaner is determined under the most adverse conditions. Measurements shall be performed on both the external part and the internal part of the vacuum cleaner. Foreseeable misuse of the vacuum cleaner and possible faults of components in contact with the flammable substances shall be taken into account.

Reduction of surface temperatures by means of thermal insulation is not permitted.

Temperature measurements shall be made according to EN ISO 80079-36:2016³, for vacuum cleaners driven by both electrical power or pneumatic power.

Where a requirement of EN ISO 80079-36:2016³ conflicts with a requirement of EN IEC 60079-0:2018², as far as applicable for non-electrical equipment, the requirement of EN ISO 80079-36:2016³ takes precedence.

Equipment may reach different service temperatures in different parts as defined by EN ISO 80079-36:2016³.

When a fan is used, the maximum surface temperature of both the inside and outside parts of the fan that can come into contact with the explosive atmosphere shall be determined.

NOTE Further information on the design and testing of the fan can be found in EN 14986.

5.1.1.2 Temperature classification

Vacuum cleaners shall be classified according to EN ISO 80079-36:2016³:

- a) with a temperature class in accordance with Table 3 for Category 3G or 2G; or
- b) by the maximum surface temperature for Category 3G, 2G, 3D or 2D for both the external and internal part of the vacuum cleaner.

In addition, the maximum surface temperature marked for the internal part of the vacuum cleaner shall be the greater of either:

- the maximum surface temperature determined in accordance with EN ISO 80079-36:2016³ including the appropriate safety margins for the different categories; or
- the maximum temperature of the air flow with a safety margin of 20 % (with temperatures measured in °C).

NOTE This safety margin of 20 % has been chosen because of the enhanced ignition risk at higher gas temperatures. For further information, see EN 1127-1:2019.

Table 3 — Classification of maximum surface temperatures for Group II vacuum cleaners

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

5.1.2 Thermal endurance

5.1.2.1 Parts of the vacuum cleaner relevant for explosion protection

For enclosures and parts of enclosures of non-metallic materials on which the type of protection depends, tests for thermal endurance shall be performed according to EN ISO 80079-36:2016³, 8.4.

5.1.2.2 Parts of the vacuum cleaner non-specifically relevant for explosion protection

For parts of the vacuum cleaner non-specifically relevant for explosion protection, continuous operating temperature range of the materials the vacuum cleaner is made of, shall correspond to the maximum and to the minimum temperatures they will be exposed during use, so the properties of the material do not deteriorate over time.

Filters in the collection tank shall be made of non-flame propagating material.

The maximum temperature of the airflow and the temperature of the substances the vacuum cleaner is designed to collect, such as hot particles, shall be taken into account.

Verification shall be performed by checking the relevant documentation and drawings, by inspecting the materials the vacuum cleaner is made of, and by proceeding with measurement and functional testing.

5.1.3 Flames and hot gases

Vacuum cleaners which have a risk of producing flames or hot gases (e.g. those intended for the collection of substances with low flash points or dusts with low MIE) shall be designed in conformance with the requirements for relevant categories indicated in EN 1127-1:2019, 6.4.3 and with other requirements as applicable and specified in EN 1127-1:2019.

If it has been determined the flammable substance collected by the vacuum cleaner can produce a flame, installation of a flame arrester at the working air exhaust of the vacuum cleaner is a known solution. Flame arresters shall comply with EN ISO 16852:2016 and their use shall comply with CEN/TR 16793:2016.

If it has been determined the flammable substance collected by the vacuum cleaner can produce a deflagration, installation of a rupture disk on the collection tank of the vacuum cleaner is a known solution. Rupture disks shall comply with EN ISO 4126-2:2019 and their design shall comply with EN 14797:2006.

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

When a flame arrester or a rupture disk is installed on the vacuum cleaner it shall be ensured the design prevent all hazards to the operator when these devices are activated.

Verification shall be performed by checking the relevant documentation and drawings, by inspecting the devices, and by proceeding with measurement and functional testing.

5.1.4 Mechanically generated sparks

5.1.4.1 General

Sparks generated by friction and mechanical impact could occur during collection of air, dust, solid parts or a combination of this.

The vacuum cleaner shall be designed to prevent this hazard at intended use and foreseeable misuse.

The vacuum cleaner shall comply with EN ISO 80079-36:2016³, 6.4 to avoid mechanically generated sparks.

If any, limitations of the intended use minimizing the risk shall be clearly specified in the instruction for use.

NOTE Typical examples are brass stop baffle at suction inlet to reduce velocity of parts and radial suction inlet.

5.1.4.2 Fans

This clause applies to fans and impellers, as rotating parts of fans, in contact with the potentially explosive atmosphere or the airflow containing combustible substances.

Fans located in the cooling airflow shall comply with EN IEC 60079-0:2018², 17.2.3.

Fans in contact with the working air, typically with an absolute pressure at inlet below 0,8 bar, shall comply with the requirements of this clause and 5.1.4.3 to prevent mechanically generated sparks.

NOTE 1 The vacuum cleaner typically operates at absolute pressure above 0,8 bar and below 1,1 bar. Internal pressure resistance in the suction hose and throughout the filters at nominal airflow results in a situation where fans in contact with the working air typically operate at an absolute pressure below 0,8 bar.

Fans 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. Test for resistance to impact shall be carried out in accordance with EN ISO 80079-36:2016³, 8.3.1.

The minimum clearance between rotating elements and the fan casing shall always 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 clearance control method and approval range at standstill shall be included in the operation and maintenance manual.

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. This test shall be performed after the impact test as specified in EN ISO 80079-36:2016³, 8.3.1.

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.

Attachment of the impeller to shaft shall give a means of both positive location and drive. The attachment shall be secured against loosening and drift.

NOTE 2 Minimum clearance takes into account all possible tolerances due to manufacture and fitting.

NOTE 3 The clearance can change with operation pressure, rotation, temperature, and due to vibrations and belt drive tension.

5.1.4.3 Material pairing for parts of fan

Material pairing as per EN 14986:2017, 4.7 shall be fulfilled when fans in contact with the potentially explosive atmosphere, or the airflow containing combustible substances, are used in the assembly and when rotating parts in contact with the potentially explosive atmosphere, or the airflow containing combustible substances, are present in the design and are rotating close to stationary parts.

NOTE For further information, see EN 14986:2017.

5.1.5 Exothermic reactions

All the metallic parts which could be in contact with metal powder, as oxidizable substances, shall not be subject to metal oxidation.

Certain combination of metal powder with a metal oxide powder can react chemically with a strong release of heat.

Paint containing iron oxides or aluminium shall not be used because of the risk of thermite sparks.

Verification shall be performed by checking the relevant documentation, drawings and by inspection.

5.1.6 Electrical equipment in contact with the potentially explosive atmosphere

All electrical equipment (i.e. motors, monitoring equipment etc.) in contact with the potentially explosive atmosphere or the airflow containing combustible substances in the vacuum cleaner, and supplied as part of the vacuum cleaner, shall comply at least with the vacuum cleaner category according to EN IEC 60079-0:2018² and, when applicable for the relevant part(s) with EN ISO 80079-36:2016³. Electrical equipment shall be appropriate for the specific environmental conditions (operating pressure, service temperature, dust and/or gas concentration etc.) at the place of installation.

5.1.7 Equipment assembled inside the collection tank

Electrical and non-electrical equipment or part of an equipment located inside the collection tank in the dirty side of the vacuum cleaner shall meet the requirements of explosion protection level Ga or Da Category 1G or 1D according to EN IEC 60079-0:2018² and EN ISO 80079-36:2016³ and shall be protected by a suitable type of protection.

NOTE Combustible substances will be present inside the collection tank in the dirty side of the vacuum cleaner continuously or for long periods of time in potentially explosive concentrations.

5.1.8 Electrostatic hazards

5.1.8.1 General

Vacuum cleaning can generate large amounts of electrostatic charge, due to the movement of the conveyed substances (in the form of dust, particles, liquid drops or small objects) and in contact with the inside surfaces of the vacuum cleaner.

To avoid the charge accumulation and the possible high voltage that could create spark discharges, (see CLC/TR 60079-32-1:2018, A.3.2) the vacuum cleaner shall ensure static electricity dissipation by bonding and earthing as given in 5.1.8.2). The constituent parts of the vacuum cleaner shall comply with 5.1.8.3.

Propagating brush discharges, as specified in CLC/TR 60079-32-1:2018, A.3.4, are as well considered to be an effective ignition source for explosive atmospheres. They can arise following highly efficient charging of non-conductive (or isolated) layers and coatings on conductive surfaces. So, if the vacuum cleaner is designed including non-conductive (or isolated) layers and coatings on conductive surfaces (including the dust itself which can create some layers) in contact with the potentially explosive atmosphere, or the airflow containing combustible substances, EN ISO 80079-36:2016³, 6.7.3 shall be applied.

5.1.8.2 Bonding and earthing

All conductive and dissipative parts of the vacuum cleaner shall be bonded to the frame in order to reach potential equalization. The manufacturer shall provide an earthing terminal as a permanent connection to the frame. The connection of the frame to the earth shall be included in the information for use.

Earthing shall be ensured by the connection mean to the power source (such as the electrical cable or the air or gas supply hose). The vacuum cleaner shall provide an additional earthing terminal to the connection mean to the power source as fixed electrical wiring routes and pneumatic lines may become live through earthing faults on “unassociated equipment” or part of equipment. This could be done using an additional grounding cable.

The earthing and bonding between the main body of the vacuum cleaners and the floor/ground can be achieved by the use of at least two electrically conductive wheels or at least two earthing straps or a combination of a single electrically conductive wheel and a single earthing strap.

Earthing straps shall be fitted to the vacuum cleaner cart at the largest practical distance between each other to ensure a permanent grounding.

In normal operation wheels and earthing straps can be contaminated causing loss of conductivity. A practical solution is to fit more than only two electrically conductive wheels or earthing straps or to combine the application of wheels and earthing straps.

The location of conductive wheels or earthing straps shall be clearly and durably marked on the vacuum cleaner cart.

Methods for earthing and bonding are explained in CLC/TR 60079-32-1:2018, Clause 13. The earthing and bonding resistance measured from any part to earth terminal shall be $\leq 10^8 \Omega$ according to CLC/TR 60079-32-1:2018, Table 2, and shall be measured in accordance with 5.1.8.4.

5.1.8.3 Constituent parts of the vacuum cleaner

5.1.8.3.1 General

To prevent any charge build-up during use and that insulating materials interrupt the earthing of connections of parts made of conductive or dissipative material, all individual part composing the vacuum cleaner in contact with the potentially explosive atmosphere, or the airflow containing combustible substances, shall be made of metal or of material complying with EN ISO 80079-36:2016³, 6.7.5 a) to d) or EN ISO 80079-36:2016³, 6.7.6 while respecting the continuity requirement expressed in 5.1.8.1 and 5.1.8.2.

In some cases, where lines are long, the use of dissipative material for the different parts of the vacuum cleaner (hoses, hoses junctions, main body, collection tank, filters, power source, tools, nozzles, wheels and accessories) may not provide a sufficiently low resistance for earthing of end-of-line conductive components (e.g. nozzles) and a dedicated earth connection to such conductive components could, therefore, be necessary. Further solution can be to use conductive material rather than dissipative material for the different parts of the vacuum cleaner. The design shall pass the test described in 5.1.8.4.

NOTE The shoulder strap is a typical constituent part of a portable hand-held vacuum cleaner to evaluate for potential charge build-up.

Selection and verification of the antistatic constituent parts of the vacuum cleaner can be done based on the specification sheet of the concerned components if proper standards listed here are mentioned.

5.1.8.3.2 Suction hose

5.1.8.3.2.1 Suction hose for the collection of combustible dust

The hose can be made of metal and non-metallic layers.

The hose material shall be dissipative inside and outside the hose if it is in contact with a hazardous area. The surface and transversal resistances shall be below $10^8 \Omega$. The suction hose shall be tested in conformity with EN ISO 8031:2020.

The conductivity of the inside of the suction hose shall not be achieved by coating it with dissipative material due to the risk of breaking this coating during use.

The hose shall be connected to earth as given in 5.1.8.2.

5.1.8.3.2.2 Suction hose for the collection of flammable liquids

The suction hose shall comply with the requirements of EN ISO 8031:2020, Grade Ω -L or Grade Ω -CL.

The need for the outer cover to meet the Grade Ω performance requirements shall be based on an assessment of the risk of the outside of the hose being electrostatically charged and coming into contact with a flammable gas or vapour atmosphere, in accordance with CLC/TR 60079-32-1:2018, 6.3.

The conductivity of the inside of the suction hose shall not be achieved by coating it with dissipative material due to the risk of breaking this coating during use.

The hose shall be electrically bonded and shall provide an end to end electrical bonding between fittings with a maximum resistance of $10^6 \Omega$ per assembly. End fittings shall provide reliable electrical contact to the vacuum cleaner suction inlet.

All conductive or dissipative sections of the hose shall have means to be reliably connected to earth during use. The hose shall be connected to earth as given in 5.1.8.2.

Unbonded metal hose clips shall be avoided.

Verification shall be performed by checking the relevant documentation and drawings, by inspecting the hose and proceeding with the relevant measurement and functional testing on the hose.

5.1.8.3.3 Cloth filters

Cloth filters shall be made of conductive or dissipative material and fibres containing conductive threads may be used.

All conductive or dissipative parts on cloth filter shall be bonded together and earthed.

NOTE Indeed, the junction of the cloth, the stitching and the way to fix the bonding stick to the cloth filter media could possibly affect electrical continuity and earthing.

The surface and transversal resistances shall be below $10^8 \Omega$ and tested in conformity with EN 1149-1:2006.

Selection of the antistatic filter can be done based on the specification sheet of the concerned filter if proper standards listed here are mentioned.

Cloth filter media shall be connected to earth as in 5.1.8.2.

5.1.8.3.4 Collection bag

The collection bag is in contact with the hazardous area and shall be conductive or dissipative. See CLC/TR 60079-32-1:2018. Bags made of paper shall not be used as collection bags for any application. The collection bag shall be in conformity with 5.1.8.3.3.

5.1.8.3.5 Suction nozzles, tools and accessories

Suction nozzles, tools and accessories are part of the vacuum cleaner and shall ensure electrical continuity with the hose and the collection tank. They shall be in conformity with 5.1.8.3.1 and shall have a design ensuring a reliable electrical contact to the suction hose.

5.1.8.3.6 Castors and wheels

5.1.8.3.6.1 General

Castors and wheels shall not generate hazardous electrostatic discharges to the floor/ground or other parts during normal operation. This can be achieved if the castors or wheels are dissipative in accordance with 5.1.8.3.6.2.

No requirements apply to castors or wheels if:

- a) castors or wheels are applied on vacuum cleaners with a travel speed not exceeding 6 km/h; or
- b) the projected area of castors or wheels to the ground/floor does not exceed:
 - 100 cm² for Group IIA or IIB; or
 - 20 cm² for Group IIB + H2 or IIB + C2H2 or IIB + H2 + C2H2. See Figure 1.

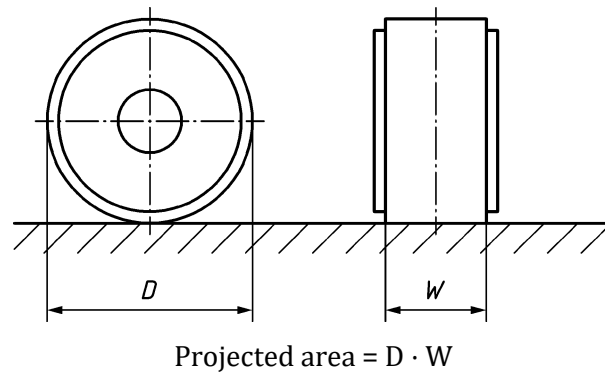


Figure 1 — Projected area of castors or wheels

5.1.8.3.6.2 Dissipative castors and wheels

Dissipative castors and wheels shall comply with the following:

- a) the tyre (non-metallic outer material) of castors and wheels shall have a maximum surface resistance of $10^9 \Omega$ measured using a test electrode of which the dimensions are shown in Figure 9 of EN IEC 60079-0:2018² with a test voltage of $500 \text{ V} \pm 5\%$ with the exclusion of the pre-conditioning and relative humidity requirements for the testing of the material; or
- b) the tyre (non-metallic outer material) of castors and wheels shall comply with the requirements for the limitation of transferred charge in accordance with EN ISO 80079-36:2016³, 6.7.5 b) with the exclusion of the third test method (test with high voltage spray electrode) and the pre-conditioning and relative humidity requirements for the testing of the material.

5.1.8.4 Verification for earthing and bonding

Verification for earthing and bonding shall be made by performing a series of measurement of the resistance between the end of the nozzle or tool used to collect the substances and the earthing terminals and between each different part.

As illustrated in Annex G, Figure G.1, the measurements of the resistances shall be made between the nozzle (A) and the hose connection fitting (B), the hose connection fitting (B) and the suction hose (C) (if made of external conductive of dissipative layer), the suction hose (C) (if made of external conductive of dissipative layer) and the hose end fitting (D), the hose end fitting (D) and the filter chamber (E), the filter chamber (E) and the main filter (F1), the connecting hose (J) (if made of external conductive of dissipative layer) and the motor cabinet (K), the motor cabinet (K) and the earthing point (Z), the earthing point (Z) and the dissipative wheels (W1 and/or W2), the nozzle (A) and the earthing point (Z), the main filter (F1) and the earthing point (Z), the suction cut off system (F2) and the earthing point (Z), the filter housing (F3) and the earthing point (Z) and more if needed. If paint is present, it shall be removed before the resistance measurements.

Those measurements shall be made in conformity with EN IEC 60079-0:2018², 26.13 using a gigaohm meter fitted with 2 electrodes. Those electrodes shall replace the 2 painted electrodes used in EN IEC 60079-0:2018², 26.13 and shall be placed on 2 measured points.

The vacuum cleaner shall be conditioned for at least 24 h and during the test at a temperature of $(23 \pm 2) ^\circ\text{C}$ and a relative humidity of $(50 \pm 5) \%$.

If needed, the two painted electrodes may be used, e.g. on some non-metallic material.

The resistances of bonding of the different parts of the vacuum cleaner shall be measured and below $10^8 \Omega$.

The resistances of connection to earth of all metal parts shall be measured and below $10^8 \Omega$.

The resistances of connection to earth of the non-metallic parts in contact with the hazardous area, shall be measured and below $10^8 \Omega$ unless it is in conformity with EN ISO 80079-36:2016³, 6.7.5 b) to d).

NOTE 1 The value of $10^8 \Omega$ has been chosen to harmonize the values mentioned in the different standards mentioned: EN ISO 80079-36:2016³, EN IEC 60079-0:2018², EN ISO 8031:2020, EN 1149-5:2018 and CLC/TR 60079-32-1:2018.

5.2 Additional requirements applicable to electrical parts of vacuum cleaners

5.2.1 General

The electrical equipment which is part of the vacuum cleaner and which is in contact with the potentially explosive atmosphere, or the airflow containing combustible substances, shall have a category in accordance with the category and intended use of the product. as given in 4.3.

5.2.2 Electrical cables

Electrical cables shall fulfil the requirements of EN 60079-14:2014 regarding the cable and wiring system for electrical vacuum cleaners.

Electrical cables ensuring a permanent electrical connection to electrical parts in vacuum cleaners are permitted.

5.2.3 Detachable power cords

Detachable power cords shall comply with requirements of EN IEC 60079-0:2018².

5.2.4 Through flow motors

Through flow motors shall not be used in vacuum cleaners for use in potentially explosive atmospheres due to explosion hazards.

5.2.5 Open enclosure motors

Open enclosure motors are not permitted in vacuum cleaners designed for use in gas explosive atmospheres.

The use of an open enclosure bypass motor is limited to Category 3D vacuum cleaners according to EN IEC 60079-0:2018² and protected by the type of protection "t" in conformance with EN 60079-31:2014.

5.2.6 Fasteners

It shall be ensured that parts necessary to achieve the level of explosion prevention and protection cannot be unintentionally and inadvertently removed. This may be achieved using fastening systems that can only be removed with the aid of a tool such as a key or a screwdriver. Fastening systems on parts necessary to achieve the level of explosion prevention and protection shall comply with EN IEC 60079-0:2018², Clause 9.

5.2.7 Vacuum relief valve

For vacuum cleaners assembled with a motor having a side channel fan, or similar, a vacuum relief valve shall be installed to protect the motor from overheating when the airflow is abnormally restricted.

The set point at which the vacuum relief valve shall react, shall be 90 % of the maximum vacuum produced by the motor measured when the suction inlet is completely blocked.

A test on the vacuum cleaner shall be performed by blocking the suction inlet and verify if the vacuum relief valve opens at the proper setting in order to protect the motor from overheating. If the machine is equipped with a motor overload protection device, it shall be made inoperable before proceeding with this test. The surface temperature of the motor shall be measured during the test. The surface temperature shall stay below the maximum surface temperature of the vacuum cleaner for at least 30 min after the vacuum relief valve is activated.

5.3 Additional requirements applicable to dry type dust collectors

5.3.1 Filtration levels

5.3.1.1 Main filter (filtration Level 1)

A main filter adapted for the collection of dust shall be placed inside the collection tank (first level of filtration) in order to prevent the majority of collected substances to get into contact with the power system which could generate mechanically generated sparks and/or electrical arcing.

The dust filtration efficiency of the main filter shall allow at minimum the installation of Category 2D equipment downstream the main filter.

NOTE 1 Filters complying with ISO 15 E as per EN ISO 29463-5:2018 with an overall value for filtration efficiency of 95 % or better fulfil the filter efficiency requirement.

NOTE 2 Explosive gas present in the working air will typically not be affected by the dust filter.

NOTE 3 The level of filtration efficiency provided by the vacuum cleaner is a way to ensure the release of dust hazardous to health is maintained below threshold limit value (TLV). Refer to applicable standards related to the collection of dust hazardous to health.

Verification shall be performed by checking the relevant documentation and drawings, by inspecting the vacuum cleaner and by proceeding with a seal and filtration efficiency test on the assembled vacuum cleaner with the main filter.

NOTE 4 The procedure for the seal and filtration efficiency test can be based on a particle counting method using a liquid test aerosol as illustrated in Annex F. This method enables calculation of filter efficiency and seal, based on particle concentrations upstream and downstream of working air and cooling air.

5.3.1.2 High-efficiency particle air filter upstream (filtration Level 2)

If the dust filtration efficiency of the main filter allows the installation of Category 2D electrical equipment downstream the main filter and in order to install a Category 3D power system or components inside the vacuum cleaner where the working air pass through, a high-efficiency particle air filter adapted for the collection of dust shall be placed after the main filter as a second level of filtration. This high-efficiency particle air filter will prevent the fine collected dusts to get into contact with the power system which could generate mechanically generated sparks and/or electrical arcing.

The filtration efficiency of the high-efficiency particle air filter shall comply, as a minimum requirement, with Group H: HEPA filters (high efficiency particle air filter) in accordance with ISO 29463-1:2017.

NOTE 1 High-efficiency particle air filters complying with ISO 35 H as in EN ISO 29463-5:2018 with an overall value for filtration efficiency of 99,95 % or better fulfil the filter efficiency requirement.

NOTE 2 Explosive gas present in the working air will typically not be affected by the dust filter.

NOTE 3 The second level of filtration is implemented as a backup protection in case the main filter is damaged.

Verification shall be performed by checking the relevant documentation and drawings, by inspecting the vacuum cleaner and by proceeding with a seal and filtration efficiency test on the assembled vacuum cleaner with the main filter and the high-efficiency particle air filter.

NOTE 4 The procedure for the seal and filtration efficiency test can be based on a particle counting method using a liquid test aerosol as illustrated in Annex F. This method enables calculation of filter efficiency and seal, based on particle concentrations upstream and downstream of working air and cooling air.

5.3.1.3 Pre-filter upstream

When an ignition hazard has been identified due to the specific damage of the main filter or the high efficiency air filter, a pre-filter adapted for the collection of dust shall be placed inside the collection tank.

NOTE 1 Pre-filter will often protect the main filter and/or the high-efficiency particle air filter and extend lifetime of these.

NOTE 2 Explosive gas present in the working air will typically not be affected by the dust filter.

Verification shall be performed by checking the relevant documentation and drawings, by inspecting the pre-filter and by proceeding with the relevant functional testing on the vacuum cleaner.

5.3.2 Electrostatic hazards

Ignition hazards may occur due to static electricity discharges by using dry type dust collectors. All parts of the vacuum cleaner, including the suction hose and the accessories, in contact with the dust explosive atmosphere shall comply with requirements for 5.1.8.3.

5.3.3 Protection against the collection of hot particles

Collection of hot particles could result in the ignition of the combustible dust present in the collection tank.

Pre-separation of this type of particles can be achieved with a specially designed spark trap. The efficiency of the spark trap shall be tested at the intended use. The instruction for use shall inform on the limitations of use based on the tests.

When it is part of its intended use and the precipitation and the neutralization of the collected hot particles is required, a wet type dust collector shall be used.

5.4 Additional requirements applicable to wet type dust collectors

5.4.1 Precipitation of the collected dust

The wet type dust collector shall be designed to efficiently precipitate and neutralize the collected combustible dust, including hot particles, or self-heating dust which otherwise can act as a source of ignition inside the collection tank.

Test specified in 5.4.5 shall be performed on the wet type dust collector.

5.4.2 Moisture capture

As some collected dust can be trapped in air bubbles during operation, a high-efficiency coalescing filter type shall be used to filter the working air upstream of the power system so it is free of moisture and fine combustible dust when it gets into contact with the power system.

The filtration efficiency of the high-efficiency coalescing filter type shall comply, as a minimum requirement, with Group H: HEPA filters (high efficiency particle air filter) in accordance with ISO 29463-1:2017.

NOTE 1 High-efficiency particle air filters complying with ISO 35 H as in EN ISO 29463-5:2018 with an overall value for filtration efficiency of 99,95 % or better fulfil the filter efficiency requirement.

NOTE 2 Explosive gas present in the working air will typically not be affected by the coalescing filter.

Verification shall be performed by checking the relevant documentation and drawings, by inspecting the vacuum cleaner and by proceeding with a seal and filtration efficiency test on the assembled vacuum cleaner with the high-efficiency coalescing filter type.

NOTE 3 The procedure for the seal and filtration efficiency test can be based on a particle counting method using a liquid test aerosol as illustrated in Annex F. This method enables calculation of filter efficiency and seal, based on particle concentrations upstream and downstream of working air and cooling air.

5.4.3 Generation of a gas explosive atmosphere

The working air downstream of the power system shall not increase the risk of an explosion in the working area due to e.g. gas created by a chemical reaction in the collector.

The potential presence of an explosive gas shall be considered when specifying the appropriate category for the equipment and the gas type for which it is designed.

NOTE Installing a venting hose connection on the working air exhaust outlet and add in the operation and maintenance manual an instruction to direct the air to a safe place (typically outdoor at roof level in safe zone area) is a possible design that can apply if such hazard has been identified.

The information for use shall include information for the operator on how to apply the solution.

5.4.4 Electrostatic Hazards

The electrostatic hazards identified under clause 5.1.8 applies for wet type dust collectors in all parts of the vacuum cleaner in contact with gas explosive atmosphere.

NOTE EN ISO 80079-36:2016³, 6.7.6 concerns the dust explosive atmosphere and does not apply to the gas explosive atmosphere.

5.4.5 Test applicable to wet type dust collector

The wet type dust collector shall be tested in order to verify it efficiently precipitates the collected dust and keeps all the collected substances inside the device.

During the test period, for safety purposes and until tests performed on the vacuum cleaner proved the design is satisfactory, it is not recommended to use a sample of the actual combustible dusts for which the vacuum cleaner has been designed in order to perform the following test. Nevertheless, the dust sample used for this test shall be as representative as possible of the dust for which the vacuum cleaner has been designed.

Characteristics of the dust sample:

- a) *Size:* Representative mix of particles which size matches the size of the dust for which the vacuum cleaner has been designed.
- b) *Average bulk density (g/cm³)* of dust sample shall be $\pm 5\%$ of average bulk density of powder for which the vacuum cleaner has been designed.

Quantity of precipitating liquid: Quantity prescribed by the manufacturer. The precipitating liquid used for the test shall be selected for efficiently being mixed with the dust sample.

Quantity of dust sample: Maximum quantity of dust which can be precipitated in the prescribed quantity of liquid as mentioned by the manufacturer.

A high-efficiency particle air filter shall be installed after the coalescing filter during test.

Both coalescing filter and high-efficiency particle air filter shall be free of dust before test.

Put the quantity of precipitating liquid into the collection tank.

Before the test: Weight collection tank with the prescribed quantity of liquid as well as the clean and dry coalescing filter and high-efficiency particle air filter.

Test procedure: start the vacuum cleaner and collect the whole quantity of dust at constant airflow. Stop the vacuum cleaner when the whole quantity of dust has been collected.

After the test: weight collection tank with mix of liquid and dust recovered as well as the coalescing filter and high-efficiency particle air filter.

Validate the design of the vacuum cleaner and the airflow produced by the vacuum cleaner allows a proper precipitation of the dust sample.

Acceptance criteria:

- less than 5 % dust weight collected in the coalescing + high-efficiency particle air filter;
- liquid tank weight increase shall be at minimum 95 % of weight of initial quantity of dust collected minus of 2 % of weight of prescribed liquid quantity (evaporation loss).

5.5 Additional requirements applicable to liquid collectors

5.5.1 Suction of low conductivity liquids

The suction of low conductivity liquids leads to a strongly charge-generating process. Mist or liquid flows with integrated air bubbles and high flow velocity are formed. Electrostatic discharges shall be expected. If a second immiscible phase (e.g. water) is present at the same time, this effect increases. A liquid collector shall not be used for the collection of liquids with low conductivity where hydrogen is present.

NOTE See CLC/TR 60079-32-1:2018, 7.1.4 for the definition of low conductivity liquids.

Requirements related to electrostatic hazards in 5.5.5 apply for liquid collectors collecting low conductivity liquids.

5.5.2 Collection of dust with liquid collectors

Dust will enter together with the liquid as fine dust is present everywhere. The design of the collector shall ensure that collection of this dust does not reduce the required safety level for the vacuum cleaner.

5.5.3 Hot particles

Hot particles shall be excluded from the intended use to prevent explosion hazards. Limitation of use shall be added in the operation and maintenance manual.

5.5.4 Generation of a gas explosive atmosphere

The working air downstream of the power system shall not increase the explosion hazard in the working area due to e.g. gas created by a chemical reaction in the collector.

The potential presence of an explosive gas shall be considered when specifying the appropriate category for the equipment and the gas type for which it is designed.

NOTE Installing a venting hose connection on the working air exhaust outlet and including in the operation and maintenance manual an instruction to direct the air to a safe place (typically outdoor at roof level in safe zone area or in an air exhaust ventilation duct) is a possible design that can apply if such hazard has been identified.

The information for use shall include information for the operator on how to apply the solution.