WE CREATE BETTER ENVIRONMENTS
BY KEEPING THEM **UNDER CONTROL**

ESD standards and test methods

STANDARIZATION FOR ESD CONTROL

Since static electricity was recognized as a problem, attempts were taken to control the risks. Centuries ago, one of the biggest issues caused by unwanted Electro Static Discharge (ESD) events was this ignition of gunpowder storage and other explosive or flammable materials. In a later stage, when the electronics industry started to grow and electronics became smaller and more sensitive; ESD control became a relevant topic for many companies.

The number of standards increased and so did the cooperation between different organizations from different industries with different perspectives.

Nowadays there are three leading categories: European Standards (EN), International Electrotechnical Commission standards (IEC) and American standards (ANSI/ASTM). The decision to work with one, or a combination of standards depends on various factors. The type of industry, segment, application area, country or even company can lead to a requirement for a specific standard.

Forbo floors for controlled environments (Colorex, Sphera SD | EC and Marmoleum Ohmex), have been tested for most of the relevant standards described in the next paragraphs. The customer can tell which standards need to be met for his projects.

ESD STANDARDS

European standards

CEN is one of three European Standardization Organizations (together with CENELEC and ETSI) that have been officially recognized by the European Union and by the European Free Trade Association (EFTA) as being responsible for developing and defining voluntary standards at European level. A standard is a document that provides rules, guidelines or characteristics for activities or their results, for common and repeated use. Standards are created by bringing together all interested parties including manufacturers, users, consumers and regulators of a particular material, product, process or service. Everyone benefits from standardization through increased product safety and quality as well as lower transaction costs and prices.. Technical specifications of Forbo flooring systems are based on international (ISO), European (EN) or local product standards. For the electrical behaviour of floor coverings, the following European standards are the most important:

International standards

The electrotechnical standardization committees develop specific standards developed by ESD specialists. The International Electrotechnical Commission (IEC) is the world's leading organization that prepares and publishes International Standards for all electrical, electronic and related technologies. More recently, a new standard for ESD control in healthcare facilities was released by IEC.

American standards

Another organization publishing standards is ANSI/ESDA; the American National Standards Institute. There is a link with the IEC standards, the starting points are the same. This is also the case for local and company specific standards.

	Description of the standard
EN 14041:2004	Resilient, textile and laminate floor coverings - essential characteristics.
EN 1081	Resilient, textile, laminate and modular multilayer floor - determination of the electrical resistance.
EN 1815	Resilient and laminate floor coverings – assessment of static electrical propensity.
IEC 61340-5-1	Resilient, textile and laminate floor coverings - essential characteristics.
IEC 61340-4-1	Resilient, textile, laminate and modular multilayer floor - determination of the electrical resistance.
IEC 61340-4-5	Resilient and laminate floor coverings – assessment of static electrical propensity.
IEC 61340-6-1	Electrostatics – electrostatic control for healthcare – general requirements for facilities.
IEC 61340-2-1	Electrostatics – measurement methods – ability of material and products to dissipate static electric charge.
IEC 60364-6	Low voltage electrical installations – verification.
ANSI/ESD 20.20	Standard for the development of an ESD control program for protection of electrical and electronic parts, assemblies and equipment (Excluding electrically initiated explosive devices).
ANSI/ESD STM 7.0	Test method for the protection of ESD susceptible items – floor materials – characterization of materials.
ANSI/ESD STM 7.1	Test method for the protection of ESD susceptible items – floor materials – resistive characterization of materials.
ANSI/ESD STM 97.1	Test method for the protection of ESD susceptible items – footwear/flooring system – resistance measurement in combination with a person.
ANSI/ESD STM 97.2	Test Method for the protection of ESD susceptible items – footwear/flooring system – voltage measurement in combination with a person.
ASTM F150 - 06	Test method for electrical resistance of conductive and static dissipative resilient flooring.

EUROPEAN STANDARDS

Within Europe there are three international organizations taking care of standardization. CEN is an association consisting of national standardization bodies of 34 European countries, developing European Standards for a wide range of industries and sectors. CENELEC is an association for Electrotechnical Standardization and ETSI is responsible for standards for ICT: telecommunications, broadcasting and other electronic communications networks and services. Only standards developed by the three international organizations are recognized as European Standards.

European standards automatically become a local standard. Products and services that meet these European Standards (EN's) can be offered and sold in all of the participating countries.

This means that all Forbo products sold in the European Union need to meet the requirements set by the European Standards which are applicable for the product category. For floor coverings, EN14041 is the most important standard. Without proof (the CE mark) that a floor meets the minimum requirements, the floor cannot be sold.

EN 14041

It is obligatory to meet minimum requirements and label the product with a CE mark, when selling a floor in the European Union. The European standard EN 14041 describes the essential characteristics for resilient floor coverings. This standard is released by the European Standardization Committee and indicates the tests and (minimum) requirements to ensure a safe and healthy floor. It is an overarching document, which links to many other international (ISO) and European (EN) standards.

Two of those standards are related to electrostatic behaviour of the floor: EN 1081 and EN 1815. The electrical resistance (EN 1081) and electrostatic propensity (EN 1815) are part of the European regulation No.305/2011, which means that they are provisions for the Declaration Of Performance (DOP) and the CE mark.

EN 1081

The European standard EN 1081 describes how to determine the electrical resistance of resilient floorcoverings. EN 1081 is only applicable to static dissipative (SD) or electro conductive (EC) floor coverings. This standard is developed by a European Technical Committee; a team of technical specialists from the flooring industry. The document includes three different test methods. These methods are explained in the headers below.

Vertical resistance (R1)

Electrical resistance measured from the surface of a material to the back of the material. This test can only be done on an uninstalled floor, preferably in a conditioned laboratory environment.

Resistance to earth (R2)

The electrical resistance measured between the surface of a material and ground. This test should be conducted on an installed floor; in a laboratory environment or on site.

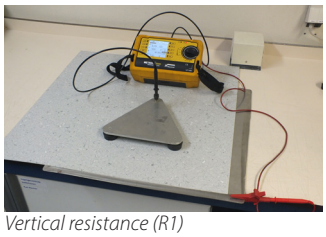
Surface resistance (R3)

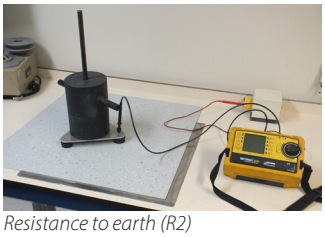
The surface resistance expresses the ability of a material to conduct electricity. This test should be conducted on an installed floor; in a laboratory environment or on site. On site the values represent the functionality of the system.

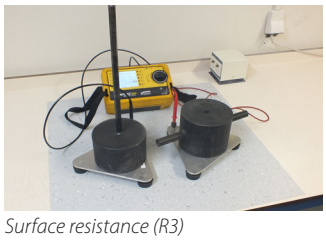
The norm values for SD and EC floorcoverings are laid down in EN 14041. The flooring is static dissipative if the vertical resistance (R1) is ≤ $1x10^9$ Ω. Conductive flooring must have a vertical resistance value of ≤ $1x10^6$ Ω. There are floor symbols to indicate the category, as you can see on the right. This so called electrical behaviour can also be found in the technical specifications of all Forbo SD and EC products.

SD

EC


Vertical resistance (R1)


Resistance to earth (R2)


Surface resistance (R3)

EN 1815

The EN 1815 standard is developed by a European Technical committee to assess the electrostatic propensity. Measurements performed according to this standard tell how much charge is generated by walking across the surface of a floor covering.

The flooring is called antistatic if the measured value is ≤2 kV (≤2000 V).

INTERNATIONAL STANDARDS

The International Electrotechnical Committee (IEC) was established in 1906, to develop terminology and standards for the electronics industry for global use. More than 80 countries are member or affiliate member of the IEC, over 20.000 experts from industry, test & research labs, government, academia and consumer groups are involved and form 212 Technical Committees.

The IEC serves as a global knowledge platform for all industries where electricity is involved; from electronic products in factories to devices at home, in offices, healthcare facilities, transport and more. The IEC's international standards make it easier to trade and use electronic components and devices across the world.

The standards include test methods for manufacturers, but also other safety precautions protect humans, animals and property. There is no room for error when it comes to electrotechnics; mistakes are often invisible, but can have fatal consequences.

Although (most) flooring does not contain electronical components, there is a number of standards where flooring is included. Electro Conductive (EC) and Static Dissipative (SD) flooring can be used as part of the solution to create an indoor environment where electronics can be produced, handled and used in a safe manner.

IEC 61340-5-1

The international standard IEC 61340-5-1 is part of the IEC 61340 series about Electrostatics. The purpose of the IEC 61340-5-1 is to communicate the requirements for an ESD control program; focussing on the protection of electronic devices from electrostatics. The document references to a number of other norms related to for example grounding of people and furniture footwear, packaging, training and ESD Protected Areas (EPA's). Norm values for flooring and a flooring-footwear system can also be found in this document. For flooring there are two standards which describe the test methods: IEC 61340-4-1 and IEC 61340-4-5.

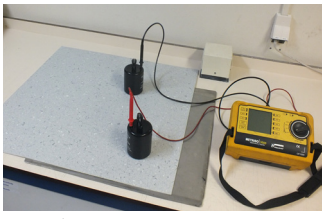
IEC 61340-4-1

The IEC 61340-4-1 specifies the test methods for the determination of the electrical resistance of floor coverings and installed floors. There are two different situations; laboratory evaluations and installed floors on site.

During laboratory evaluations, floorcoverings for use in EPA's shall not exceed the resistance limit of $<1x10^9$ Ω when connected to a groundable point. Testing is performed in a laboratory where the environment is kept at 12 % RH and 23 °C. This is done to create a "worst case" scenario. Higher humidity levels usually lead to better conductivity. When measured on site, the resistance to ground shall also be $<1x10^9$ Ω, but in this case it is (often) not possible to influence the RH % and temperature conditions of the environment. The document includes two different test methods: vertical resistance and resistance to ground.

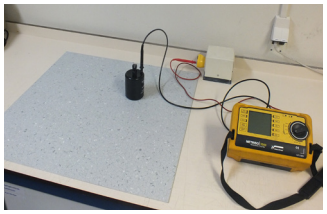
Vertical resistance (point-to-point / PtP)

Electrical resistance measured from the surface of a material to the back of the material. Why: to test if the floor itself is functioning. Especially interesting to check if floors which are constructed with conductive granules conduct from top to bottom. If the conductive granules are too small there may be places where the path to ground is interrupted by non-conductive material. This test is for laboratory evaluations only.



Vertical resistance

Resistance to ground (point-to-ground / PtG)
Electrical resistance measured between the surface of a material and ground. Why: to test if the charges are flowing to ground. This test can be done on both uninstalled and installed material. For installed material, the system is measured: flooring, adhesive, grounding + grounding point.

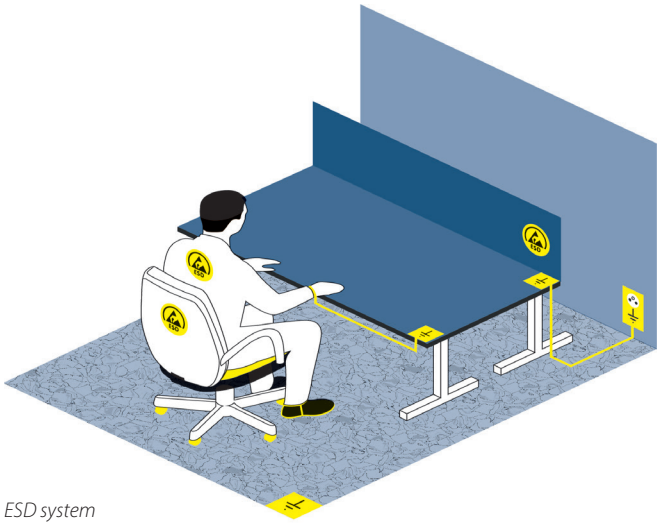

Resistance to earth

IEC 61340-4-5

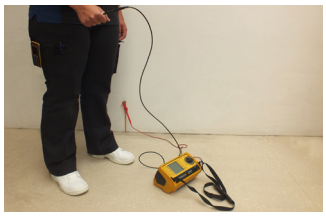
The IEC 61340-4-5 standard describes two test methods with the purpose to determine if the system for personnel grounding is meeting the requirements. A flooring – footwear system can be part of personnel grounding. Methods commonly used to control ESD are wrist straps, footwear, furniture, garment and flooring. The total system needs to function to guarantee protection against ESD events.

Requirements for a person-flooring-footwear systems are laid down in IEC 61340-5-1. The total resistance of the system shall be < 3.5×10^7 Ω and/or the body voltage generation shall be <100 V in combination with a system resistance of <1×10^9 Ω.

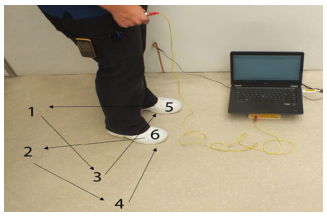
IEC 61340-4-5 includes the following test methods:


ESD system

System resistance
The electrical resistance to ground of a combination of person/footwear/flooring.


System resistance

Body Voltage Generation (BVG)
The voltage generated by walking across a surface or a floor. Tested by a person walking a specific pattern.



Body Voltage Generation

IEC 61340-6-1

The IEC 61340-6-1 standard was created in 2018. It provides technical requirements and recommendations for controlling electrostatic phenomena specifically for healthcare facilities. Use of ESD flooring can be required (G2 locations), recommended (G1/G0 locations) or not mandatory (unclassified locations). Typical application areas are described for the different location types. The standard includes different technical requirements for electrostatic control:

- Determination of resistance to ground measured in accordance to IEC 61340-4-1.
- System resistance (person, footwear, floor) in accordance to IEC 61340-4-5
- Body voltage generation in accordance to IEC 61340-4-5
- Decay time in accordance to IEC 61340-2-1. Decay time is the time it takes for charges to flow from one material to the other, to a given percentage (10%) of its original value.

IEC 60364-6

The objective of the IEC 60364-6 is to protect people against electrical shocks. The standard provides requirements for low voltage electrical installations, like they are used in many private and public buildings.

In normal circumstances people do not get exposed to electrical installations, but there are situations where people risk direct access to mains voltage (electric power), like in test areas and specific work places.

When the human body becomes part of an electrical system, the muscles (including the heart) can react on the electrical current. To eliminate the risk of electrocution, safety measures are laid down in IEC 60364-6. The standard provides requirements for initial and periodic verification of an electrical installation.

Part of the norm consists of test methods for measuring the insulation resistance of flooring s y stems. F l ooring w ith a resistance value > 5 x 10^4 Ohm, measured at a minimum of 500V, is considered "insulating" enough to protect people. In practice, this is only the case for SD floors; EC floors are too conductive and will form a risk for personnel. There are many local standards derived from the IEC 60364-6:

- VDE 0100 (German standard)
- BS 7671 (British standard)
- NEN 1010 (Dutch standard)

AMERICAN STANDARDS

ANSI is the American National Standards Institute; a private, not-for-profit organization. ANSI facilitates the development of American National Standards (ANS) by accrediting the procedures of organizations developing the standards. The organization was one of the founding members of the International Organization for Standardization (ISO), and they also represent the United States in the International Electrotechnical Commission (IEC).

EOS/ESD Association was founded in 1982 and initially focussed on ESD on electronic components. Nowadays the Association has broadened its horizons to include areas such as textiles, plastics, web processing, cleanrooms, and graphic arts.

EOS/ESD is the only organization accredited by ANSI to write and produce standards on electrostatics. They expand ESD awareness through standards, development, education programs, local chapters, publications, tutorials, certification, and symposia. Although headquartered in the United States, over 55 countries are members and the standards are used internationally.

ASTM is one of the world's largest organizations developing (inter)national standards for a wide variety of materials, products, systems and services. Our Volunteer members belong to standards-writing committees, representing producers, users, consumers, government, and academia from more than 140 countries and dozens of industry sectors.

ANSI/ESD STM 7.1
Broadly equivalent to IEC 61340-4-1. ANSI/ESD STM 7.1 specifies the test methods for the determination of the electrical resistance of floor coverings and installed floors. Laboratory tests are done at 12% and 50% RH with 10 V or 100 V. Not applicable to facilities where ordnance, flammables or explosives are stored or handled. In this case, ASTM F150-06 shall be used.

ASTM F150 – 06
This standard is similar to ANSI/ESD STM 7.1 and IEC, except the humidity is 50% (or ambient).

ANSI/ESD STM 97.1
Broadly equivalent to the system resistance in IEC 61340-4-5. ANSI/ESD STM 97.1 describes methods to measure the resistance of the system person/footwear/flooring.

ANSI/ESD STM 97.2
Broadly equivalent to the Body Voltage Generation (BVG) in IEC 61340-4-5. ANSI/ESD STM 97.2 describes methods to measure the body voltage of the footwear/flooring system.

TESTING IN **PRACTICE**

Forbo products with electrostatic conductive (EC) or static dissipative (SD) products are tested to the relevant EN, IEC and ANSI/ASTM standards. The values are laid down in the technical datasheets (TDS), available on the Technical Database Sharepoint, and communicated on the marketing tools. Test reports to prove conformity can also be found on the Technical Database Sharepoint. Process and end product control, including conductivity measurements to IEC standards, are part of the ISO9001 based quality system of Forbo production sites.

After the installation of a floor, the performance can be tested on site. This should be done with appropriate measuring equipment by someone with the know how to test according to the standards. Small things can make a big difference in the measuring result:

The frequency of post installation testing is dependent on the customer and application area. In some cases test are preformed frequently; others only test once. It depends on the risks, legislation and know-how of the end user.

Topic	Influence on the test result
Cleaning	Proper cleaning of the probes and test area is very important. Visible and invisible contamination and dirt can lead to a higher value.
RH %	In general; a higher the relative humidity level the better the results. Moisture helps the flow of electricity. The RH% shall be noted with the test results:
Footwear	ESD footwear must be used. Even ESD approved shoes can negatively influence conductivity values of a system resistance or body voltage test. Over time they can lose some of their properties.
Person	Especially in the BVG test the person is part of the test; he determines his movements, the stepping pattern and speed of the steps. This all has an influence on the test result.
Time	Measuring immediately after installation will give different results than a measurement after two weeks. Moisture content and curing of the adhesive will influence the outcome .