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Selection, use, care and maintenance of personal protective equipment for preventing electrostatic risks in hazardous areas (explosion risks)

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Selection, use, care and maintenance of personal protective equipment for preventing electrostatic risks in hazardous areas (explosion risks)

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Foreword

This document (CEN/CLC/TR 16832:2015) has been prepared by Technical Committee CEN/CLC/JWG 7 “PPE against electrostatic risks”, the secretariat of which is held by NEN.

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Introduction

European Standards for personal protective equipment (PPE) are developed to ensure compliance with the European Directive 89/686/EEC. Since the primary aim of this directive is to guarantee a free market in the European Union, these standards are made to meet the needs for a common set of safety requirements and test methods.

The actual use of PPE is not covered by this directive, nor by related standards.

This Technical Report has been developed to meet the needs for a document on selection, use, care and maintenance. Regulations on health and safety are based on Directive 89/686/EEC, giving minimum requirements on the selection and use of PPE in the workplace. EU Member States may impose more stringent requirements and may define exposure limits.

The information in this Technical Report has been produced to assist employers in making the necessary decisions regarding the selection, use, care and maintenance of PPE. The guidance given may also be useful for other parties such as suppliers of PPE or services, inspection agencies, insurance companies, etc.

The purpose of this Technical Report is to highlight the main areas that an employer needs to consider.

This Technical Report may serve as guidance and as a checklist when a company is preparing its own management system or programme for PPE.

1 Scope

This Technical Report sets out guidance for the selection, use, care and maintenance of clothing and related items of personal protective equipment designed to prevent hazards caused by static electricity in hazardous areas.

Static electricity should not be confused with mains supply electricity, or other forms of electric current; the requirements for protection against static electricity are different to the requirements for protection against hazards associated with electric current. Protection against electrostatic risks should not be confused with protection against electric arc; the former is concerned with electrical properties and the latter is concerned with heat, flame and projectile protection.

Directive 89/686/EEC requires that PPE intended for use in explosive atmospheres must be so designed and manufactured that it cannot be the source of an electric, electrostatic or impact-induced arc or spark likely to cause an explosive mixture to ignite. Whereas this Technical Report addresses electrostatic ignition risks, it does not address other possible sources of ignition. Nevertheless, other possible sources of ignition are required to be considered when certifying PPE to the requirements of Directive 89/686/EEC.

NOTE EN 13463–1 gives guidance on assessing possible ignition sources in non-electrical equipment that may be used for some items of PPE.

2 Normative references

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

EN 1081, *Resilient floor coverings — Determination of the electrical resistance*

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

EN 1149-2, *Protective clothing — Electrostatic properties — Part 2: Test method for measurement of the electrical resistance through a material (vertical resistance)*

EN 1149-3, *Protective clothing — Electrostatic properties — Part 3: Test methods for measurement of charge decay*

EN 1149-5, *Protective clothing — Electrostatic properties — Part 5: Material performance and design requirements*

CEN/TR 15321:2006, *Guidelines on the selection, use, care and maintenance of protective clothing*

EN 16350, *Protective gloves — Electrostatic properties*

EN 60079-10-1, *Explosive atmospheres — Part 10-1: Classification of areas — Explosive gas atmospheres (IEC 60079-10-1)*

EN 60079-10-2, *Explosive atmospheres — Classification of areas — Combustible dust atmospheres (IEC 60079-10-2)*

CLC/TR 60079-32-1:2015, *Explosive atmospheres — Part 32-1: Electrostatic hazards, Guidance (IEC/TS 60079-32-1:2013)*

EN 60079-32-2:2015, *Explosive atmospheres — Part 32-2: Electrostatics hazards — Tests (under consideration) (IEC 60079-32-2:2015)*

EN 61340-4-1, *Electrostatics — Part 4-1: Standard test methods for specific applications — Electrical resistance of floor coverings and installed floors (IEC 61340-4-1)*

EN 61340-4-3, *Electrostatics — Part 4-3: Standard test methods for specific applications — Footwear (IEC 61340-4-3)*

EN 61340-4-5, *Electrostatics — Part 4-5: Standard test methods for specific applications — Methods for characterizing the electrostatic protection of footwear and flooring in combination with a person (IEC 61340-4-5)*

EN ISO 11611, *Protective clothing for use in welding and allied processes (ISO 11611)*

EN ISO 13688, *Protective clothing — General requirements (ISO 13688)*

CEN ISO/TR 18690, *Guidance for the selection, use and maintenance of safety and occupational footwear and other personal protective equipment offering foot and leg protection (ISO/TR 18690)*

EN ISO 20344, *Personal protective equipment — Test methods for footwear (ISO 20344)*

EN ISO 20345, *Personal protective equipment — Safety footwear (ISO 20345)*

EN ISO 20346, *Personal protective equipment — Protective footwear (ISO 20346)*

EN ISO 20347, *Personal protective equipment — Occupational footwear (ISO 20347)*

ISO 7000, *Graphical symbols for use on equipment — Registered symbols*

ISO 10965, *Textile floor coverings — Determination of electrical resistance*

3 Term and definitions

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

3.1
hazard
situation which can be the cause of harm or damage to the health of the human body

[SOURCE: CEN/TR 15321:2006, 2.1]

Note 1 to entry: The effects of static electricity can be a nuisance. Electrostatic attraction of dirt and electrostatic shocks to personnel, for example, are not directly harmful, but they are nonetheless undesirable. Nuisance effects may cause hazards indirectly. For example, a person working on a ladder may fall off the ladder because of an involuntary reflex after receiving an electrostatic shock. If nuisance shocks are felt, it is an indication that there is an electrostatic ignition risk, if the person concerned is in a hazardous area.

3.2
risk
combination of the frequency, or probability, of occurrence and the consequence of a specified hazardous event

[SOURCE: CEN/TR 15321:2006, 2.2]

3.3
selection
process of determining the type of protective equipment (garments) that is necessary for the required protection

[SOURCE: CEN/TR 15321:2006, 2.3]

3.4
use
application of protective clothing including its limitations

[SOURCE: CEN/TR 15321:2006, 2.4]

3.5
care
to keep in good working order, including procedures for cleaning, decontamination and storage

[SOURCE: CEN/TR 15321:2006, 2.5]

3.6
maintenance
to preserve from loss or deterioration, to include procedures for inspection, repair and ultimate removal from service

[SOURCE: CEN/TR 15321:2006, 2.6]

3.7
explosive atmosphere
mixture with air, under atmospheric conditions, of flammable substances in the form of gas, vapour, dust, fibres, or flyings which, after ignition, permits self-sustaining propagation

[SOURCE: IEV 426-01-06]

3.8
hazardous area
area in which an explosive material, pyrotechnic article or explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for construction and use of personal protective equipment

[SOURCE: IEV 426-03-01, modified — The definition has been modified and the original Notes to the definition are not reproduced here.]

3.9
hazardous zone
hazardous area classified based on the frequency of the occurrence and duration of an explosive atmosphere

Note 1 to entry: See Annex B.

3.10
electricity
set of the phenomena associated with electric charges and electric currents

[SOURCE: IEV 121-11-76]

3.11
electric current
electric charges that continuously move through a conductor under the influence of a potential gradient

3.12
electric field
electrostatic field
vector field that surrounds electric charge

3.13
electric induction
electrostatic induction
phenomenon in which the electric charge distribution in a body is modified by an electric field

[SOURCE: IEV 121-11-68]

3.14
static electricity
accumulation of electric charge on an object or surface

3.15
electrostatic
associated with static electricity

3.16
electrostatic discharge
ESD
transfer of electric charge between bodies of different electrostatic potential in proximity or through direct contact

[SOURCE: IEV 161-01-22, modified — "Electric" is here replaced with "electrostatic" and the original Note to the definition is not reproduced here.]

3.17
brush discharge

type of electrostatic discharge that occurs when rounded (as opposed to sharp) earthed conductors are moved towards charged insulating objects or surfaces; characterized by branching discharge channels

3.18
spark discharge
spark
type of electrostatic discharge that occurs between two conductors; characterized by a well-defined luminous discharge channel carrying a high density current

3.19
corona discharge
corona
type of electrostatic discharge with slight luminosity produced in the neighbourhood of a pointed, or small radius conductor and limited to the region surrounding the conductor in which the electric field exceeds a certain value

Note 1 to entry: Other types of electrostatic discharge exist (e.g. propagating brush discharge, cone discharge, lightning, etc.), but they are not normally associated with PPE in the context of this document.

3.20
electrostatic shock
physiological effect resulting from an electrostatic discharge passing through a human body

3.21
tribocharging
triboelectric charging
triboelectrification
electrical charging process in which net charge is generated by the contact and separation of two surfaces which may be solid, liquid or particle-carrying gases

3.22
triboelectric series
list of materials ranked in order of how they charge when in contact with one another

Note 1 to entry: See Annex A.

3.23
antistatic
antielectrostatic
property of a material or object that reduces its tendency to acquire charge by contact or rubbing, or that reduces the time taken for charge to dissipate to an acceptable level

Note 1 to entry: Although “antistatic” is a commonly used term, it is deprecated in some standards documents because it has many different meanings, depending on the context in which it is used, and this can lead to confusion.

3.24
low charging
a-static
property of a material or object that reduces its tendency to acquire charge by contact or rubbing

3.25
conductive
describing materials or objects that allow charge to be dissipated rapidly by conduction to earth

3.26
insulating
describing materials or objects that retain charge for long periods of time even when connected to earth

Note 1 to entry: Conductive and insulating materials and objects are commonly defined quantitatively by their resistance or resistivity. The range of acceptable values of resistance or resistivity can vary significantly depending on the material or object and its application.

3.27
electrostatic dissipative (used in EN 1149 (all parts))
static dissipative
dissipative
describing materials or objects that dissipate charge to an acceptable level within an acceptable period of time

Note 1 to entry: Electrostatic dissipative materials and objects may be defined quantitatively by their resistance or resistivity, or by other parameters such as decay time, shielding factor, etc. If resistance or resistivity is used to define electrostatic dissipative materials or objects, the acceptable range of values is between that of conductive materials and objects and insulating materials and objects.

3.28
oxygen-enriched atmosphere
atmosphere in which the oxygen content exceeds 21,5 % volume fraction of air

Note 1 to entry: Minimum ignition energy values are commonly specified for mixtures with air containing normal levels of oxygen, i.e. (21,0 ± 0,5) % volume fraction.

Note 2 to entry: In normal industrial situations, it is unlikely that people will be working in an oxygen-enriched atmosphere. Nevertheless, an oxygen-enriched atmosphere can occur inadvertently, for example when gas welding is carried out. Oxygen-enriched atmospheres can also occur in medical applications.

3.29
earth (verb)
ground
to connect a conductor to the main body of the Earth to ensure that it is at earth potential

3.30
earth (noun)
ground
part of the Earth which is in electric contact with an earth electrode and the electric potential of which is not necessarily equal to zero

[SOURCE: IEV 195-01-03]

NOTE In some contexts, earth can have a different meaning to ground, but for the purposes of this document earth and ground are synonyms.

3.31
equipotential bonding
to electrically connect all conductors and static dissipative materials and objects within a system together to ensure that no hazardous potential differences exist within the system

Note 1 to entry: For the purposes of this document, and unless otherwise stated, equipotential bonding may be used in cases where earthing is impossible or impractical.

3.32
resistance to earth
leakage resistance
total electrical resistance through a system between a person or item or component of PPE and earth

3.33
capacitance
relationship between charge on a conductor (Q) and its electrical potential (V) given by $C = \frac{Q}{V}$

Note 1 to entry: Capacitance is variable and is dependent on the proximity of the conductor relative to other large bodies or earth planes

3.34
minimum ignition energy
MIE (abbreviation)
minimum energy that can ignite a mixture of a specified flammable material with air or oxygen, measured by a standard procedure

Note 1 to entry: ASTM E582 defines standard procedures for determining MIE of gas and vapours; IEC 61241–2-3, EN 13821 and ASTM E2019 define standard procedures for determining MIE of dusts.

Note 2 to entry: Annex A of this Technical Report and CLC/TR 60079–32–1:2015, C.6 give additional information on minimum ignition energy.

3.35
probability of charging
probability of a charge mechanism occurring

Note 1 to entry: Probability of charging is only concerned with the occurrence of a charging mechanism, not the quantity of charge generated.

4 Selection

4.1 General

The primary defence against hazardous electrostatic discharges from personnel is to ensure that they are properly earthed (see 5.1). When people are earthed there is no possibility of electrostatic discharges occurring from their bodies. However, electrostatic discharges from their clothing and other items of PPE may still be possible and consideration should be given to the need for electrostatic dissipative protective clothing and equipment.

Depending of the sensitivity to ignition, and the probability of an explosive atmosphere being present, it may be possible to safely use PPE that has limited areas or limited widths of insulating materials. The size limitations for insulating materials that can be safely used in hazardous areas are given in CLC/TR 60079–32–1:2015, Table 3. For example, in Zone 1 with gases of explosion group IIA and IIB, it is permissible to have continuous areas of insulating material up to 10 000 mm^2 and up to 30 mm in width. Smaller items of PPE may fall within the permissible limits, but clothing and other large items of PPE will generally exceed the permissible size limits for insulating materials and it is for these items of PPE that there is normally a need for electrostatic dissipative materials to be used.

It is important to note that the use of electrostatic dissipative protective clothing and equipment cannot eliminate the risk of hazardous electrostatic discharges from isolated personnel. Some items of PPE, e.g. conductive or antistatic footwear is intended to provide an adequate connection between personnel and earth, but such items of PPE are only effective if the connection to earth is not compromised. For example, conductive or antistatic footwear is only effective if used in conjunction with conductive or dissipative flooring. Although electrostatic dissipative protective clothing and equipment may help to reduce the risk of hazardous electrostatic discharges, they cannot be used as a substitute for proper earthing.

Directive 1999/92/EC requires employers to eliminate all possible ignition sources from areas where it is identified that explosive atmospheres exist. If, for example, a person is working with a flammable gas – may be at a hydrogen filling station – there is a risk that a brush discharge from plain clothing could ignite the gas because the energy in a brush discharge may be greater than the minimum ignition energy (MIE) of the gas. In this case the employer has an obligation under Directive 1999/92/EC to provide electrostatic dissipative protective clothing if the hazard associated with explosive atmosphere cannot be eliminated by technical measures.

On the other hand, if a powder with MIE of a greater than 1 mJ is being handled, there is no risk of a brush discharge from plain clothing causing an ignition of the powder. In this case the employer can still comply with Directive 1999/92/EC by providing insulating clothing and ensuring that personnel are properly earthed.

The risk associated with electrostatic discharges from clothing depends on the presence and sensitivity to ignition of explosive atmospheres. To assist in identifying different levels of risk, EN 60079-10-1 and EN 60079-10-2 classify hazardous areas into zones depending on the nature of the flammable material (gas and vapour, or dust) and on the probability of an explosive atmosphere being present (see Annex B).

Another factor in determining risk is the probability of a charging mechanism occurring. The most common way in which clothing becomes charged is by contact and rubbing, a process known as tribocharging. A jacket, for example, may be tribocharged when a person sits in and then rises from a seat, the jacket having rubbed against the surface of the seat. A jacket, therefore, may be considered to have a high probability of being exposed to a charging mechanism. Conversely, a hat may not come in contact with other objects and may, therefore, be considered to have a low probability of being exposed to a charging mechanism. Clothing and other items of PPE can also become charged by exposure to equipment that generates ions, charged sprays or aerosols.

Another charging mechanism, only applicable to isolated conductors, is induction, which is the separation of charge in the presence of an electric field. Standards and codes of practice require that conductors, which in this context includes people, are properly and securely earthed in hazardous areas, so in most cases the risk of induction charging is not significant. However, care should be exercised in selecting PPE that may include small conductors that cannot be earthed for practical reasons.

Table 1 gives some examples of different situations with high and low probability of charging. The situations described in Table 1 are illustrative examples only and should not be considered as definitive statements of actual charging behaviour. Charging is dependent on a number of factors and should be evaluated on a case by case basis. Expert advice should be obtained if the probability of charging is not understood, particularly when evaluating new situations.

Although the nature of materials largely determines their propensity for charging, environmental factors, i.e. temperature and humidity, also have an influence. In general, as relative humidity, decreases, the propensity of materials to acquire and retain charge increases. Risk assessment should take account of the full range of environmental conditions workers are likely to be exposed to, including seasonal variations, outdoor or indoor working (or both), and the presence of heating and air conditioning in the workplace. A typical conditioning environment specified in test standards (e.g. EN 1149-1 and EN 1149-3) is (23 ± 1) °C and (25 ± 5) %RH. This conditioning environment is a compromise between the worst case conditions likely to occur in practice, and the practical limitations of testing. However, if risk assessment shows that workers are likely to be exposed for prolonged periods to drier conditions than this, testing of PPE should be done under correspondingly lower humidity conditions.