30.7.2020

Certificate of Qualification

ESD control items – Dr. Schutz® ESD Control Flooring

Resistance to groundable point of sample boards was measured in accordance with IEC 61340-4-1:2003+A1:2015. Person footwear flooring system was assessed in accordance with IEC 61340-4-5:2018. Table 1 shows the different flooring structures installed on plywood boards. Summary of the qualification is presented in Table 2. Detailed information on testing is provided in a technical report C697/2020 V1.1.

Table 1: Sample boards, Dr. Schutz®

1.	Non-conductive PVC, Copper wire, 2x ESD Color Base, 1x ESD Top Coat
2.	Non-conductive Epoxy, Copper wire, 2x ESD Color Base, 1x ESD Top Coat
3.	Non-conductive Epoxy, ESD HiCon Primer, Copper wire, 2x ESD Color Base, 1x ESD Top Coat
4.	Conductive PVC, 1x ESD Medicoat
5.	Conductive PVC, 2x ESD Base Coat, 1x ESD Top Coat
6.	Conductive PVC, 2x ESD Color Base, 1x ESD Top Coat
7.	Conductive Epoxy, 2x ESD Color Base, 1x ESD Top Coat

Product IDs: Dr. Schutz® - HiCon Primer, ESD Color Base, ESD Base Coat, ESD Top Coat and ESD Medicoat.

Table 2: Summary of qualification tests

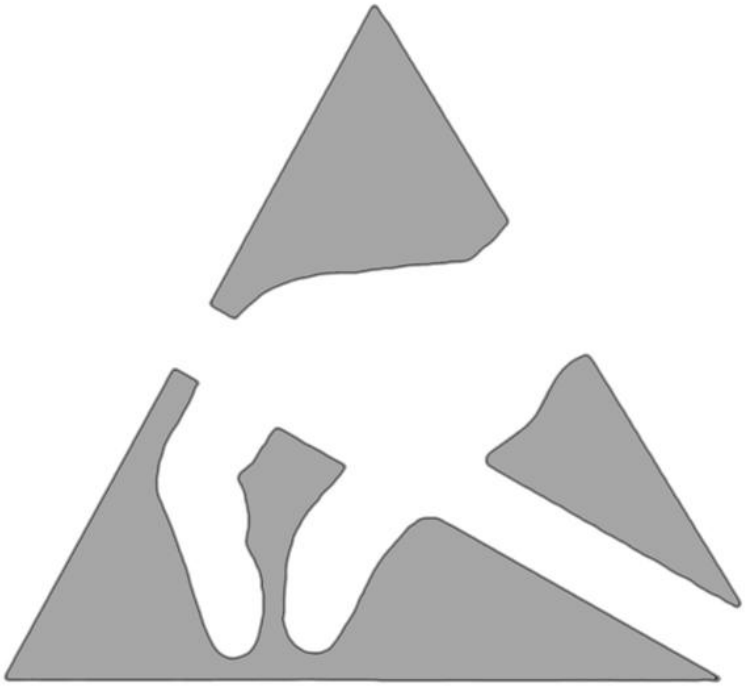
Client	Dr. Schutz, Holbeinstr. 17, 53175, Bonn, Germany
Contact	Gerhard Schäfer, gsc@dr-schutz.com, +49 172 68 444 78
Dates of Test	July 23 – 27, 2020
Place of Test	Cascade Metrology, Electrostatics Laboratory, Hakulintie 32, 08500 Lohja, +358 4456 88 599
Conditioning	48 hours, T = (23 ± 2) °, RH = (12 ± 3) %rh
Test Equipment	MIT415/2 Sn 101489531, 3M 711 Sn 20980308, TDS 2022 Sn C031701
Test Method(s)	IEC 61340-4-1:2003+A1:2015, IEC 61340-4-5:2018
Assessment Criteria	IEC 61340-5-1:2016, IEC 61340-6-1:2018
Summary of results and conclusions	The sample boards met the requirements of flooring used to ground personnel and equipment in reference to IEC 61340-6-1:2018 (R_{gp} < 1 GΩ). The sample boards met the electrostatic protected area requirements in reference to IEC 61340-5-1:2016 (R_{gp} < 1 GΩ). Personnel grounding requirements of the person/footwear/flooring system were met with the tested person/footwear combinations (IEC 61340-5-1:2016).
Note	This certificate may only be reproduced in full, except with the prior written permission by issuing laboratory. The results relate only to the tested items.
Date and place	Author
Lohja 30.7.2020	Toni Viheriäkoski, CEO, Cascade Metrology, ESD Engineer

Toni Viheriäkoski
Cascade metrology Oy, Hakulintie 32, 08500 Lohja
toni.viheriakoski@cascademetrology.com

7.8.2020

Qualification of ESD Control Floorings

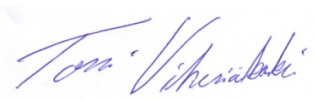
Dr. Schutz® ESD



Dr. Schutz®

1. Index

Table 1: General information of the document

Document	**No: C697/2020**	**Version: 1.2**	**Date: 7.8.2020**
Date(s) of test	23. - 27.7.2020		
Place of test	Electrostatics laboratory, Hakulintie 32, 08500 Lohja		
Client	Dr. Schutz, Holbeinstr. 17, 53175, Bonn, Germany		
Contact person	Gerhard Schäfer, gsc@dr-schutz.com, +49 172 68 444 78		
Author(s)	Toni Viheriäkoski, ESD Engineer, Certified by NARTE, USA Cascade Metrology Oy, Electrostatics laboratory, Hakulintie 32, 08500 Lohja, Finland, GSM +358 44 5688 599		
Assessment criteria	IEC 61340-6-1: 2018, Electrostatic control for healthcare - General requirements for facilities [1] IEC 61340-5-1:2016, Protection of electronic devices from electrostatic phenomena [2]		
Notes	Technical information of the report is classified confidential		
Date and place Lohja 7.8.2020	Signature  Toni Viheriäkoski		

2. Introduction and Scope

Electrostatic properties of four reference floorings and seven sample boards of Dr. Schutz® ESD floorings were measured and analysed at the laboratory of Cascade Metrology Oy. ***Summary of results and conclusions are presented in Section 8***.

3. Flooring Samples under Test

The sample boards were manufactured by Dr. Schutz. Coatings were installed on plywood boards (1150 mm × 750 mm × 10 mm). Samples 3 to 11 had groundable points (copper tape 100 mm × 10 mm × 40 µm). Identifications of the flooring samples under test are shown in Table 2. Samples were tested as delivered without the treatment. Pictures of the samples are shown Figure 1.

Table 2: Identifications of the sample boards

Sample	Identification
1.	Reference 1, PVC, Non-conductive PVC sample.
2.	Reference 2, Epoxy cast flooring, Non-conductive epoxy sample, Shiny grey.
3.	Reference 3, PVC, Conductive PVC installed with conductive adhesive.
4.	Reference 4, Epoxy cast flooring, Conductive epoxy cast application on highly conductive primer layer, Shiny grey.
5.	Non-conductive PVC as reference 1, Copper wire, 2x ESD Color Base, 1x ESD Top Coat, Mat grey.
6.	Non-conductive Epoxy as reference 2, Copper wire, 2x ESD Color Base, 1x ESD Top Coat, Mat grey.
7.	Non-conductive Epoxy as reference 2, ESD HiCon Primer, Copper wire, 2x ESD Color Base, 1x ESD Top Coat, Mat grey.
8.	Conductive PVC as reference 3, 1x ESD Medicoat.
9.	Conductive PVC as reference 3, 2x ESD Base Coat, 1x ESD Top Coat.
10.	Conductive PVC as reference 3, 2x ESD Color Base, 1x ESD Top Coat, Mat grey.
11.	Conductive Epoxy as reference 4, 2x ESD Color Base, 1x ESD Top Coat, Mat grey.

Product identifications: Dr. Schutz® - HiCon Primer, ESD Color Base, ESD Base Coat, ESD Top Coat and ESD Medicoat.

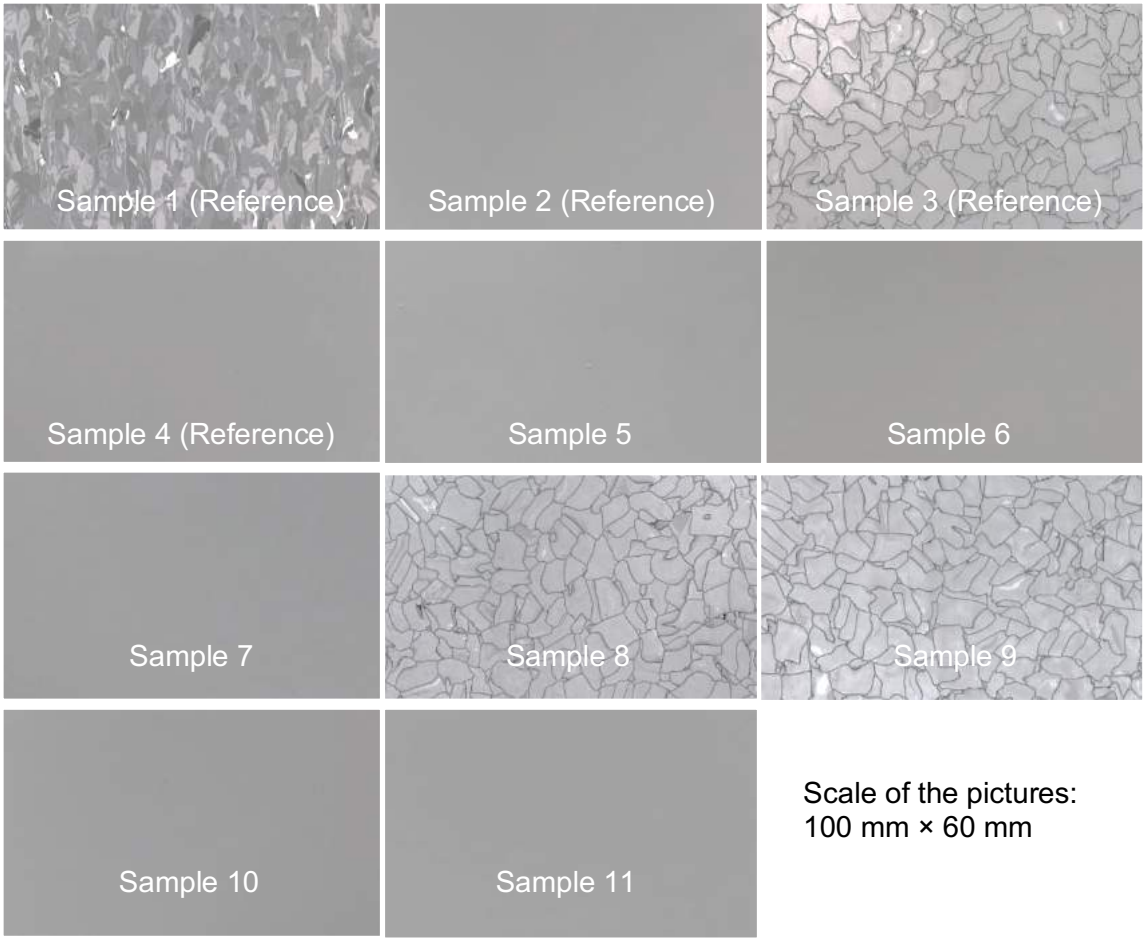


Figure 1: Samples under test

4. Test Conditions and Instrumentation

Test conditions are shown in Table 3. Measurement equipment is presented in Table 4.

Table 3: Ambient test conditions

Conditioning	Temperature	Relative Humidity
48 h	23 ˚C ± 2 ˚C	12 %rh ± 3 %rh

Measurements are carried out, when applicable, in reference to ISO/IEC/EN 17025 “General Requirements for the Competence of Calibration and Testing Laboratories”.

Table 4: Measurement equipment

Manufacturer	Type	Model	Serial number
Tektronix	Oscilloscope	TDS 2022	C031701
3M	Charge analyzer	711	20980308
Megger	Isolation multimeter	BMM2000ESD	6111-550/061106/1387
Megger	Isolation multimeter	MIT415/2	101489531
ETS	*Rg* electrodes	850	4940, 4925
Vaisala	Humidity meter	HM 41	M1850876

Calibrations are traceable to national standards laboratories through the unbroken chain of stated uncertainties. Calibration periods are based on the periodic verifications and traceable history of the instruments.

5. Test Methods

Resistance to ground of flooring was measured in accordance with IEC 61340-4-1:2003+A1:2015 [3] (Figure 2).

Person footwear flooring system was measured in accordance with IEC 61340-4-5:2018 [4] (Figures 3 and 4).

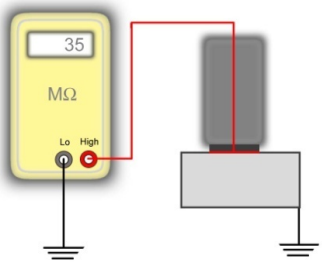


Figure 2: Resistance to ground

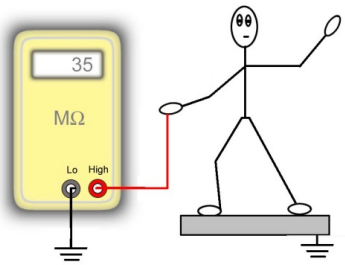


Figure 3: System resistance

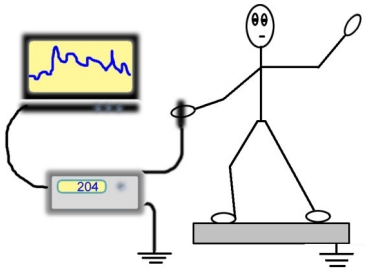


Figure 4: Body potential

6. Requirements

6.1 EPA Requirements

Flooring: R_g < 1 GΩ [1, 2].

6.2 Personnel Grounding Requirements

Person/footwear/flooring system: R_g < 1 GΩ and body voltage [2],
$|V|$ < 100 V (average of 5 highest peaks) [2].

7. Test Results

7.1 Flooring

Resistance to Groundable Point [3]

Test results are shown in Tables 5 and 6. Electrification time was 15 s. The samples 1 and 2 did not have groundable point. Point to point resistance was measured instead.

Table 5: Resistance to groundable point, Reference samples 1 to 4

	Sample 1, $R_{p\text{-}p}$		Sample 2, $R_{p\text{-}p}$		Sample 3, R_{gp}		Sample 4, R_{gp}	
No	**(V)**	**(Ω)**	**(V)**	**(Ω)**	**(V)**	**(Ω)**	**(V)**	**(Ω)**
1	100	>1E+10	100	>1E+10	10	4E+05	10	9E+04
2	100	>1E+10	100	>1E+10	10	3E+05	100	1E+05
3	100	>1E+10	100	>1E+10	10	4E+05	10	5E+05
4	100	>1E+10	100	>1E+10	10	3E+05	**500***	1E+05
5	100	>1E+10	100	>1E+10	10	5E+05	10	9E+05
6	100	>1E+10	100	>1E+10	10	6E+05	100	4E+07
7	100	>1E+10	100	>1E+10	10	4E+05	**500***	8E+04
8	100	>1E+10	100	>1E+10	10	4E+05	**500***	9E+04
9	100	>1E+10	100	>1E+10	10	6E+05	100	2E+05
10	100	>1E+10	100	>1E+10	10	4E+05	100	4E+05
Min @ ≤ 100 V		>1E+10		>1E+10		3E+05		9E+04
Max @ ≤ 100 V		N/A		N/A		6E+05		N/A
Median @ ≤ 100 V		N/A		N/A		4E+05		7E+05
Average		N/A		N/A		4E+05		N/A
Geometric mean		N/A		N/A		**4E+05**		N/A
Standard deviation		N/A		N/A		1E+05		N/A

Note to sample 4: Significant voltage dependence was observed occasionally (R_{gp} > 1 GΩ at 100 V when 500 V was applied)

Table 6: Resistance to groundable point, Samples 5 to 11

	Sample 5		Sample 6		Sample 7		Sample 8		Sample 9		Sample 10		Sample 11	
No	**(V)**	**(Ω)**	**(V)**	**(Ω)**	**(V)**	**(Ω)**	**(V)**	**(Ω)**	**(V)**	**(Ω)**	**(V)**	**(Ω)**	**(V)**	**(Ω)**
1	10	3E+05	10	1E+05	10	4E+04	100*	1E+05	10	2E+05	10	6E+04	10	2E+05
2	10	4E+05	10	2E+05	10	3E+04	10	9E+05	10	2E+05	10	7E+04	10	2E+05
3	10	3E+05	10	2E+05	10	4E+04	100*	8E+04	10	3E+05	10	7E+04	10	2E+05
4	10	3E+05	10	9E+04	10	5E+04	100*	1E+05	10	4E+05	10	8E+04	10	2E+05
5	10	3E+05	10	2E+05	10	4E+04	100*	1E+05	10	4E+05	10	5E+04	10	3E+05
6	10	3E+05	10	2E+05	10	3E+04	100*	2E+05	10	3E+05	10	6E+04	10	3E+05
7	10	4E+05	10	2E+05	10	3E+04	100*	2E+05	10	2E+05	10	7E+04	10	3E+05
8	10	4E+05	10	1E+05	10	2E+04	100*	9E+04	10	2E+05	10	7E+04	10	2E+05
9	10	3E+05	10	1E+05	10	3E+04	100*	1E+06	10	4E+05	10	5E+04	10	2E+05
10	10	2E+05	10	2E+05	10	4E+04	100*	1E+06	10	3E+05	10	6E+04	10	2E+05
Min @ ≤ 100 V		2E+05		9E+04		2E+04		8E+04		2E+05		5E+04		2E+05
Max @ ≤ 100 V		4E+05		2E+05		5E+04		1E+06		4E+05		8E+04		3E+05
Median @ ≤ 100 V		3E+05		2E+05		4E+04		1E+05		3E+05		7E+04		2E+05
Average		3E+05		2E+05		4E+04		4E+05		3E+05		6E+04		2E+05
Geometric mean		**3E+05**		**1E+05**		**3E+04**		**2E+05**		**3E+05**		**6E+04**		**2E+05**
Standard deviation		6E+04		4E+04		8E+03		5E+05		7E+04		1E+04		3E+04

Note to sample 8: Voltage dependence was observed (R_{gp} > 1 MΩ at 10 V when 100 V was applied)

7.2 Person/Footwear/Flooring System

Reference footwear: Sievi Relax XL S147-52236-103-0PM
(Person footwear system: R_g ~ 4 MΩ).

Resistance to Groundable Point [4]

Test results are shown in Table 7. Electrification time was 15 s.

Table 7: Resistance to groundable point at 100 V

	Resistance to Groundable Point (MΩ) Sample								
No	**3 ref**	**4 ref**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1	32	> 1	7	6	5	19	8	5	6
2	26	> 1	9	7	6	20	9	6	6
3	22	> 1	12	7	5	15	8	6	5
4	35	> 1	9	8	7	14	11	7	5
5	47	> 1	7	11	7	15	9	5	7
6	20	> 1	6	9	8	26	12	8	7
7	22	> 1	7	7	6	32	8	7	6
8	19	> 1	9	7	5	18	7	9	8
9	26	> 1	8	6	6	22	9	6	7
10	22	> 1	7	7	5	16	8	5	7
Minimum	19	> 1	6	6	5	14	7	5	5
Maximum	47	N/A	12	11	8	32	12	9	8
Median	24	N/A	8	7	6	19	9	6	7
Average	27	N/A	8	8	6	20	9	6	6
Geometric mean	**26**	N/A	**8**	**7**	**6**	**19**	**9**	**6**	**6**
Standard deviation	9	N/A	2	2	1	6	2	1	1

Body Voltage [4]

Averages of the five highest peaks during 60 s measurement sequences:
- Samples 3, 5, 6, 7, 8, 9, 10, 11: $|V| < 100$ V,
- Sample 4: $|V| > 100$ V.

Examples of six step walking pattern test results are shown in Figures 5 to 13.

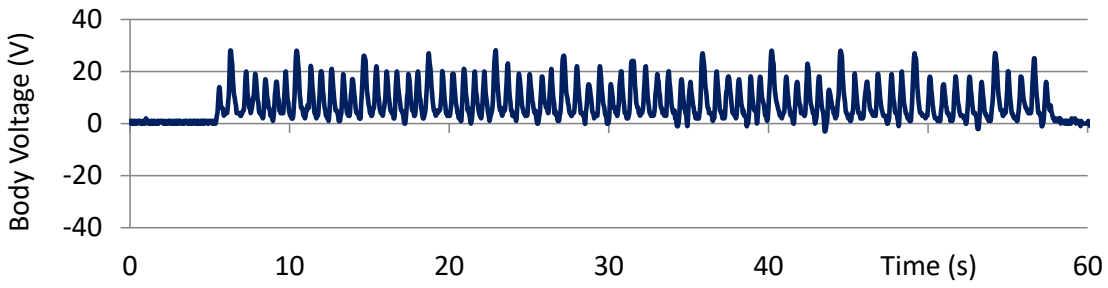


Figure 5: Walking test, Sample 3 (Reference)

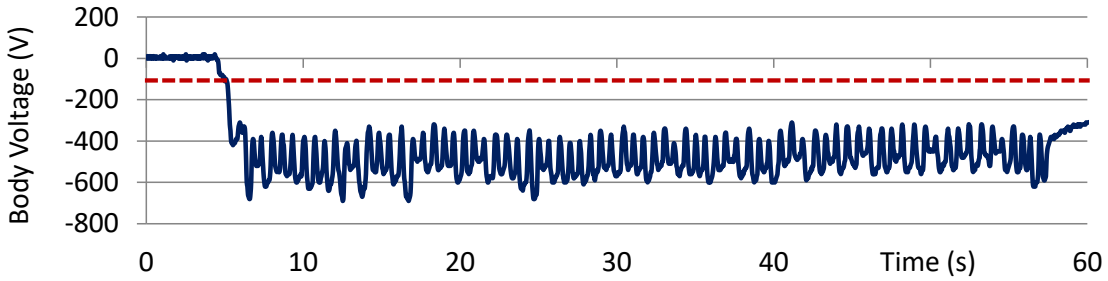


Figure 6: Walking test, Sample 4 (Reference)

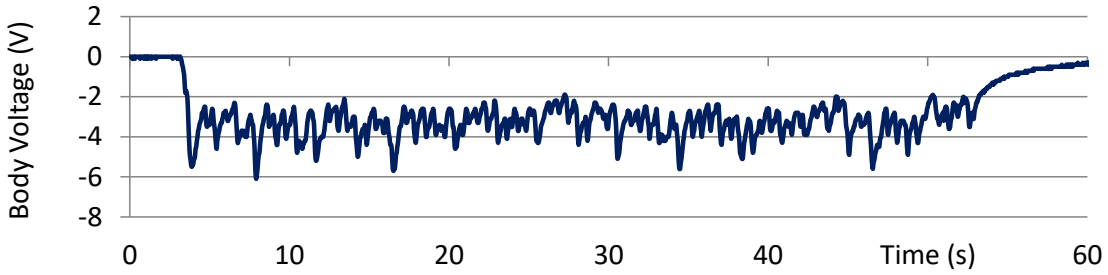


Figure 7: Walking test, Sample 5

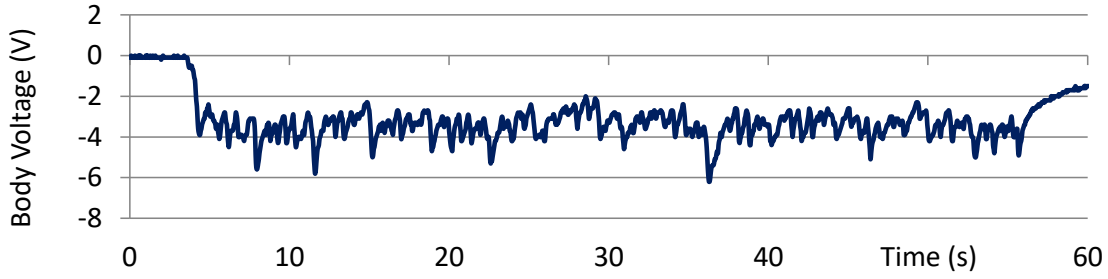


Figure 8: Walking test, Sample 6

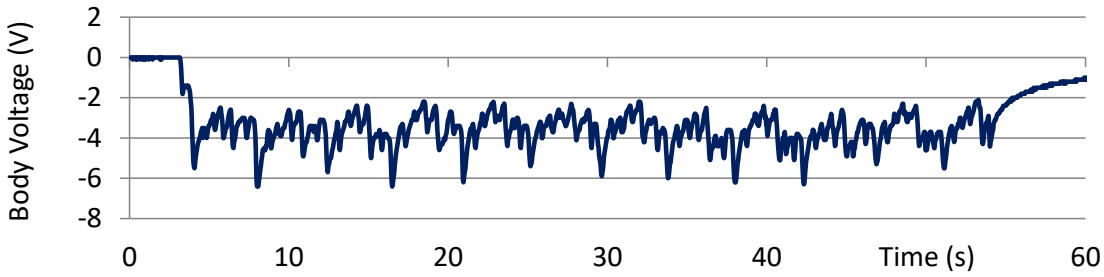


Figure 9: Walking test, Sample 7

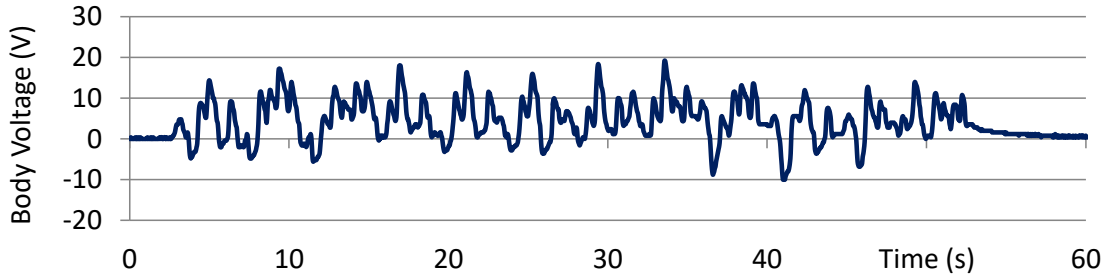


Figure 10: Walking test, Sample 8

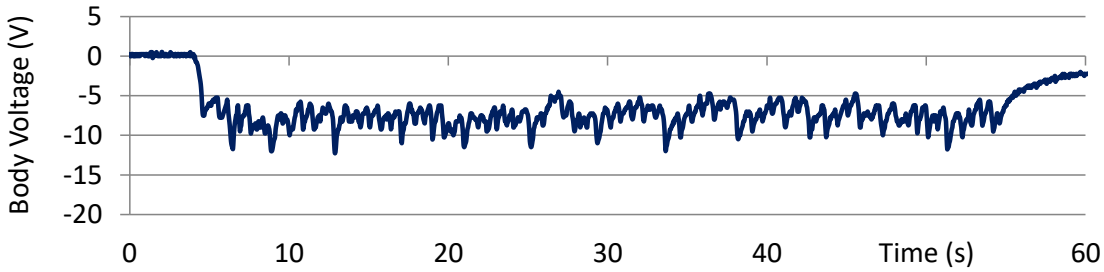


Figure 11: Walking test, Sample 9

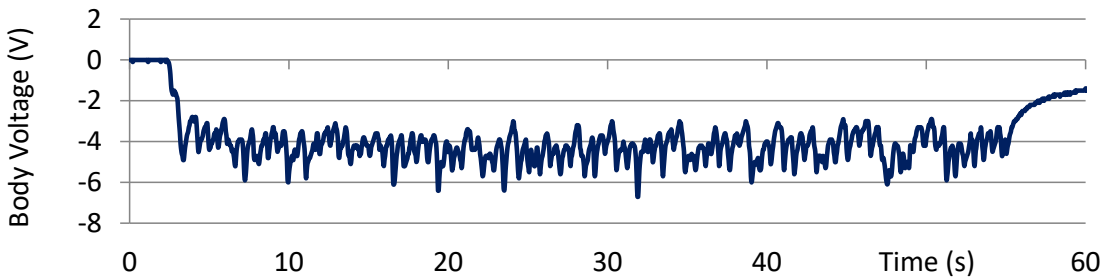


Figure 12: Walking test, Sample 10

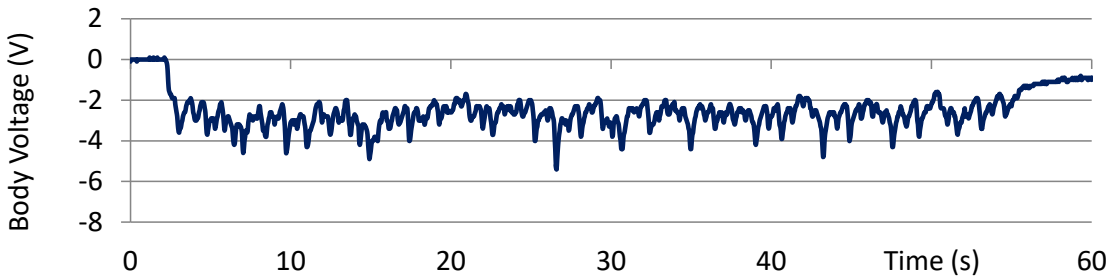


Figure 13: Walking test, Sample 11

8. Summary and Conclusions

The sample boards (samples 5 to 11) met the requirements of flooring used to ground personnel and equipment in reference to IEC 61340-6-1:2018 [1].

The sample boards (samples 5 to 11) met the electrostatic protected area requirements in reference to IEC 61340-5-1:2016 [2].

Personnel grounding requirements of the person/footwear/flooring system (samples 5 to 11) were met with the tested person/footwear combinations (IEC 61340-5-1:2016) [2].

9. Discussion and Suggestions

The electrical conductivity of the flooring may be affected by cleaning with inappropriate materials or the usage of aftercare products. It is important to pay attention to the manufacturer's recommendation regarding cleaning and maintenance of the floor.

10. References

[1] IEC 61340-6-1: 2018, Electrostatics - Part 6-1: Electrostatic control for healthcare - General requirements for facilities

[2] IEC 61340-5-1:2016, Electrostatics - Part 5-1Protection of electronic devices from electrostatic phenomena – General Requirements

[3] IEC 61340-4-1:2003+A1:2015, Electrostatics - Part 4-1: Standard test methods for specific applications - Electrical resistance of floor coverings and installed floors

[4] IEC 61340-4-5:2018, 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