PD IEC/TS 61340-4-2:2013

BSI Standards Publication

Electrostatics

Part 4-2: Standard test methods for specific applications — Electrostatic properties of garments

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TECHNICAL SPECIFICATION

SPÉCIFICATION TECHNIQUE

colour inside

Electrostatics –
Part 4-2: Standard test methods for specific applications – Electrostatic properties of garments

Électrostatique –
Partie 4-2: Méthodes d'essai normalisées pour des applications spécifiques – Propriétés électrostatiques des vêtements

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CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 7
3 Terms and definitions 8
4 Atmosphere for conditioning and testing 8
5 Preparation of samples and test materials 9
5.1 Samples 9
5.2 Test equipment and materials 9
6 Test methods 9
6.1 General 9
6.2 Resistance and resistivity 10
6.2.1 Selection of the appropriate resistance measurement test method 10
6.2.2 Conversion to resistivity values 11
6.3 Charge decay time 11
6.3.1 Selection of the appropriate charge decay time test method 11
6.3.2 Corona charging method 12
6.3.3 Induction charging method 12
6.3.4 Charge decay by conduction through a garment to a human body 12
6.3.5 Surface potential suppression of isolated garments 12
6.4 Measurement of electrostatic discharges 12
6.5 Field suppression 13
6.6 Tribocharging tests 13
6.6.1 General 13
6.6.2 Tribocharging by removal of garments 14
6.6.3 Tribocharging the outer surface of garments 14
6.6.4 Tribocharging using seats 14
6.7 Clinging tests 14
6.8 Capacitance loading 14
Annex A (normative) Tribocharging by removal of garments 16
Annex B (normative) Tribocharging using seats 20
Annex C (normative) Test of chargeability 25
Annex D (normative) Capacitance loading 37
Annex E (informative) Simple tribocharging tests 49
Bibliography 50

Figure A.1 – Test equipment for measuring body voltage and charge on removed garments 17
Figure B.1 – Example of test equipment set up for measuring body voltage when rising from a seat 22
Figure B.2 – Typical body voltage recordings 24
Figure C.1 – Diagram of the test stand with a mannequin 26
Figure C.2 – Measuring scheme with a mannequin and Faraday cage 27
Figure C.3 – Measuring scheme with a mannequin and net table 27
Figure C.4 – Net table used to measure the charging level of clothes 28

Documents
Document Sharing Hub
Full document details: PD IEC/TS 61340-4-2:2013

Figure C.5 – Measuring scheme with a test person and net table 29
Figure C.6 – Possible ways of taking off clothes from the mannequin trunk or from the test person 32
Figure C.7 – Diagram of the stand for testing mechanical tribocharging on the outer surface of clothing 34
Figure C.8 – Diagram of the system for measurement of the test person charging level resulting from manual rubbing of its clothing 35
Figure D.1 – Example of an arrangement for measurement of corona charge decay and arrangements for ‘open backing’ and ‘earthed backing’ 38
Figure D.2 – Equipment for charge decay time calibration 40
Figure D.3 – Arrangement for measuring received charge 41
Figure D.4 – Example of variation of capacitance loading with quantity of corona 45
Figure D.5 – Adjustment of factor for matching induction to conduction measurements 48

Table 1 – Suitability of test methods for garments and garment materials 10
Table 2 – Test method standards for resistance measurements 10

Documents
Document Sharing Hub
Full document details: PD IEC/TS 61340-4-2:2013

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ELECTROSTATICS –

Part 4-2: Standard test methods for specific applications – Electrostatic properties of garments

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- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

This document is being issued in the Technical Specification series of publications (according to the ISO/IEC Directives, Part 1, 3.1.1.1) as a "prospective standard for provisional application" in the field of determination of the electrostatic properties of garments and garment materials because there is an urgent need for guidance on how standards in this field should be used to meet an identified need.

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This document is not to be regarded as an “International Standard”. It is proposed for provisional application so that information and experience of its use in practice may be gathered. Comments on the content of this document should be sent to the IEC Central Office.

A review of this technical specification will be carried out not later than 3 years after its publication with the options of: extension for another 3 years; conversion into an International Standard; or withdrawal.

IEC 61340-4-2, which is a technical specification, has been prepared by IEC technical committee 101: Electrostatics.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
101/374/DTS	101/388/RVC

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

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the 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 publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- transformed into an International Standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The garments worn by most people in their everyday lives are not usually designed to dissipate static electricity. Some natural fibres, such as cotton or linen, have sufficient retained moisture to provide some degree of conductivity and may dissipate charge at an acceptable rate. However, synthetic fibres, such as polyester or polyamide, or natural fibres under low humidity conditions are not able to dissipate charge quickly. If electrostatic charge builds up on a garment it may cause a number of effects:

a) dust and airborne contaminants can be attracted to the surface of charged garments;

b) light-weight garments can cling to the body of the wearer;

c) the electric field associated with charge on garments can damage or disrupt sensitive electronic systems or components;

d) electrostatic discharges from garments can ignite flammable or explosive materials and can damage or disrupt sensitive electronic systems or components;

e) charge on garments induces a potential on the body of an isolated person wearing the garments and this can lead to damaging or hazardous spark discharges from the body.

Some of the effects can often be tolerated but in many situations the presence of these effects is unacceptable. In order to evaluate whether or not there is a potential problem, it is necessary to determine the propensity of garments to acquire charge or produce electrostatic discharges, or to determine their ability to dissipate charge within an acceptable time. If normal garments are found to be unacceptable, they are replaced with garments specifically designed and manufactured to prevent the undesirable effects of static electricity, i.e. static control garments. Suitable test methods are required both to evaluate the extent of potential problems and to determine the effectiveness of charge dissipation mechanisms in static control garments.

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ELECTROSTATICS –

Part 4-2: Standard test methods for specific applications – Electrostatic properties of garments

1 Scope

This part of IEC 61340, which is a technical specification, describes test methods and procedures that can be used to evaluate the electrostatic charging and discharging propensity, field suppression properties and charge dissipation properties of garments and materials from which garments are constructed.

The test methods described are suitable for evaluating garments worn on or about the upper and lower body, including headwear, but excluding footwear, which is covered in other parts of IEC 61340 (see IEC 61340-4-3 and IEC 61340-4-5)[1][1], and excluding gloves and finger cots.

The test methods described may not be suitable for evaluating garments and garment materials in relation to safety of personnel.

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.

IEC/TR 61340-1:2012, *Electrostatics – Part 1: Electrostatic phenomena – Principle and measurements*

IEC 61340-2-1:2002, *Electrostatics – Part 2-1: Measurement methods – Ability of materials and products to dissipate static electric charge*

IEC/TR 61340-2-2, *Electrostatics – Part 2-2: Measurement methods – Measurement of chargeability*

IEC 61340-2-3:2000, *Electrostatics – Part 2-3: Methods of test for determining the resistance and resistivity of solid planar materials used to avoid electrostatic charge accumulation*

IEC 61340-4-9, *Electrostatics – Part 4-9: Standard test methods for specific applications – Garments*

ISO 3175-2, *Textiles – Professional care, drycleaning and wetcleaning of fabrics and garments – Part 2: Procedure for testing performance when cleaning and finishing using tetrachloroethene*

ISO 3175-3, *Textiles – Professional care, drycleaning and wetcleaning of fabrics and garments – Part 3: Procedure for testing performance when cleaning and finishing using hydrocarbon solvents*

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[1] Numbers in square brackets refer to the Bibliography.

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ISO 6330, *Textiles – Domestic washing and drying procedures for textile testing*

ISO 15797, *Textiles – Industrial washing and finishing procedures for testing of workwear*

AATCC[2] Test Method 115, *Electrostatic Clinging of Fabrics: Fabric-to-Metal Test*

BS 7506-1:1995, *Methods for measurement in electrostatics – Part 1: Guide to basic electrostatics*

EN 1149-3:2004, *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*

NT ELEC 036:2006, *Fabrics and inhomogeneous materials: Measurement of a direct discharge from an ESD protective material, such as an ESD garment/fabric*

NT ELEC 037:2006, *Protective garments: Measurement of the charge decay time of ESD-protective garments*

3 Terms and definitions

For the purposes of this document, the following terms and definitions, as well as those given in IEC/TR 61340-1:2012 apply. Additional definitions given in the references listed in Clause 2 also apply where relevant to this standard.

3.1
capacitance loading
measure of the degree to which surface potential is suppressed compared to an insulator and is calculated as the surface potential achieved per unit quantity of charge for a thin film of a good insulator divided into the surface potential achieved per unit of charge with a similar surface charge distribution on the test material

3.2
field suppression
attenuation of static electric field emanating from charged undergarments

3.3
induction charging
generation of potential difference on a test material by the influence of an electric field from a nearby charged electrode

4 Atmosphere for conditioning and testing

As the electrostatic properties of materials are influenced by temperature and relative humidity, it is important that measurements are made under controlled conditions where possible.

If conditions are not otherwise specified, in product standards for example, the conditions specified in the test methods referenced in this part of IEC 61340 may be used, or may be adjusted to be suitable for specific applications. The most appropriate conditions and the time of conditioning before measurements are made shall be selected with regard to the type of

[2] American Association of Textile Chemists and Colorists.

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material, the intended application and the expected conditions of use. It is recommended that at least two sets of measurements be made, one at the lowest expected relative humidity and one at the highest expected relative humidity.

If environmental control is not possible, a record of the temperature and relative humidity at the time of measurement shall be made. If the conditions during the 24 h preceding the measurements are known, the range of these conditions shall also be recorded.

The atmosphere for conditioning and testing shall be included in the test report for all measurements made in accordance with this part of IEC 61340.

5 Preparation of samples and test materials

5.1 Samples

New garments may have been treated with topical finishes to help reduce charging or increase charge dissipation. Even if such finishes are not deliberately applied, there may be residual processing finishes present that have similar effects. Residual processing finishes and some deliberately applied finishes may not be permanent and their effects will diminish with use and with cleaning. It may be necessary when evaluating garments and garment materials for longterm use to ensure that temporary finishes are removed by cleaning prior to testing.

Samples may be tested before and after cleaning in order to evaluate the effects of the cleaning procedures.

Unless otherwise specified in product standards or by agreement between interested parties, cleaning to remove temporary finishes, if required, shall be carried out in accordance with international standards such as ISO 6330 (domestic washing), ISO 15797 (industrial washing) or ISO 3175-2 or ISO 3175-3 (dry cleaning). Cleaning procedures (including number of cycles, wash temperature, detergent, etc.) shall be selected with regard to the type of material, manufacturer's recommended cleaning procedures, the intended application, and the expected conditions of use.

Full details of any cleaning procedures used prior to testing shall be included in test reports.

5.2 Test equipment and materials

Test equipment and materials that come into contact with samples, particularly during tribocharging tests, shall be maintained in a clean condition and shall be free of contaminants that might influence test results.

6 Test methods

6.1 General

Test methods for making suitable measurements on garments and garment materials are summarized in Table 1.

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Table 1 – Suitability of test methods for garments and garment materials

Measurement	Standard/ Technical specification	Clause in IEC/TS 61340-4-2 (this technical specification)	Suitable for		
			Garments	Materials	Compliance verification
Resistance	IEC 61340-2-3 IEC 61340-4-9	6.2	Yes	Yes	Yes
Charge decay time	IEC 61340-2-1	6.3.2	Yes	Yes	Yes
	EN 1149-3	6.3.3	Yes	Yes	Yes
	NT ELEC 037	6.3.4	Yes	Yes	Yes
	NT ELEC 037	6.3.5	Yes	Yes	Yes
Size of electrostatic discharges	NT ELEC 036	6.4	No	Yes	No
Field suppression	EN 1149-3	6.5	Yes	Yes	Yes
Triboelectric charging	IEC/TS 61340-4-2 (this technical specification)	6.6.3 Annex A Clause C.2	Yes	Yes	Yes
	IEC/TS 61340-4-2 (this technical specification)	6.6.4 Clause C.3	Yes	Yes	Yes
	IEC/TS 61340-4-2 (this technical specification)	6.6.5 Annex B	Yes	Yes	Yes
	IEC/TS 61340-4-2 (this technical specification)	Annex E	Yes	No	Yes
Clinging	AATCC 115	6.7	No	Yes	No
Capacitance loading	IEC/TS 61340-4-2 (this Technical Specification)	6.8 Annex D	Yes	Yes	Yes
NOTE Compliance verification includes daily and pre-use checks. Test methods may require modifying to suit the application.					

6.2 Resistance and resistivity

6.2.1 Selection of the appropriate resistance measurement test method

Resistance measurements on garment materials and garments shall be carried out using the procedures specified in Table 2.

Table 2 – Test method standards for resistance measurements

Test samples	Parameter	Standard
Garment materials	Surface resistance	IEC 61340-2-3
	Volume resistance	
	Point-to-point resistance	
Garments	Surface resistance	
	Volume resistance	
	Point-to-point resistance	IEC 61340-4-9
	Sleeve-to-sleeve resistance	
	Resistance to groundable point	

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If the garment under test is of sufficient size, three measurements of surface resistance and/or volume resistance shall be made at different locations on a single sample. Alternatively, one measurement can be made on each of three separate garments. The latter option shall be used for any garment that is too small to accommodate three measurement locations.

Measurements using the electrodes specified in IEC 61340-2-3 are impractical on garments smaller than 80 mm in any direction. In such cases, measurements shall be made on larger samples of material from which the garment under test is constructed. If this is not possible, smaller electrodes may be used provided they are fully described in the test report.

Volume resistance measurements on garments are usually made between the inside and outside surfaces. To achieve this on areas such a sleeves or trouser legs, or on items such as gloves, it is necessary to insert the bottom electrode (described as probe 2 in IEC 61340-2-3) inside the garment. If, as in the example of gloves, the bottom electrode is too large to fit inside the garment, the garment shall be cut open, or smaller electrodes shall be used provided they are fully described in the test report.

6.2.2 Conversion to resistivity values

When required, surface resistance and volume resistance values shall be converted to surface resistivity and volume resistivity, respectively, using the formulae specified in Clause 9 of IEC 61340-2-3:2000.

NOTE 1 It is common for the surface resistivity of textile materials to be calculated using a different formula to that specified in 9.1 of IEC 61340-2-3:2000. A typical example is EN 1149-1:1996 [3]. The difference in the values calculated by the two different formulae is 3,3 % of the smaller value for the electrodes specified in IEC 61340-2-3:2000.

NOTE 2 Resistivity values can only be defined if the garment material is electrically homogeneous, i.e. material in which all the constituent components have similar electrical properties, or in which components of differing electrical properties are uniformly blended to produce a material that has macroscopically uniform electrical properties.

6.3 Charge decay time

6.3.1 Selection of the appropriate charge decay time test method

The principle of a charge decay time test is to deposit or generate charge on, or in a material and observe the rate at which that charge is dissipated. Test methods vary mainly in the procedure used to deposit or generate charge. In this part of IEC 61340, different methods are described, each one with a different means of charging the test material. Charge is not measured directly but dissipation of charge is determined by measurement of related parameters. In three of the procedures, the rate of charge dissipation is observed using a charged plate monitor (CPM) to measure electric potential, and in the other three procedures a field meter is used to observe the change in electric field caused by charge dissipation.

Selection of the most appropriate method to use is made by considering the nature of the garment under test, the way in which it may become charged in use, and the way in which it is required to dissipate charge. Some of the methods described are generally suitable for a range of different applications, whilst others are suitable for more specific applications. For example, the corona charging method can be used to evaluate most types of garment material for a wide range of applications. The charged metal plate method, as another example, is best suited for evaluating the ability of materials to dissipate charge from conductors that come into contact with them, such as the dissipation of charge from hand tools via gloves.

The point at which timing is started and stopped is specified in some of the test methods referenced in this part of IEC 61340. If no other values are specified, in product standards for example, these timing points may be used, or may be adjusted to be suitable for specific applications. The start point and end point of any charge decay time measurement made in

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accordance with this part of IEC 61340 shall be included in the test report in a format appropriate to the test method used.

NOTE 1 Although charge decay time may be presented in the same format for different test methods, the results may not be directly comparable because of differences in the test procedures.

NOTE 2 If more than one material or material combination is involved in the charge decay, more than one time constant is present. This is the main reason why different methods give different results, since defining the initial potential value is crucial.

6.3.2 Corona charging method

The ability of a garment or garment material to dissipate charge deposited or generated on its surface can be evaluated using the method described in 4.3 and Clause A.1 of IEC 61340-2-1:2002.

6.3.3 Induction charging method

The ability of a garment or garment material to dissipate charge deposited or generated on its surface can be evaluated using the method described in EN 1149-3:2004, test method 2. This test method uses an electrode positioned close to the garment or material under test. Although charge is not applied directly, the movement of charge within the test sample induced by the field from the charged electrode is related to the ability of the sample to dissipate charge. The EN 1149 series of standards have been developed for evaluating personal protective clothing for use in hazardous explosive environments. The performance requirements specified in EN 1149-5 shall be used for evaluating garments and garment materials intended for such applications. For other applications, the test method can be used but careful consideration shall be given to the applicability of the related performance requirements.

6.3.4 Charge decay by conduction through a garment to a human body

The ability of all parts of a garment to dissipate charge to ground via the body of the wearer can be evaluated using the method described in NT ELEC 037. The test parameters specified in NT ELEC 037 are applicable to garments intended for use in electrostatic discharge protected areas (EPA). If the test procedures are used to evaluate garments intended for other applications, careful consideration shall be given to the relevance of the test parameters to the specific application. Test parameters may be adjusted to suit specific applications.

The test procedure described in NT ELEC 037 relies on charge being applied via a conductive clamp in direct contact with the garment under test. The conductive clamp may not achieve good electrical contact with embedded conductive or dissipative elements that are incorporated in some garment materials. In such cases, the corona charging method described in 6.3.2, or the induction charging method described in 6.3.3 can be used to evaluate the ability of the garment to dissipate charge.

6.3.5 Surface potential suppression of isolated garments

The test method described in 6.3.5 can be used to evaluate garments that are worn with at least part of the garment in good electrical contact with the skin of the wearer, either directly or via conductive or dissipative undergarments. The test procedure described in the Appendix of NT ELEC 037:2006 can be used to evaluate the ability of a garment to suppress surface potential as charge is distributed over the garment and forms a capacitance with the grounded body of the wearer. This test procedure is useful for evaluating garments that are worn over other clothing that prevents good electrical contact with the body of the wearer.

6.4 Measurement of electrostatic discharges

Perhaps the greatest risk from charged garments is the possibility of an electrostatic discharge (ESD) from the garment material itself, particularly when garments hang away from the body of the wearer, or when they are removed. Such discharges can damage or disrupt sensitive electrical or electronic components or systems and can cause the ignition of

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flammable and explosive materials. One way to evaluate the risk of ESD from charged garment materials is to generate, capture and measure ESD directly.

The test method described in NT ELEC 036 can be used to measure direct ESD from garments and garment materials. A procedure is described for testing garment materials. Full garments can be tested using the same basic procedure, using a suitable support for the garment. Alternatively, measurements can be made on garments whilst they are worn.

The acceptance and rejection criteria specified in 6.9 of NT ELEC 036:2006 are only applicable for garments intended for use in EPA where components or systems susceptible to damage by ESD greater than or equal to 100 V human body model (HBM) are handled. For other applications, the acceptance and rejection criteria shall be re-evaluated to ensure they are valid for the applications in question.

NOTE Subclause 6.9 of NT ELEC 036:2006 states that the maximum measured peak current shall be less than 300 mA. For equivalence to 100 V human body model, the correct limit is 67 mA. Equivalence in respect to peak current does not necessarily imply equivalence in other aspects of the discharge waveform.

6.5 Field suppression

One property of static control garments that is required in some applications is the ability to attenuate the net electric field from any charged undergarments. In many cases, although undergarments may charge by rubbing against the body or other clothing, the net field remains close to zero because opposite polarity layers of charge are effectively balanced. In other cases, either owing to asymmetric charging or to partial dissipation of charge from one layer, a net charge may exist on undergarments; hence a net electric field will be present.

Test method 2 described in EN 1149-3:2004 can be used to evaluate the field suppression properties of garments and garment materials.

NOTE EN 1149-3:2004, test method 2, is only concerned with the suppression of electric field associated with static electric charge. It does not address other electromagnetic phenomena, e.g. electromagnetic interference caused by ESD.

6.6 Tribocharging tests

6.6.1 General

Tribocharging is a useful means of generating charge on the surface of garments and garment materials as a precursor to charge decay time measurements. It is also useful as a test method in its own right, to evaluate the propensity of garments and garment materials to acquire charge when contacting and rubbing against other materials. Even if materials have low-charging properties they may still retain some charge for a significant period of time, which can be measured using one or more of the methods described in 6.6.2 to 6.6.4.

In many applications, daily checks are made on static control items to ensure correct functioning prior to use. For items that provide a conductive path to earth, simple resistance measurements can be made. Examples include wristband or footwear check stations that are required to be used before entering ESD controlled areas. Similar checks can be made on garments that form part of the personnel earthing system. However, there are applications in which garments are not part of the earthing system and are not required to be earthed, but nevertheless are required to be low charging. A simple tribocharging test can be used as a daily check for this type of garment.

Annex E describes simple tribocharging tests that can be used for daily checks on garments. These simple tests are unlikely to be suitable for qualification purposes, but they can provide a means of screening out garments that exhibit high levels of charging.

If the tests described in Annex E are used as a screening check prior to use, the tests shall be carried out in a safe area where the generation of static electricity does not present a risk to personnel, components or systems.

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6.6.2 Tribocharging by removal of garments

The propensity of garments and full garment assemblies to acquire charge when contacting and rubbing against other materials can be evaluated using the method described in Annex A or Clause C.2.

Although the removal of garments is generally prohibited in EPA and hazardous explosive area, the test methods described in Annex A and Clause C.2 provide a relatively simple but controlled procedure for tribocharging full garments and assemblies of garments.

6.6.3 Tribocharging the outer surface of garments

The propensity of garments and full garment assemblies to acquire charge when contacting and rubbing against other materials can be evaluated using the method described in Clause C.3.

6.6.4 Tribocharging using seats

The propensity of garments and full garment assemblies to acquire charge when contacting and rubbing against other materials can be evaluated using the method described in Annex B.

The test method described in Annex B can be used as an alternative to that described in Annex A for evaluating tribocharging in general. It can also be used to evaluate tribocharging in specific applications that involve personnel and seats (e.g. car seats, fork lift truck seats, work station chairs, etc.).

6.7 Clinging tests

The propensity for lightweight garment materials to acquire charge by tribocharging and the ability for the materials to lose charge by surface leakage can be evaluated using a clinging test method such as that described in AATCC Test Method 115.

The principle of the clinging test is to suspend a charged test specimen from the top edge of an angled metal plate that is connected to earth. If the test specimen has acquired sufficient charge after tribocharging, it will cling to the metal plate. As charge leaks away from the test specimen through the earthed metal plate, there will come a time when there is insufficient charge to cause the test specimen to cling and it will then hang freely. A measure of the test material's ability to dissipate charge can be obtained by recording the time taken for the test specimen to stop clinging.

Clinging tests may not be suitable for evaluating heavier garment materials because even when they are highly charged, they may not cling because their weight is greater than the electrostatic force.

6.8 Capacitance loading

The potentials arising on surfaces when these are contacted or rubbed by other surfaces can be evaluated by determining capacitance loading. The basis of the method is as follows:

a) Most risks from static electric charge retained on materials relate directly to the local surface voltage created. The surface voltage indicates opportunity for direct air discharge (for voltages over about 300 V), opportunity for charge induction on devices nearby, and opportunity for attraction of airborne particles.

b) There is a direct relationship between the surface voltage present at the time when practical surfaces separate after contact and rubbing actions and values of charge decay time and capacitance loading shown by the materials. Surface voltages will be limited to low values if the time for decay of surface voltage is very short and/or if the capacitance experienced by surface charge is very high.

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c) The behaviour of materials in practical situations with tribocharging is well represented by measurements on sample areas of the material with corona charging.

The measurement and calculation procedures for determining capacitance loading are described in Annex D.

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