INTERNATIONAL STANDARD

IEC 61241-1-2

Second edition
1999-06

Electrical apparatus for use in the presence of combustible dust –

Part 1-2:
Electrical apparatus protected by enclosures and surface temperature limitation – Selection, installation and maintenance

Matériels électriques destinés à être utilisés en présence de poussières combustibles –

Partie 1-2:
Matériels électriques protégés par enveloppes et limitation de la température de surface –
Sélection, installation et maintenance

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For general terminology, readers are referred to IEC 60050: *International Electrotechnical Vocabulary* (IEV).

For graphical symbols, and letter symbols and signs approved by the IEC for general use, readers are referred to publications IEC 60027: *Letter symbols to be used in electrical technology*, IEC 60417: *Graphical symbols for use on equipment. Index, survey and compilation of the single sheets* and IEC 60617: *Graphical symbols for diagrams*.

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST –

Part 1-2: Electrical apparatus protected by enclosures and surface temperature limitation –

Selection, installation and maintenance

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.
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International Standard IEC 61241-1-2 has been prepared by subcommittee 31H: Apparatus for use in the presence of combustible dust, of IEC technical committee 31: Electrical apparatus for explosive atmospheres.

This second edition cancels and replaces the first edition, published in 1993, and constitutes a technical revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
31H/91/FDIS	31H/97/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

Annex A is for information only.

A bilingual version of this standard may be issued at a later date.

IEC 61241 consists of the following parts under the general title: *Electrical apparatus for use in the presence of combustible dust:*

– Part 1: Electrical apparatus protected by enclosures and surface temperature limitation
– Part 2: Test methods
– Part 3: Classification of areas where combustible dusts are or may be present
– Part 4: Type of protection pressurization "p" [1)]
– Part 5: Intrinsically safe apparatus [1)]

1) Under consideration.

INTRODUCTION

Combustible dust can be ignited by electrical apparatus in several main ways:

- by surfaces of the apparatus that are above the minimum ignition temperature of the dust concerned. The temperature at which a type of dust ignites is a function of the properties of the dust, whether the dust is in a cloud or layer, the thickness of the layer and the geometry of the heat source;
- by arcing or sparking of electrical parts such as switches, contacts, commutators, brushes, or the like;
- by discharge of an accumulated electrostatic charge;
- by radiated energy (for example electromagnetic radiation);
- by mechanical sparking or frictional sparking or heating associated with the apparatus.

In order to avoid ignition hazards it is necessary that

- the temperature of surfaces, on which dust can be deposited, or which would be in contact with a dust cloud, is kept below the temperature limitation specified in this standard;
- any electrical sparking parts, or parts having a temperature above the temperature limit specified in this standard
  - are contained in an enclosure which adequately prevents the ingress of dust, or
  - the energy of electrical circuits is limited so as to avoid arcs, sparks or temperatures capable of igniting combustible dust;
- any other ignition sources are avoided.

The protection specified in this standard will not provide the required level of safety unless the electrical apparatus is operated within its rating and is installed and maintained according to the relevant codes of practice or requirements, for example in respect of protection against over-currents, internal short circuits, and other electrical faults. In particular, it is essential that the severity and duration of an internal or external fault be limited to values that can be sustained by the electrical apparatus without damage.

Two different types of practice, A and B, are specified in this standard. Both are intended to provide an equivalent level of protection.

ELECTRICAL APPARATUS FOR USE IN THE PRESENCE OF COMBUSTIBLE DUST –

Part 1-2: Electrical apparatus protected by enclosures and surface temperature limitation –

Selection, installation and maintenance

1 Scope

This part of IEC 61241 gives guidance on the selection, installation and maintenance of electrical apparatus protected by enclosures and surface temperature limitation for use in areas where combustible dust may be present in quantities which could lead to a fire or explosion hazard.

NOTE – IEC 61241-1-1 specifies requirements for the design, construction and testing of electrical apparatus. Apparatus within the scope of this standard may also be subject to additional requirements in other standards – for example, IEC 60079-0.

The ignition protection is based on the limitation of the maximum surface temperature of the enclosure, and other surfaces which could be in contact with dust, and on the restriction of dust ingress into the enclosure by the use of "dust-tight" or "dust-protected" enclosures.

The application of electrical apparatus in atmospheres which may contain explosive gas as well as combustible dust, whether simultaneously or separately, requires additional protective measures.

Where the apparatus has to meet other environmental conditions, for example, protection against ingress of water and resistance to corrosion, additional methods of protection may be necessary. The method used is not to adversely affect the integrity of the enclosure.

The principles of this standard may also be followed when combustible fibres or flyings cause a hazard.

This standard does not apply to dusts of explosives which do not require atmospheric oxygen for combustion, or to pyrophoric substances.

This standard is not applicable to electrical apparatus 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. This standard does not take account of any risk due to an emission of flammable or toxic gas from the dust.

This standard does not include other types of protection and is only applicable to protection by enclosures and surface temperature limitation.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 61241. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 61241 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60050(426):1990, *International Electrotechnical Vocabulary (IEV) – Chapter 426: Electrical apparatus for explosive atmospheres*

IEC 60079-0:1998, *Electrical apparatus for explosive gas atmospheres – Part 0: General requirements*

IEC 60079-14:1996, *Electrical apparatus for explosive gas atmospheres – Part 14: Electrical installation in hazardous areas (other than mines)*

IEC 60364 (all parts), *Electrical installations of buildings*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*

IEC 61241-1-1:1993, *Electrical apparatus for use in the presence of combustible dust – Part 1: electrical apparatus protected by enclosures – Section 1: Specification for apparatus*

IEC 61241-2-1:1994, *Electrical apparatus for use in the presence of combustible dust – Part 2: Test methods – Section 1: Methods for determining the minimum ignition temperatures of dust*

IEC 61241-3:1997, *Electrical apparatus for use in the presence of combustible dust – Part 3: Classification of areas where combustible dusts are or may be present*

ISO 4225:1994, *Air quality – General aspects – Vocabulary*

3 Definitions

For the purpose of this part of IEC 61241, the following definitions apply.

3.1
dust
small solid particles in the atmosphere which settle out under their own weight, but which may remain suspended in air for some time (includes dust and grit as defined in ISO 4225)

3.2
combustible dust
dust, fibres or flyings that can burn or glow in air and could form explosive mixtures with air at atmospheric pressure and normal temperatures

3.3
conductive dust
dust, fibres or flyings with electrical resistivity equal to or less than 10^3 Ω m

3.4
explosive dust atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of dust or fibres in which, after ignition, combustion spreads throughout the unconsumed mixture [IEV 426-02-04]

3.5
minimum ignition temperature of a dust layer
lowest temperature of a hot surface at which ignition occurs in a dust layer of specified thickness on this hot surface [see IEC 61241-2-1]

3.6
minimum ignition temperature of a dust cloud
lowest temperature of the hot inner wall of a furnace at which ignition occurs in a dust cloud in air contained therein [see IEC 61241-2-1]

3.7
dust ignition protection (DIP)
all relevant measures specified in this standard (for example dust ingress protection and surface temperature limitation) applied to electrical apparatus to avoid ignition of a dust layer or cloud

3.8
dust-tight enclosure
enclosure capable of preventing the ingress of all observable dust particles

3.9
dust-protected enclosure
enclosure in which the ingress of dust is not totally prevented but dust does not enter in sufficient quantity to interfere with the safe operation of the equipment. Dust should not accumulate in a position within the enclosure where it is liable to cause an ignition hazard

3.10
maximum surface temperature
highest temperature which is attained by any part of the surface of electrical apparatus when tested under the defined dust free or blanket conditions

NOTE – This temperature is attained under the test condition. Increasing the layer thickness can increase this temperature due to the thermal insulation properties of dust.

3.11
maximum permissible surface temperature:
highest temperature a surface of electrical apparatus is allowed to reach in practical service to avoid ignition. The maximum permissible surface temperature will depend upon the type of dust, whether as a cloud or layer, if a layer, its thickness and the application of a safety factor

NOTE – For details, see clause 6.

3.12
zones
classified areas are divided into zones based upon the frequency and duration of the occurrence of explosive dust/air mixtures. Dust layers should also be taken into consideration

3.13
zone 20
area in which combustible dust, as a cloud, is present continuously or frequently, during normal operation, in sufficient quantity to be capable of producing an explosive concentration of combustible dust in mixture with air and/or where layers of dust of uncontrollable and excessive thickness can be formed. This can be the case inside dust containment where dust can form explosive mixtures frequently or for long periods of time. This occurs typically inside equipment

3.14
zone 21
area not classified as zone 20 in which combustible dust, as a cloud, is likely to occur during normal operation, in sufficient quantities to be capable of producing an explosive concentration of combustible dust in mixture with air

This zone can include, among others, areas in the immediate vicinity of powder filling or emptying points and areas where dust layers occur and are likely in normal operation to give rise to an explosive concentration of combustible dust in mixture with air

3.15
zone 22
area not classified as zone 21 in which combustible dust clouds may occur infrequently, and persist for only a short period, or in which accumulations or layers of combustible dust may be present under abnormal conditions and give rise to combustible mixtures of dust in air. Where, following an abnormal condition, the removal of dust accumulations or layers cannot be assured, then the area is to be classified zone 21.

This zone can include, among others, areas in the vicinity of equipment containing dust, which dust can escape from leaks and form deposits (such as milling rooms in which dust can escape from the mills and then settle)

4 Area classification

The dust exclusion efficiency of the apparatus needs to be matched to the environmental conditions likely to be encountered, and a three-way zone system has been adopted.

The present zonal classification of gases and vapour is for three zones: 0, 1 and 2, but there is general consensus that a common zonal classification of both gases and dust is not feasible.

Unlike gas or vapour zones, areas where combustible dust may be present cannot be divided into normal or abnormal conditions dependent upon time, since dust, unlike gas or vapour, is not necessarily self-correcting by ventilation over a stipulated period. In fact, it can be the very opposite, in that accelerated ventilation may lead to dust clouds and therefore give a greater, not a lesser, hazardous condition.

Once a dust layer has been formed, it is cumulative and semi-permanent, unless physically cleared or capable of being safely exhausted into a collector. Therefore, equipment which is placed in a dust atmosphere shall be dust-tight and have a surface temperature limitation below the temperature at which a dust cloud or layer will ignite.

Equipment placed in areas outside the main dust hazard zone, but which may be temporarily subjected to a dust-laden atmosphere due to an occasional failure in the plant, or any untoward happening, shall be dust-protected and have a surface temperature limitation below the dust minimum ignition temperatures.

See IEC 61241-3 for details regarding classification of areas where combustible dusts are, or may be, present.

5 Practices A and B

Two different types of practice are specified in this standard, both intended to provide an equivalent level of protection against ignition.

5.1 Practice A

Design details and test methods are as follows:

- minimum ignition temperatures of a dust layer determined as specified in IEC 61241-2-1;
- maximum surface temperature measured under dust-free conditions as specified in 20.4.5.4 of IEC 61241-1-1;

- maximum permissible surface temperature for apparatus having dust layers up to a thickness of 5 mm, calculated as specified in 6.1.2.1;
- construction of enclosure meeting the general requirements as specified in IEC 61241-1-1;
- dust tightness tested by the method specified in IEC 60529 for category 1 (using artificial depression) meeting the requirements of table 1.

Table 1 – Dust tightness (practice A)

Zone 20 **Zone 21** **Zone 22 with conductive dust**	**Zone 22**
IP6X Marking DIP A20 or DIP A21	IP5X Marking DIP A22

5.2 Practice B

Design details and test methods are as follows:

- minimum ignition temperature of a dust layer determined as specified in IEC 61241-2-1;
- maximum surface temperatures measured under dust blanket conditions as specified in 20.4.5.5 of IEC 61241-1-1;
- maximum permissible surface temperature for apparatus having dust layers up to a thickness of 12,5 mm, calculated as specified in 6.1.2.2;
- construction of enclosure meeting the general requirements specified in IEC 61241-1-1;
- dust-tightness tested by the heat cycling dust test using the inherent depression of the apparatus, as specified in IEC 61241-1-1.

Table 2 – Dust tightness (practice B)

Zone 20 **Zone 21** **Zone 22 with conductive dust**	**Zone 22**
Dust-tight as specified in 20.4.3.4 of IEC 61241-1-1 Additional requirements as specified in clause 13 of IEC 61241-1-1 Marking DIP B20 or DIP B21	Dust protected as specified in 20.4.3.5 of IEC 61241-1-1 Clause 13 of IEC 61241-1-1 is not applicable Marking DIP B22

6 Selection according to temperature

6.1 Temperature limitation

The maximum surface temperature permitted for apparatus operating in either zone 21 or zone 22 is determined by the deduction of a safety margin from the minimum ignition temperature of the dust concerned, when tested in accordance with the methods specified in IEC 61241-2-1 for both dust clouds and layers up to a thickness of 5 mm or 12,5 mm. Dust layers exhibit two properties as layer thickness increases, a reduction in minimum ignition temperature and an increase in thermal insulation.

6.1.1 Temperature limitations because of the presence of dust clouds

The maximum surface temperature of the apparatus shall not exceed two-thirds of the minimum ignition temperature in degrees Celsius of the dust/air mixture concerned:

$$T_{max} = 2/3\ T_{C1}$$

where T_{C1} is the minimum ignition temperature of the cloud of dust.

6.1.2 Temperature limitation because of presence of dust layers

6.1.2.1 Practice A apparatus for dust layers up to a thickness of 5 mm

6.1.2.1.1 The maximum surface temperature of the apparatus when tested in the dust-free test method in 20.4.5.4.1 of IEC 61241-1-1 shall not exceed a value of 75 K below the minimum ignition temperature for a 5 mm layer thickness of the dust concerned:

$$T_{max} = T_{5\ mm} - 75\ K$$

where $T_{5\ mm}$ is the minimum ignition temperature of a 5 mm layer of dust.

6.1.2.1.2 Where there is a possibility that dust layers in excess of 5 mm may be formed on practice A apparatus, the maximum permissible surface temperature shall be reduced. For guidance, examples of the reduction in maximum permissible surface temperature of apparatus used in the presence of dusts having minimum ignition temperatures in excess of 250 °C for a 5 mm layer are shown in the graph below (figure 1) for increasing depths of layers.

NOTE – Before applying the information in this graph reference should be made to IEC 61241-2-1.

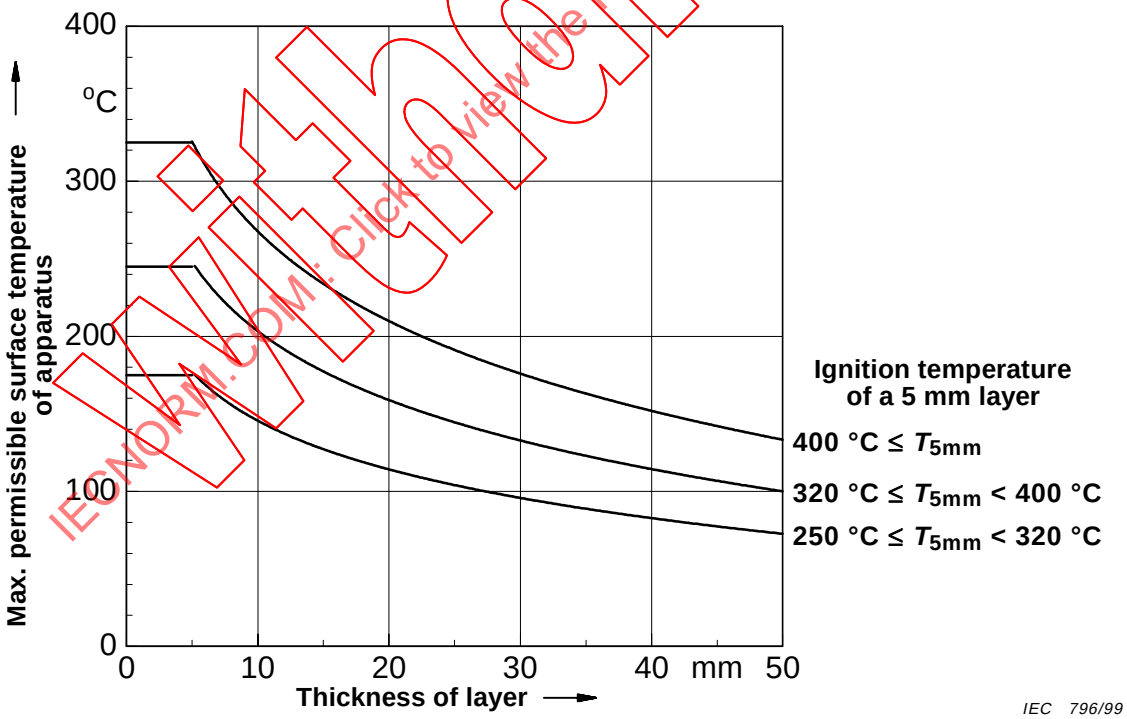

Figure 1 – Maximum permissible surface temperature versus dust layer thickness

Laboratory tests should be carried out to find minimum ignition temperature as a dependence of dust layer thickness. The graph should be taken as a semi-quantitative guideline.

6.1.2.2 Practice B apparatus for dust layers up to 12,5 mm thickness

The maximum surface temperature of the apparatus shall not exceed a value of 25 K below the minimum ignition temperature for the 12,5 mm layer thickness of the dust concerned when the apparatus is tested to the dust blanket test method in 20.4.5.5.1 of IEC 61241-1-1:

$$T_{max} = T_{12,5\ mm} - 25\ K$$

where $T_{12,5\ mm}$ is the ignition temperature of a 12,5 mm layer of dust

NOTE – T_{max} obtained from this clause and T_{max} from 5.2.1 are considered to offer equivalent safety.

6.1.2.3 Laboratory tests

Laboratory tests shall be carried out for

- zone 20;
- practice A apparatus where the minimum ignition temperature of a 5 mm layer is below 250 °C or there is any doubt concerning the application of the graph;
- practice B apparatus covered by dust layers in excess of 12,5 mm;
- practices A and B dust layer thickness in excess of 50 mm.

6.1.2.4 Unavoidable dust layers

Where it cannot be avoided that a dust layer forms around the sides and bottom of an apparatus or where the apparatus is totally submerged in the dust due to the insulation effect, a much lower surface temperature may be necessary. This special requirement can be met by a system of power limitation with or without inherent temperature control which shall be investigated under simulated working conditions.

6.2 Maximum permissible surface temperature

The lowest of the values obtained in 6.1.1 and 6.1.2.1 for practice A and in 6.1.1 and 6.1.2.2 for practice B will determine the maximum surface temperature of the apparatus to be used.

If the apparatus is to be used in conditions covered by 6.1.2.1.2 or 6.1.2.4 then these lower values shall be applied.

7 Selection of apparatus

7.1 Selection of practice A dust ignition protected apparatus

The apparatus shall be designed and tested to meet the relevant requirements of IEC 61241-1-1 and its maximum surface temperature shall be within the limits given in clause 6, depending on the possible build-up of dust layers.

Type of dust	Zone 20 or 21	Zone 22
Conductive	DIP A20 or DIP A21	DIP A21 (IP6X)
Non-conductive	DIP A20 or DIP A21	DIP A22 or DIP A21

7.2 Selection of practice B dust ignition protected apparatus

The apparatus shall be designed to meet the relevant requirements of IEC 61241-1-1 and its maximum surface temperature shall be within the limits given in clause 6, with a possible build-up of dust layers up to 12,5 mm.

Type of dust	Zone 20 or 21	Zone 22
Conductive	DIP B20 or DIP B21	DIP B21
Non-conductive	DIP B20 or DIP B21	DIP B22 or DIP B21

7.3 Selection of radiating equipment

For equipment radiating in the optical spectral range that is to be installed in the hazardous area, all relevant requirements of this standard including 7.3 shall be applied.

For equipment installed outside of, but radiating into, the hazardous area, only the requirements of 7.3 need be applied.

7.3.1 Ignition process

Radiation in the optical spectral range can, especially in the case of focusing, become a source of ignition for dust clouds or dust layers.

Sunlight, for example, may initiate an ignition, if objects concentrate the radiation (for example, concave mirror, lenses, etc.).

The radiation from high-intensity light sources, for example, photo-flash lamps is, in certain circumstances, so greatly absorbed by dust particles, that these particles become an ignition source for dust clouds or for dust layers.

In the case of laser radiation (for example, signalling, telemeters, surveying, range-finders), the energy or power density even of the unfocused beam at long distances may be so great that ignition is possible. Here, too, the heating is mainly caused by the effect of the laser beam on dust layers or by absorption on dust particles in the atmosphere. Particularly intense focusing may cause temperatures far in excess of 1 000 °C at the focal point.

Consideration shall be given to the possibility that the equipment itself producing the radiation (for example, lamps, electric arcs, lasers, etc.) may be an ignition source.

7.3.2 Safety measures in zone 20 or 21

Radiation-generating electrical equipment, if tested and permitted in accordance with this specification for zone 20 or 21, may be used. Independently of this fact, it shall be ensured that irradiation power or irradiation that may penetrate into or occur in zone 20 or 21, even in the case of rare disturbances in the entire part of the radiation process proceeding in zone 20 or 21 and at any point in the radiation cross-section shall not exceed the following values:

5 mW/mm^2 for continuous wave lasers and other continuous wave sources, and 0,1 mJ/mm^2 for pulse lasers or pulse light sources with pulse intervals of at least 5 s.

Radiation sources with pulse intervals of less than 5 s are regarded as continuous light sources in this respect.

7.3.3 Safety measures in zone 22

Equipment generating radiation may be used. The irradiation intensity or irradiation shall not exceed 10 mW/mm^2 continuous and 0,5 mJ/mm^2 for pulse in normal operation.

7.4 Selection of ultrasonic equipment

For ultrasonic transmitting equipment that is to be installed in the hazardous area all relevant requirements of this standard including those of 7.4 shall be applied.

For equipment installed outside of, but transmitting into the hazardous area, 7.4 shall be applied only.

7.4.1 Ignition process

When ultrasonics are applied, large proportions of the energy released by the sound transducer are absorbed by solid or liquid materials. Heating can occur in the material affected and, in extreme cases, may heat the material beyond the minimum ignition temperature.

7.4.2 Safety measures

The following remarks refer solely to the ignition hazard produced by the sonic power. In the case of safety measures, it shall be considered, among other things, that the electric charges shall be safely eliminated from the piezo-ceramics frequently used as transducers in ultrasonic equipment by means of suitable circuit elements.

7.4.2.1 Safety measures in zone 20 or 21

In zone 20 or 21, ultrasonics may be used only when the working method is recognized as perfectly suitable for use in this zone by reason of the low sonic power available, which shall not exceed a power density in the sound field of 0,1 W/cm^2 and a frequency of 10 MHz.

7.4.2.2 Safety measures in zone 22

In zone 22 in the case of working processes with the usual ultrasonic devices (for example, ultrasonic therapy appliances – diagnostic appliances and impulse chip testing devices) no special safety measures against ignition hazards due to the use of ultrasonics themselves are necessary, insofar as the power density in the sound field generated does not exceed 0,1 W/cm^2 and a frequency of 10 MHz.

8 Installation

8.1 General

In addition to the requirements of IEC 60364 for installations in areas free of combustible dust, and IEC 60079-14 for earthing and potential equalization, the further requirements for installation for use in the presence of combustible dust are described below.

Where electrical apparatus is installed in zone 20, special consideration shall be given to the selection of apparatus (under consideration for installation rules).

8.2 Access for inspection

Installations shall be designed and the apparatus installed to provide ease of access for inspection, maintenance and cleaning.

8.3 Plans and records

Plans of each site shall be maintained to show the following.

- The classification and extent of the hazardous areas as specified in IEC 61241-3; information including the zoning and maximum layer thickness, if greater than 5 mm for practice A or 12,5 mm for practice B.
- Records of the types and marking details of protected apparatus and sufficient information to enable them to be maintained properly.
- Types, routes and details of wiring systems.

8.4 Installation of apparatus

Electrical apparatus shall be protected against external influences (for example chemical, mechanical and thermal stresses) to which it may be subjected.

These additional measures shall not impair the normal heat dissipation of the apparatus or the integrity of the degree of protection provided by the enclosure. The method of installing the apparatus and of leading cables etc. into the apparatus shall not impair the degree of protection of the enclosure. All unused cable entries shall be sealed with suitable plugs.

8.5 Integrity of insulation

Care should be taken during installation to maintain the creepage and clearance distances provided during the design and manufacture of the apparatus so that the possibility of arcing or sparking is avoided.

8.6 Isolation

All electrical circuits shall be provided with an effective means of complete circuit isolation including the neutral, but not the protective conductor. Such means of isolation should be provided for each item of electrical apparatus and/or each subcircuit. Adequate labelling should be provided immediately adjacent to each means of isolation to permit rapid identification of the apparatus or subcircuit that it controls.

9 Wiring systems

9.1 Types of wiring

9.1.1 The types of wiring that may be used in zone 20, zone 21 and zone 22 areas are:

- cables drawn into screwed, solid drawn or seamed welded conduit; or
- cables that are inherently protected against mechanical damage and are impervious to dust.

9.1.2 Examples of the types of cable which meet these requirements are:

- thermoplastic or elastomer insulated, screened or armoured cable with a PVC, PCP, or similar sheath overall;
- cables enclosed in a seamless aluminium sheath with or without armour;
- mineral insulated cables with metal sheath with or without insulation sleeving.

NOTE – Mineral insulated cables may need to be derated to limit surface temperature.

9.1.3 Cable systems and accessories should be installed, so far as practicable, in positions that will prevent them being exposed to mechanical damage and to corrosion or chemical influences, and to the effects of heat. Where exposure of this nature is unavoidable, protective measures, such as installation in a conduit, shall be taken or appropriate cables selected (for example to minimize the risk of mechanical damage, armoured, screened, seamless aluminium-sheathed, mineral insulated, metal-sheathed or semi-rigid sheathed cables could be used).

9.1.4 Where cable or conduit systems are subject to vibration, they shall be designed to withstand that vibration without damage.

NOTE – Precautions should be taken to prevent damage to the sheathing or insulating materials of PVC cables when they are to be installed at temperatures below –5 °C.

9.2 Static build-up

Cable runs should be arranged so that they are not exposed to the friction effects and static build-up due to the passage of dust. Precautions shall be taken to prevent the build-up of static on surfaces of cables.

9.3 Dust collection

Cable runs should be arranged in such a way that they collect the minimum amount of dust whilst remaining accessible for cleaning. Where trunking, ducts or pipes or trenches are used to accommodate cables, precautions should be taken to prevent the passage or collection of combustible dusts in such places.

9.4 Cable and conduit entries

9.4.1 The manufacturer shall specify in the documents submitted according to 20.2 of IEC 61241-1-1, the entries intended for use with cable or conduit, their position on the apparatus and the maximum number permitted.

9.4.2 Cable and conduit entries shall be constructed and fixed so that they do not alter the specific characteristics of the type of protection of the electrical apparatus on which they are mounted. This shall apply to the whole range of cable dimensions specified by the manufacturer of the cable entries as suitable for use with those entries.

9.4.3 Entry by conduit shall be either by screwing into threaded holes or by locking in plain holes:

- in the wall of the enclosure; or
- in an adaptor plate designed to be fitted in or on the walls of the enclosure; or
- into a suitable stopping box, integral with or attached to the wall of the enclosure.

9.4.4 Blanking elements, intended to close openings in the walls of electrical apparatus, when they are not fitted with cable or conduit entries, shall, together with the enclosure wall of the apparatus, satisfy the requirements of the specific type of protection concerned. The means provided for this shall be such that the blanking element can be removed only with the aid of a tool.

9.5 Accessories

Where accessories are used (for example junction boxes) for the interconnection of cables and for apparatus they shall also be of a type of enclosure suitable for the zone of application.

9.6 Course of wiring

Wherever possible cables that are not associated with hazardous areas should not pass through such an area. If this is unavoidable, then the requirements of this standard will apply to these cables.

9.7 Thermal rating

Where layers of dust are liable to form on cables and impair the free circulation of air, consideration shall be given to derating the current-carrying capacity of the cables, especially if low minimum ignition temperature dusts are present.

9.8 Barriers

Where cables pass through a floor, wall, partition or a ceiling that forms a dust barrier, then the hole that is provided should be sealed to prevent the passage or collection of combustible dust.

9.9 Flexible connection

For terminal connections to fixed apparatus that may be required from time to time to be moved a small distance (for example motors on slide rails), cables should be arranged to permit the necessary movement without detriment to the cable. Either this or one of the types of cables suitable for use with transportable apparatus may be used. Suitably protected terminal boxes for the junction with the fixed wiring and the wiring to the apparatus shall be provided where the fixed wiring is not itself of a type suitable to permit the necessary movement. If flexible metallic tubing is used, it and its fittings shall be so constructed that damage to the cable consequent upon its use is avoided. Adequate earthing or bonding shall be maintained; the flexible tubing shall not be the sole means of earthing. The flexible tubing shall be impervious to dust and its use shall not impair the integrity of the enclosure of the apparatus to which it is joined.

If, for portable and transportable electrical apparatus, a metallic flexible armour or screen is incorporated in the cable, this shall not be used as the only protective conductor.

9.10 Metal conduit systems

Where metal conduit systems are used they shall be impervious to dust and, in addition, comply with the requirements of 9.12 of this standard.

9.11 Plastic conduit systems

In areas of low risk of mechanical damage, rigid plastic conduits and fittings meeting the test conditions in table 4 of IEC 60079-0 may be used. The system shall be impervious to dust. Joints shall either comply with the requirements of 9.12 of this standard or be solvent welded.

9.12 Conduit system joints

Joints between case and removable parts, such as covers, inspection plates, etc., shall be either gasketed joints, threaded joints, spigot joints, flanged joints or a combination of these.

Where gasketed or plain flanged joints are used, a sufficient number of securing bolts or screws or other types of clamping devices shall be used to ensure that the flanges are brought together over the whole joint area.

Joints between the conduit and terminal case of the apparatus shall conform to the requirements of the apparatus specification and shall, as a minimum requirement, be either gasketed joints, threaded joints, spigot joints, flanged joints or a combination of these.

Threaded joints shall have an adequate number of threads to maintain the ingress protection of the enclosure. Sealant may be used if provision is made for continuity of the equipotential bonding system.

10 Inspection and maintenance

10.1 General

To minimize the risk of ignition by electrical apparatus in hazardous areas, efficient inspection and maintenance of apparatus, systems and installations are essential. This shall include a check to ascertain that the original design conditions (type of dust, maximum layer thickness, etc.) are unchanged. It should be noted that correct functional operation does not itself indicate conformity with the recommendations for the safe use of apparatus.

The recommendations for inspection and maintenance of apparatus protected by enclosure against ingress of combustible dust are described below.

10.2 Qualifications of personnel

The inspection and maintenance of electrical apparatus for use in combustible dusts shall only be carried out by personnel who are familiar with the concept of protection.

10.3 Isolation

Before any apparatus is opened in a hazardous area it shall be isolated from all sources of supply including the neutral, and effective measures taken to prevent inadvertent re-energization whilst equipment is open.

10.4 Maintenance

Electrical apparatus for use in the presence of combustible dust shall be inspected and maintained on a regular scheduled basis, the periods of which will depend upon the general environment, the amount of use the apparatus is subjected to and the manufacturer's recommendations.

10.5 Examination

Wherever practical, electrical apparatus should be taken to a dust-free area for maintenance which requires the opening of the apparatus. If this is not practical, suitable measures shall be taken to prevent dust entering the enclosure.

Care shall be taken during dismantling that the parts that provide the integrity of the enclosure, for example seals, joint faces, etc. shall not be damaged, if it is not intended to replace them.

On reassembling, the manufacturer’s recommendation for sealing shall be provided and followed.