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TECHNICAL SPECIFICATION

Electrostatics –
Part 6-2: Electrostatic control in healthcare, commercial and public facilities – Public spaces and office areas

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INTERNATIONAL
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FOREWORD

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IEC TS 61340-6-2 has been prepared by IEC technical committee 101: Electrostatics. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
101/682/DTS	101/695/RVDTS

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

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 61340 series, published under the general title *Electrostatics*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

This document provides guidance on how to control static electricity in office areas and public places. Static electricity can be the source of the following hazards and nuisances:

- electrostatic shocks to people;
- electromagnetic interference (EMI) or electrostatic discharge (ESD) disruption or damage to electronic equipment, audiovisual systems, computers and mobile devices such as telephones, tablet computers, laptop computers;
- contamination caused by electrostatic attraction (ESA) or electrostatic repulsion (ESR) of airborne pathogens;
- ignition of flammable gases, vapours, liquids, aerosols, combustible flyings, powders and dusts.

Adequate electrostatic control can eliminate these hazards and nuisances, or at least reduce involved risk to tolerable levels. Electrostatic controls can be established in many different ways.

ELECTROSTATICS –

Part 6-2: Electrostatic control in healthcare, commercial and public facilities – Public spaces and office areas

1 Scope

This part of IEC 61340 applies to the interior design of public places, retail and office areas such as, but not limited to staircases, offices, meeting rooms, auditoriums, airports, train stations, shopping centres, restaurants and theatres. This document includes guidelines for architects, interior designers and facility managers.

Hazards, nuisances and other problems associated with electrostatic phenomena and the principles of their control are outlined. This document includes requirements and recommendations for materials, and products used to control static electricity.

The handling of electrostatic sensitive components is described in IEC 61340-5-1 [1][1] and the avoidance of hazards due to static electricity in explosive atmospheres is presented in IEC TS 60079-32-1 [2]. The requirements for electrostatic control in healthcare facilities are specified in IEC 61340-6-1 [3]. The guidance in this document is not intended to replace or supersede the requirements of the aforementioned standards and technical specification, but can be used in association with them to establish appropriate electrostatic control measures.

These guidelines do not replace or supersede any requirements for personnel safety specified in other standards or codes of practice.

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.

IEC 61340-2-1, *Electrostatics – Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge*

IEC 61340-2-3, *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid materials used to avoid electrostatic charge accumulation*

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

IEC 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*

ISO 18080-2, *Textiles – Test methods for evaluating the electrostatic propensity of fabrics – Part 2: Test method using rotary mechanical friction*

1 Numbers in square brackets refer to the Bibliography.

ISO 18080-3, *Textiles – Test methods for evaluating the electrostatic propensity of fabrics – Part 3: Test method using manual friction*

ISO 18080-4, *Textiles – Test methods for evaluating the electrostatic propensity of fabrics – Part 4: Test method using horizontal mechanical friction*

EN 1149-3:2004, *Protective clothing – Electrostatic properties – Part 3: Test methods for measurement of charge decay*

3 Terms and definitions

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

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
acceptance testing
testing used to determine if systems or products meet specified requirements when installed or before first use

Note 1 to entry: Acceptance testing can be the same as testing used for qualification or can be simpler testing more appropriate for use in a facility rather than a controlled testing laboratory.

3.2
conductor
object providing a sufficiently high conductivity so that potential differences over any parts of it are not sufficiently large as to be of practical significance

3.3
electromagnetic compatibility
EMC
ability of an equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

3.4
electromagnetic interference
EMI
degradation of the performance of a device, equipment or system caused by an electromagnetic disturbance

Note 1 to entry: Disturbance and interference are cause and effect respectively.

3.5
electrostatic attraction
ESA
effect of the force on charged or polarized particles caused by an electrostatic field

Note 1 to entry: The electrostatic force between oppositely charged objects or between charged objects and polarized objects can cause the objects to move towards each other, which can result in the increased deposition of particles onto charged surfaces.

3.6
electrostatic conductive material
material providing a sufficiently high conductivity so that potential differences over any parts of it are not sufficiently large as to be of practical significance

3.7
electrostatic discharge
ESD
transfer of electric charge between bodies of different electric potential in proximity or through direct contact

3.8
electrostatic dissipative material
material which allows charge to migrate over its surface or through its volume, or both, in a time that is short compared to the timescale of the actions creating the charge or that will cause an electrostatic problem

3.9
electrostatic insulating material
material with very low mobility of charge so that any charge on the surface will remain there for a long time

3.10
ESD ground
terminal used to connect parts to ground for ESD control purposes

Note 1 to entry: Protective earth or functional ground can be used as ESD ground.

Note 2 to entry: Equipment ground is one form of protective earth.

3.11
electrostatic repulsion
ESR
movement of charged particles away from objects charged to the same polarity

Note 1 to entry: Charged particles repelled from one surface can cause contamination of nearby surfaces.

3.12
functional ground
terminal used to connect parts to ground for reasons other than safety

Note 1 to entry: A functional ground can be a ground rod, stake or a separate wiring system that is bonded to the AC ground at the main service panel.

Note 2 to entry: In the absence of a dedicated functional ground, a protective earth can be used as a functional ground.

3.13
grounding
electrical connection of conductors, usually with ESD ground, to allow dissipation of charge and eliminate the possibility of voltage build-up

Note 1 to entry: In this document grounding means either equipotential bonding or grounding.

Note 2 to entry: In this document ground and grounding are synonymous with earth and earthing.

3.14
isolated conductor
non-grounded conductor

3.15
low charging material
material with a tendency to minimize charge generation when contacting and rubbing against other materials

Note 1 to entry: As contact electrification and triboelectric charging are dependent on the nature of both contacting surfaces and the local environment, materials qualified as low charging under specific test conditions are not necessarily low charging under all possible conditions.

Note 2 to entry: Low charging material pairs are generally electrostatic conductive, electrostatic dissipative or slowly dissipative materials.

3.16
protective earth
terminal used to connect parts to earth for safety reasons

Note 1 to entry: Protective earth is also known as equipment grounding conductor.

3.17
qualification
process of evaluating test data or system or product data sheets to ensure that systems, materials or finished products meet specified requirements

3.18
slowly dissipative material
material with a tendency to dissipate charge faster than an electrostatic insulating material but slower than an electrostatic dissipative material

Note 1 to entry: Slowly dissipative materials, in general, have a tendency to minimize charge generation when contacting and rubbing against other materials.

4 Static electricity

4.1 General

Electrostatic charge generation, charge transfer and electrostatic discharge are briefly described in this document. The fundamental principles of electrostatic phenomena including charge generation, retention and dissipation, and electrostatic discharges are explained in more detail in IEC TR 61340-1 [4].

4.2 Triboelectrification

All materials have positive and negative charges in their atoms. When two materials touch, charge is transferred from one material to the other at the points of contact. When they separate, a net positive charge remains on one surface and a net negative charge remains on the other surface. The quantity of charge is increased by the separation velocity and the size of the contact area. The size of the contact area is affected by contact pressure. Additional rubbing also increases the effective contact area. Substances subject to triboelectrification can be solid/solid, liquid/liquid, and solid/liquid. Such solids include dust, and the liquids include mists.

4.3 Retention of charge

After separation in the charging process, electrostatic charges will re-combine either directly or via earth unless they are prevented from doing so. If charge is on an electrostatic insulating material, it is retained by virtue of the resistance of the material itself. To retain charge on an electrostatic conductive or electrostatic dissipative material it shall be isolated from other electrostatic conductive or electrostatic dissipative materials and from earth.

4.4 Induction

There are electric fields and electrostatic forces around charged objects. A conductor or electrostatic dissipative material introduced into this field changes the distribution of the electric field in its vicinity and at the same time there is a redistribution of charges in the material under the influence of the field, which creates an electric potential (voltage) on the material.

4.5 Charge transfer by conduction

Whenever an electrostatic conductive or electrostatic dissipative object touches another electrostatic conductive or electrostatic dissipative object, the total charge is shared between them. If the potential difference between the two objects is large enough, an electrostatic discharge (see 4.6) can occur, which can transfer charge between the objects without physical contact occurring.

4.6 Electrostatic discharge (ESD)

An electrostatic discharge (ESD) occurs when two objects at different voltages either touch, or approach close enough for the breakdown field strength to be exceeded between them.

A typical example of an ESD is a discharge between a person's finger and a metal handle.

5 Electrostatic hazards and nuisances

5.1 General

The use of synthetic materials such as electrostatic insulating polymers has increased incidences of electrostatic hazards and nuisances during recent decades. Floorings, furnishings and textiles are often made of electrostatic insulating polymers.

Commonly used synthetic materials can result in triboelectrification or charging by induction, and charge accumulation causing electrostatic hazards.

Combinations of electrostatic insulating materials and conductors (e.g. metals) can create isolated conductors that can accumulate charge and create electrostatic hazards.

5.2 Electrostatic shocks to people

The most unpleasant electrostatic shocks to people occur typically in indoor areas when the outdoor temperature is low and heating decreases indoor relative humidity. Other conditions that lower the relative humidity of the environment can also increase the occurrence of electrostatic shocks.

ESD is typically characterized as an annoying phenomenon, but the discharge energy can also be high enough to cause painful sensations. The discharge to or from the human body is generally not considered dangerous, although it can result in involuntary movements, which can lead to accidents.

The risk of electrostatic shock can be reduced to tolerable levels by choice of materials, grounding of electrostatic conductive or electrostatic dissipative objects such as mobile equipment and personnel, or by active control measures.

NOTE Electrostatic conductive or electrostatic dissipative footwear is commonly used for grounding personnel through footwear to a grounded electrostatic conductive or electrostatic dissipative floor (see 6.5.3.2).

5.3 Electrostatic discharge and electromagnetic compatibility

Electrostatic discharge (ESD) and inadequate electromagnetic compatibility (EMC) are typical reasons for disruption of data transfer in office areas. ESD can also cause loss of functions to electrical equipment such as repeaters, servers, personal computers, audiovisual systems and mobile devices. Insufficient electrostatic control can also cause unnecessary repair costs, as well as corruption of data affecting operational quality and reliability. Owing to demanding analysis techniques, the root causes of failures are difficult or impossible to recognize.

ESD immunity testing for EMC does not cover all real discharge scenarios, such as those where metal parts having different voltages are touched together. Charge accumulation in a mobile metal object can also result in high ESD energies in uncontrolled environments. Especially in low relative humidity, discharge energies can exceed the stress levels used in IEC 61000-4-2 [5].

A completely integrated system of electronic equipment is not necessarily tested against transients caused by ESD, although individual parts of the system have generally passed EMC qualification. Therefore, testing does not always consider all the realistic coupling and failure scenarios of the whole system.

Architectural design and engineering should take electrostatic control into account to ensure the functionality of information technology and security systems. In addition, electrostatic control should also be applied in public locations where people use mobile electronic devices.

5.4 Electrostatic attraction and repulsion

Electrostatically charged surfaces attract or repel airborne particles. The phenomenon is called electrostatic attraction (ESA) or electrostatic repulsion (ESR). Airborne particles attracted to a charged surface are one source of surface contamination. Airborne particles repelled from a charged surface can be deposited on other surfaces, thereby creating another source of surface contamination.

Electrostatic control should be considered when cleanliness is necessary, and especially if frequent cleaning of surfaces is to be avoided.

Charge accumulation and surface charge densities can be reduced to tolerable levels by choice of materials, grounding of electrostatic conductive or electrostatic dissipative objects such as mobile equipment and personnel, or by active control measures.

5.5 Ignition of flammable substances

The use of flammable substances should be minimized, but flammable materials can be present for short times and used in small quantities. The risk of fires or explosions can be increased if flammable solvents or other chemicals are temporarily used for example in cleaning or maintenance.

The risk of incendiary ESD can be reduced to tolerable levels by choice of materials, grounding of electrostatic conductive or electrostatic dissipative objects such as mobile equipment and personnel, or by active control measures.

NOTE Electrostatic conductive or electrostatic dissipative footwear is commonly used for grounding personnel through footwear to a grounded electrostatic conductive or electrostatic dissipative floor (see 6.5.3.2).

6 Electrostatic control

6.1 General

Electrostatic control in this context refers to the different optional actions or selections required to reduce electrostatic hazards and nuisance. Electrostatic control in public locations and office areas is recommended and should be considered at the design stage of new facilities or when refurbishing existing facilities.

6.2 Passive control methods

6.2.1 Material selections

Materials for electrostatic control shall: limit the generation of electrostatic charge; quickly dissipate electrostatic charge; suppress or attenuate electrostatic field or electrostatic potential associated with residual electrostatic charge. To a certain extent, these functions are related. For example, a material that is able to dissipate charge faster than it is generated will appear to be one that limits the generation of charge. However, in some cases, the functions can be independent. Some materials that do not dissipate charge quickly, can show limited accumulation of charge or low measured surface potential.

6.2.2 Grounding or equipotential bonding

Discharges from conductors or from a human body can be prevented with grounding. Electrostatic conductive parts of fixed metal objects should be connected to the ESD ground. Grounding people and all electrostatic conductive parts of every item through the flooring or with direct electrical connection to an ESD ground should be a priority for effective electrostatic control.

Grounding of personnel via flooring requires that the resistance to ground from personnel via their footwear and flooring is $< 1 \times 10^9$ Ω, see 6.5.3.2. The resistance of footwear and flooring in combination with a person shall be measured according to IEC 61340-4-5. Whilst in many cases mandating specific footwear is not practically possible, the use of flooring with a resistance to ground of $< 1 \times 10^9$ Ω can provide a means of grounding personnel that happen to be wearing footwear of sufficiently low resistance. It can also help to reduce charge generation, see 6.5.3.3.

If a functional ground is used as ESD ground, it should be electrically bonded to protective earth, where possible to avoid potential differences between the two systems.

In situations where an ESD ground is not possible, within a vehicle for example, equipotential bonding can be used as an alternative to grounding. Equipotential bonding is achieved by connecting people and all electrostatic conductive parts of every item through the flooring or with direct electrical connection to a common connection point.

6.2.3 Passive ionization

Ions produced in the air, commonly created by corona discharge, can be used to reduce the accumulation of charge on electrostatic insulating surfaces, or other surfaces that cannot be grounded. Passive ionization involves introducing grounded arrays of fine conductive points or fine wires close to the source of charge generation. For example, when winding or unwinding of plastic films, a passive ionizer can be positioned close to the area where the sheet comes off the roll.

Passive ionization is generated by the electric field from charge on a surface. As charge is neutralized, the field strength falls and will eventually reach a level where air ionization stops. Passive ionization, therefore, cannot completely neutralize charged surfaces. Nevertheless, it can be useful in reducing high levels of charge to tolerable levels.

6.3 Active control methods

6.3.1 Humidity

Triboelectrification can be more pronounced and charge dissipation slows down in low humidity. Low humidity levels can, therefore, cause high levels of charge to be generated and retained. Such conditions often occur indoors when heating or cooling systems are used which inadvertently dry the air. Localized incidences of low humidity can also occur as a consequence of the heat generated by the use of electrical equipment.

Increasing humidity can decrease charge accumulation, discharge energies and incidence of electrostatic discharge. Humidity levels can be improved in several ways including the use of evaporative humidifiers, commercial humidifiers, and growing vegetation in individuals' microenvironments.

Relative humidity is a measure of moisture content in air relative to saturated air at the same temperature. Within the limited range of typical indoor temperatures, it is recommended in many situations to maintain levels of approximately 40 % to 60 % relative humidity to help reduce electrostatic charge accumulation. Dew point temperature is another measure of moisture content in air and can be used as an alternative to relative humidity as a control parameter. The interpolation of the Ministry of Health of The Russian Federation's standard [6] indicates that the optimum dew point temperature indoors is approximately 12 °C, and that dew point temperatures equal to or greater than 4 °C are acceptable.

6.3.2 Active ionization

Ionization can be used as an optional method to limit electrostatic charge build-up on electrostatic insulating materials where replacement with electrostatic control materials is not possible or practical. The need for ionization, and the specification of the ionizing equipment, should be considered based on the risks of ignition of flammable substances, deposition of particle contaminants, and sensitivity of electronic systems to ESD or excess electrostatic fields.

The main purpose of the ionization is to neutralize electrostatic charges on charged electrostatic insulating materials and remove electrostatic charges from electrically isolated conductors.

For ionization to be effective, a balance between positive ions and negative ions should be maintained. Guidance on the use, cleaning and servicing of ionization equipment to maintain correct operation can be obtained from equipment manufacturers or installers or both. Test methods for ionization are given in IEC 61340-4-7 [7].

Regular testing of ionization equipment to check for effective operation and ion balance should be carried out, see 6.4.3.

NOTE Ionization can have positive or negative effects on health and well-being. Guidelines for this application are outside the scope of this document, but further information can be found in the literature [8], [9].

6.4 Design of facilities

6.4.1 Incorporating electrostatic control into building design

Incorporating electrostatic control into offices and public spaces can significantly reduce hazards and nuisances to tolerable levels and help with the general well-being of occupiers and users. Charging levels and the occurrence of ESD can be efficiently reduced by appropriate material selection, and by grounding electrostatic conductive and electrostatic dissipative objects. In some cases, it can be necessary to employ active electrostatic control methods. Without electrostatic control, areas can become uncomfortable or even hazardous.

Electrostatic control is recommended in office areas and public places. Technical guidelines apply to staircases, offices, meeting rooms, auditoriums and public places such as airports, train stations, shopping centres, restaurants and theatres. However, not all electrostatic control methods described in this document will be appropriate for all applications. Therefore, consideration should be given to selecting those electrostatic control methods that can be practically incorporated into building designs.

Precautions against electrostatic hazards and nuisances are mainly based on passive control methods using appropriate flooring, furniture, etc.

Active controls can also be considered at the design stage or can be added at a later stage if passive precautions prove to be less than satisfactory.

6.4.2 Responsibility for selecting and operating electrostatic control measures

Architects and interior designers should consult with their clients to determine which electrostatic control measures are appropriate for the intended application. Operation of active electrostatic control systems and maintenance and cleaning of all electrostatic control systems and materials is generally the responsibility of building owners or occupiers but should always be done in accordance with the manufacturers' instructions.

6.4.3 Qualification and verification

All new installations and materials used for electrostatic control should be qualified before procurement. In addition, sample-based acceptance testing at minimum should be done for flooring and other installations prior to their first use. Periodic verifications or random checks of control items are also recommended.

The atmosphere for conditioning and testing for qualification purposes shall be (23 ± 2) °C and (12 ± 3) % relative humidity, and the conditioning time prior to testing shall be at least 48 h, unless otherwise agreed. Verification testing should be done under the range of ambient temperature and humidity conditions within the facility. For assessing the worst-case conditions, humidity and temperature should be measured at different times of the year when different humidity conditions can be experienced.

If air conditioning systems are used for electrostatic control, they should be checked after installation to ensure they can maintain temperature and humidity conditions within the required range throughout all areas of the facility in which electrostatic control is required. It is recommended that sensors be installed at various locations to enable constant monitoring of conditions throughout the facility.

Qualification test methods for ionizers are specified in IEC 61340-4-7 [7] and verification tests are described in IEC TS 61340-5-4 [10]. The performance requirements associated with these tests are intended for protection of ESD sensitive devices. The general principles of the test methods are valid for other applications. Test parameters should be tailored for the hazards or nuisances that are of concern.

6.5 Technical requirements and recommendations

6.5.1 Electrical safety

Electrical installation requirements of public places and office areas are provided in the electrical safety rules specified in the IEC 60364 series [11].

It is essential to recognize that electrical safety does not necessarily provide precautions for prevention of the risks of static electricity and electrostatic discharge (ESD).

6.5.2 Material classification

6.5.2.1 General requirements for material classification

Surface and volume resistance measurements (see 6.5.2.2) are one way to classify a material's ability to dissipate electrostatic charge and, in many cases, to limit electrostatic charge generation. If materials are to be used in the ground path for grounding personnel and other conductors, resistance measurements are essential. Nevertheless, there are materials that can be used for electrostatic control for which resistance measurements are not appropriate. Alternative test methods (see 6.5.2.3) should be used for such materials.

Another option is to specify other methods and classification requirements, either based on other standards, or defined within the specific needs. Guidance on electrostatic test methods can be found in IEC TR 61340-1 [4], IEC TR 61340-2-2 [12] and IEC 60079-32-2 [13].

6.5.2.2 Material classification based on resistive properties

6.5.2.2.1 Electrostatic conductive materials

Electrostatic conductive materials can be surface conductive, volume conductive or both. A surface conductive material should have a surface resistance of $< 1 \times 10^4$ Ω. Volume conductive materials should have a volume resistance $< 1 \times 10^4$ Ω. Electrostatic control items can have different limits depending on the standard. Surface and volume resistance measurements shall be made according to IEC 61340-2-3.

6.5.2.2.2 Electrostatic dissipative materials

Electrostatic dissipative materials can be surface dissipative, volume dissipative or both. Surface dissipative materials should have a surface resistance ≥ 1×10^4 Ω and < 1×10^{11} Ω. Volume dissipative materials should have a volume resistance ≥ 1×10^4 Ω and < 1×10^{11} Ω. Electrostatic control items can have different limits depending on the standard. Surface and volume resistance measurements shall be made according to IEC 61340-2-3.

6.5.2.2.3 Electrostatic insulating materials

Electrostatic insulating materials have both surface insulating and volume insulating properties, with a surface resistance and a volume resistance ≥ 1×10^{11} Ω. Electrostatic control items can have different limits depending on the standard. Surface and volume resistance measurements shall be made according to IEC 61340-2-3.

NOTE Electrostatic insulating materials can have slowly dissipative properties that mitigate charge generation and charge accumulation in application.

6.5.2.3 Material classification based on charge decay time and triboelectric charging

6.5.2.3.1 Charge decay time measurements

Charge decay time measurements can be made according to IEC 61340-2-1. Another recommended test method for textiles is the evaluation of the charge decay properties according to EN 1149-3:2004, Method 2. Charge and potential decay of planar and shaped objects can be analysed with a fast step voltage as described in the reference of characterizing slowly dissipative materials [14]. Measurements shall be made with both polarities.

6.5.2.3.2 Electrostatic dissipative materials

Electrostatic dissipative materials should have a charge decay time, measured using the corona charging method of IEC 61340-2-1, of ≤ 2 s from an initial voltage of between 190 V and 1 050 V down to (100 ± 5) V. A material is also classified as electrostatic dissipative if on application of a corona voltage of at least 7 kV the maximum surface voltage is less than 190 V.

6.5.2.3.3 Slowly dissipative materials

Slowly dissipative materials are generally classified as electrostatic insulating materials based on resistive properties. However, these materials mitigate contact electrification and charge accumulation in applications. Charge decay is generally hundreds of times faster compared to highly insulating materials ($R \geq 1 \times 10^{14}$ Ω). Slowly dissipative materials shall have a half decay time of ≤ 30 s from an initial value of (1 100 ± 100) V to 50 % of the initial value measured according to Method 2 of EN 1149-3:2004 or an equivalent method [14].

6.5.2.3.4 Low charging materials

Low charging materials shall meet one or more of the following requirements:

a) friction-charged electrostatic potential ≤ 1 000 V (ISO 18080-2 or ISO 18080-4);

b) friction charge density ≤ 2 $\mu C/m^2$ (ISO 18080-3);

NOTE Low charging material pairs are generally electrostatic conductive, electrostatic dissipative or slowly dissipative. The ISO 18080 series [15] of test methods are primarily intended for textile materials. All the test methods described in the ISO 18080 series can be used to evaluate similar thin, flexible materials. ISO 18080-3 can also be used with minimum modification to evaluate many different types of material.