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70-em/kle/bla

Test Report
Order No. 2716258 / Part 1

Client:	Dr. Schutz GmbH Steinbrinksweg 30 31840 Hessisch Oldendorf
Date of order:	13 September 2017
Order:	Test of the electrostatic properties of a resilient floor with coverings coated with "ESD Top Coat"
Contractor:	EPH – Laboratory Surface Testing
Engineer in charge:	Dipl.-Ing. Detlef Kleber

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1 Task

The laboratory EPH was ordered by Dr. Schutz GmbH to determine different surface resistances and constant resistance of resilient floor with coverings coated with "ESD Top Coat" in a walking test according to DIN EN 61340-4-1, DIN EN 61340-4-5, DIN EN 61340-2-3 and ANSI/ESD STM7.1, ANSI/ESD S4.1. In addition, the suitability of the surface in ESA-areas should be tested according to DIN EN 61340-5-1/ ANSI S20.20 and explosive areas according to TRGS 727 or IEC TS 60079-32-1:2013.

2 Test Material

The client, Dr. Schutz GmbH, has sent 3 different samples of resilient floor with coverings coated with "ESD Top Coat" (thickness d = 2.5 mm).

Sample		Description by the producer / articel	Measurement position
A1	A1.1	ESD Top Coat, Sample1	left side
	A1.2		right side
A2	A2.1	ESD Top Coat, Sample 2	left side
	A2.2		right side
A3	-	ESD Top Coat, Sample 3	-

3 Requirements and measurement

3.1 Conditions for measurement

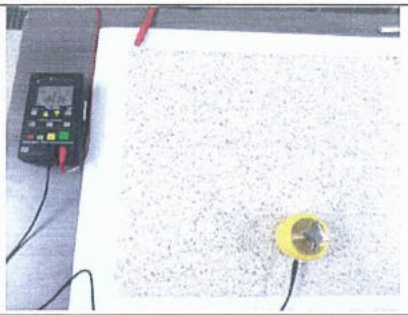
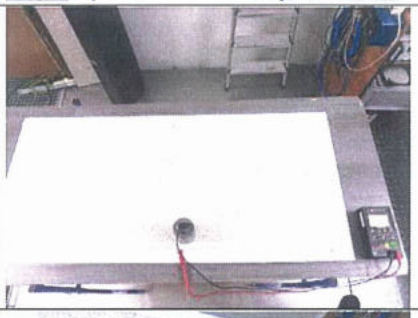
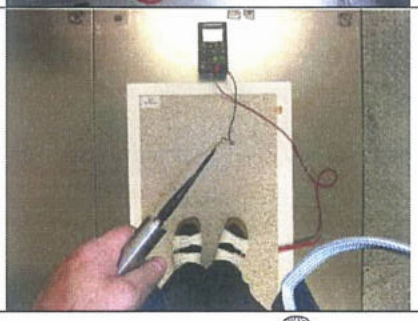
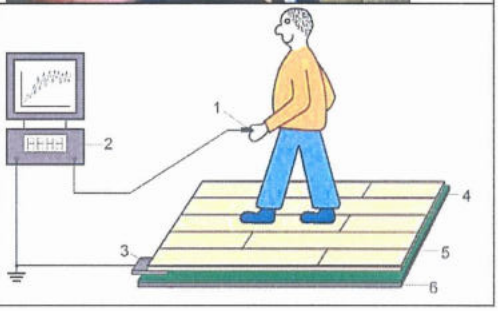
The test areas were conditioned 72 hours at drying atmosphere (23 °C ± 2 K, 12 % ± 3 % relative air humidity) and were tested in the same climate

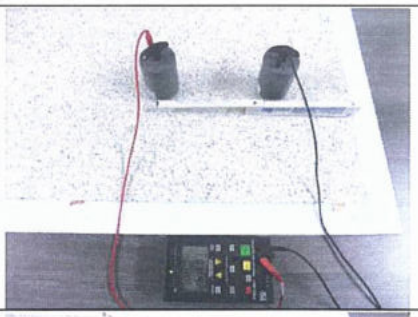
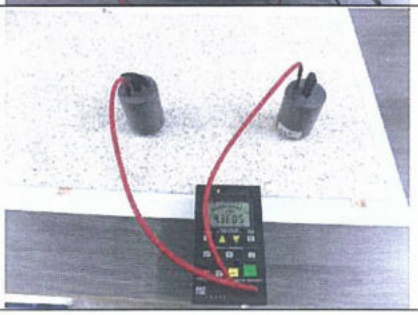
3.2 Measuring Instruments

The following resistance test devices were used: "PRS 801" (OF-27, fabricate PROSTAT) used measuring range 1 x 10^0 ... 2 x 10^{13} Ohm, measuring voltage 10 V and 100 V (measurement uncertainty < 5 %, lower than statistical variance of the measurement values).

3.3 Measurement setup

The following test was carried out according to different international norms:

Pos.	Properties	Measurement setup
1a	R_{gp} resistance measured between an electrode placed an the surface of attest specimen and a groundable point fittet to the test specimen according to DIN EN 61340-4-1	
1b	R_{gp} (surface-) resistance measured between an electrode placed an the surface of attest specimen and a groundable point fittet to the test specimen according to ANSI/ESD STM7.1	
2a	R_{p-p} (surface-) resistance measured between two electrodes placed a specified distance apart on the same surface of a test specimen (distance d = 300 mm) according to DIN EN 61340-4-1	
3a	R_g resistance measured between an electrode placed an the surface of attest specimen (hand electrode tester) and a local (earth-) ground according to DIN EN 61340-4-5 measurement according to ANSI/ ESD STM97.1 are equivalent, measured values can be transmitted/ transferred	
4a	Walking test according to DIN EN 61340-4-5 (U_p < 100 V)	
4b	Walking test according to ANSI ESD STM97.2	

Pos.	Properties	Measurement setup
5a	R_{p-p} (surface-) resistance measured between two electrodes placed a specified distance apart on the same surface of a test specimen (distance d = 250 mm) according to DIN EN 61340-2-3	
5b	R_{p-p} (surface-) resistance measured between two electrodes placed a specified distance apart on the same surface of a test specimen according to ANSI/ESD STM7.1 in line with ANSI/ESD S4.1 (see pos.2.a)	

The leakage resistance shall refer to an point with earthing properties (see picture pos. 1a). For the determination of resistance, earthing points on the backside according to the norms were used. There were appropriated self-adhesive cupper stripes electrodes, featuring resistance R < 0.001 Ω. The R_{gp} resistance refer to the point to point resistance (e.g. electrode gap according to EN 61340-4-1, d = 300 mm, see picture sample Pos. 2a). The R_g resistance refer to leakage resistance between a person body/ ESD (conducting) footwear and earthed floor covering. This resistance could be described as a system resistor (see picture pos. 3a).

The (yello) electrode with a diameter of 65 mm and weight 2.5 kg was used for the examination according to DIN EN 61340-4-1. The (gray) electrode with a diameter of 63.5 mm and weight 2.27 kg was used for measurements according to DIN EN 61340-2-3, ANSI/ESD STM7.1 und ANSI/ESD S4.1. In addition, the resistor value $R_x < 10^6$ Ω was measured at voltage U_M = 10 V. Higher resistance values $R_x > 10^6$ Ω were measured at voltage U_M = 100 V.

4 Results

Table 1: Determined resistance values according to EN 61340-4-1

Measurement	A1		A2	
	U_M = 10 V; 100 V			
	R_{gp}[Ω]	R_{P-P}[Ω]	R_{gp}[Ω]	R_{P-P}[Ω]
1	1.80E+06	1.10E+07	1.00E+06	1.30E+07
2	1.10E+06	5.80E+06	1.20E+06	4.60E+06
3	1.40E+06	7.20E+06	1.60E+06	4.90E+06
4	1.20E+06	5.30E+06	1.40E+06	6.80E+06
5	3.40E+06	9.10E+06	1.90E+06	7.10E+06
6	1.80E+06	7.10E+06	1.70E+06	4.40E+06
geometric mean	**1.7E+06**	**7.4E+06**	**1.4E+06**	**6.3E+06**

Table 2: Determined leakage resistance (system resistor) according to EN 61340-4-5

Measurement	A1	A2
	U_M = 10 V; 100 V	
	R_g [Ω]	
1	5.40E+07	4.70E+07
2	1.60E+08	5.40E+07
3	1.40E+08	7.40E+07
4	1.30E+08	6.60E+07
5	1.20E+08	7.50E+07
6	1.40E+08	8.70E+07
arithmetic mean	1.24E+08	6.72E+07
	7.4E+07	

Table 3: Determined resistance values according to EN 61340-2-3

Measur.	A1.1		A1.2		A2.1	
	U_M = 10 V; 100 V					
	R_{gp}[Ω]	R_{P-P}[Ω]	R_{gp}[Ω]	R_{P-P}[Ω]	R_{gp}[Ω]	R_{P-P}[Ω]
1	2.60E+05	9.30E+05	4.10E+05	1.50E+06	1.70E+06	5.70E+07
2	1.80E+05	1.40E+06	2.00E+05	1.30E+06	1.70E+06	6.30E+07
3	7.10E+05	8.10E+05	5.80E+05	1.40E+06	7.00E+07	1.30E+07
4	4.00E+05	1.30E+06	5.80E+05	1.20E+06	3.80E+06	4.20E+06
5	1.30E+06	1.30E+06	7.80E+05	1.60E+06	1.20E+06	2.80E+06
6	8.50E+05	1.10E+06	5.90E+05	1.40E+06	1.30E+06	2.40E+06
arithmetic mean	**6.2E+05**	**1.1E+06**	**5.2E+05**	**1.4E+06**	**3.3E+06**	**1.0E+07**

Table 4: Determined body voltage U_P [V] **according to** DIN EN 61340-4-5 sample A (A3)

Measurement/-points	body voltage IU_PI [V]					
	1	2	3	1	2	3
	„sink value“			„crest value“		
AP 1	27	29	39	51	53	53
AP 2	26	28	36	45	52	53
AP 3	25	28	32	44	51	53
AP 4	24	27	28	44	50	53
AP 5	24	25	28	43	50	53
arithmetic mean (10V roundet)	**30**	**30**	**30**	**50**	**50**	**50**
Total arithmetic mean	**30**			**50**		

Table 5: Determined resistance values according to ANSI/ESD S7.1

Measurement U_M = 10 V; 100 V		A1.1	
		U_M = 10 V; 100 V	
		R_{gp}/ Ω	R_{P-P}/ Ω
earthing point X	1	6.2E+05	6.8E+05
	2	6.4E+05	8.8E+05
	3	8.5E+05	6.8E+05
	4	6.5E+05	9.4E+06
	5	7.3E+05	1.0E+06
	6	1.1E+06	1.7E+06
earthing point Y	1	1.1E+06	1.0E+06
	2	1.5E+06	8.2E+05
	3	3.1E+05	9.1E+05
	4	5.8E+05	8.4E+05
	5	7.6E+05	1.0E+06
	6	1.0E+06	1.4E+06
arithmetic mean		**8.2E+05**	**1.7E+06**
Median		7.5E+05	9.6E+05
Maximum		**1.5E+06**	**9.4E+06**
Minimum		**3.1E+05**	**6.8E+05**

Table 6: Determined resistance values according to ANSI/ESD S4.1 (Probe A 1.1)

Measure.	A1.1		A1.2		A2.1	
	U_M = 10 V; 100 V					
	R_{gp}[Ω]	R_{P-P}[Ω]	R_{gp}[Ω]	R_{P-P}[Ω]	R_{gp}[Ω]	R_{P-P}[Ω]
X1	1.2E+06	1.7E+06	1.3E+06	1.7E+06	4.7E+05	9.5E+05
X2	7.4E+05	-	2.1E+05	-	8.2E+05	-
X3	4.6E+05	-	6.5E+05	-	8.8E+05	-
Y1	6.4E+05	1.0E+06	1.2E+06	7.6E+05	9.8E+05	1.1E+06
Y2	8.7E+05	-	8.7E+05	-	9.1E+05	-
Y3	4.5E+05	-	6.2E+05	-	7.7E+05	-
Median	**6.9E+05**	**1.7E+06**	**7.6E+05**	**1.2E+06**	**8.5E+05**	**1.0E+06**
Maximum	**1.2E+06**	**1.7E+06**	**1.3E+06**	**1.7E+06**	**9.8E+05**	**1.1E+06**
Minimum	**4.5E+05**	**1.7E+06**	**2.1E+05**	**7.6E+05**	**4.7E+05**	**9.5E+05**

Table 7: Determined body voltage U_P [V] according to ANSI/ESD STM97.2 sample A (A3)

Measurement/-points	body voltage IU_PI [V]																			
	1	2	3	4	5	6	7	8	9	10	1	2	3	4	5	6	7	8	9	10
	„sink value“										„crest value“									
AP 1	49	23	19	19	24	18	33	24	26	-	61	39	43	35	39	33	38	36	34	-
AP 2	45	22	16	15	23	17	28	23	24	-	58	38	37	33	38	31	37	36	33	-
AP 3	45	20	16	15	23	16	25	23	24	-	58	38	32	32	35	30	35	34	33	-
AP 4	43	18	16	14	21	16	24	19	19	-	54	37	32	32	35	30	34	34	33	-
AP 5	39	17	14	14	19	14	22	17	15	-	53	36	43	32	34	30	34	33	32	-
arithmetic mean	**44**	**20**	**16**	**15**	**22**	**16**	**26**	**21**	**22**	-	**57**	**37**	**37**	**32**	**36**	**31**	**36**	**35**	**33**	-
total arithmetic mean	**23**										**37**									

5 Evaluation

The presented samples A were evaluated for the properties tested as follows:

ESD-area: Sample A - ESD TopCoat

Pos.	Properties	Results	Requirement/Assessment according to EN 61340-5-1	
			23 °C und 12 % rel. Feuchte	Result
1a	Resistance R_{gp} at the point with earthing properties according to EN 61340-4-1	$1.8 * 10^5\ \Omega < R_{gp} < 8.5 * 10^6\ \Omega$	$R_{gp} < 10^9\ \Omega$	fulfill for floorings
2a	R_{p-p} resistance between two points according to DIN EN 61340-4-1	$7.3 * 10^6\ \Omega < R_{p-p} < 3.2 * 10^7\ \Omega$	-	-
3a	Resistance R_g according to EN 61340-4-5*	$R_g = 7.4 * 10^7\ \Omega$ *	$R_g < 10^9\ \Omega$	fulfill for personnel grounding
4a	Body voltage according to EN 61340-4-5 (Up < 100 V)	$30\ V < U_M < 50\ V$	U < 100 V	
5a	R_{p-p} resistance between two points according to EN 61340-2-3	$5.2 * 10^5\ \Omega < R_{gp} < 3.3 * 10^6\ \Omega$ $1.1 * 10^6\ \Omega < R_{p-p} < 1.0 * 10^7\ \Omega$	$R_{gp} < 10^9\ \Omega$ $R_{p-p} < 10^9\ \Omega$	fulfill for work surfaces/ storage racks

Pos.	Properties	Results	Requirement/Assessment according to ANSI S20.20	
1b	Resistance R_{gp} at the point with earthing properties according to ANSI/ESD STM7.1	$3.1 * 10^5\ \Omega < R_{gp} < 1.6 * 10^6\ \Omega$	$R_{gp} < 10^9\ \Omega$	fulfill for floorings
2b	Surface resistance R_{p-p} between two points according to ANSI/ESD STM7.1	$6.8 * 10^5\ \Omega < R_{p-p} < 9.4 * 10^6\ \Omega$	-	-
3b	System resistance R_g according to ANSI/ESD STM97.1	$R_g = 7.4 * 10^7\ \Omega$ *	$R_g < 10^9\ \Omega$	fulfill for personnel grounding
4b	Body voltage according to ANSI/ESD STM97.2	$23\ V < U_M < 37\ V$	U < 100 V	
5b	Resistance R_{p-p} according to ANSI/ESD S4.1	$2.1 * 10^5\ \Omega < R_{gp} < 1.3 * 10^6\ \Omega$ $1.0 * 10^6\ \Omega < R_{p-p} < 1.7 * 10^6\ \Omega$	$R_{gp} < 10^9\ \Omega$ $R_{p-p} < 10^9\ \Omega$	fulfill for work surfaces/ storage racks

* measurement according to ANSI/ ESD STM97.1 are equivalent , measured values can be transmitted/ transferred

Note explosion protection

In potentially explosive atmospheres requirement for floorings are described in "Technical Rules for Hazardous Substances" national standard (TRGS 727:2016; Germany) and international norm (IEC TS 60079-32-1:2013). Both regulations require for conductive resistance a value $R_E < 10^8\ \Omega$. The required leakage resistance corresponds to the resistance R_{gp} of the presented samples to a point with earthing properties (see sample A: $R_{gpmax} < 2.5 * 10^6\ \Omega$ - Table 2). The value determined at sample A fulfils this requirement. The test samples of resilient floor coverings coated with "ESD Top Coat", which have been reported, are approved to be suitable for hazardous areas.

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