

AMENDMENT NO. 1 NOVEMBER 2024
TO
IS 13778 (PART 5) : 2012/IEC 60851-5 : 2008 WINDING WIRES — TEST
METHODS
PART 5 ELECTRICAL PROPERTIES
(First Revision)

This amendment to IS 13778 (Part 5) : 2012 is identical to merged Amendment No. 1 (2011) and Amendment No. 2 (2019) of IEC 60851-5 : 2008.

Price Group 4

4 Test 13: Breakdown voltage

4.2 Equipment

Add the following new dashed text at the end of the list:

- metal mandrel, 80 mm \pm 3 mm in diameter.

4.3 Enamelled round wire with a nominal conductor diameter up to and including 0,100 mm

Replace the existing title of Subclause 4.3 with the following new title:

4.3 Enamelled round wire

Re-designate the text under 4.3 as the new Subclause 4.3.1 and modify the first paragraph as follows:

4.3.1 Grade 1 to grade 3 with a nominal diameter up to and including 0,100 mm

The test is carried out on a cylinder with a diameter of 25 mm \pm 1 mm. A straight piece of wire with the insulation removed at one end shall be connected to the upper terminal as shown in Figure 1 and wound once around the cylinder. A load as specified in Table 2.1 shall be applied to the lower end of the wire to keep the specimen in close contact with the cylinder.

Renumber Table 2 as follows:

Table 2.1 – Loads applied to the wire

Add the following new Subclause 4.3.2 as follows:

4.3.2 Grade of FIW 3 to FIW 9 with a nominal conductor diameter up to and including 1,600 mm

The test is carried out on a cylinder with a diameter as set out in Table 2.2.

A straight piece of wire with the insulation removed at one end shall be connected to the upper terminal as shown in Figure 1 and wound once around the cylinder. A load as specified in Table 2.2 shall be applied to the lower end of the wire to keep the specimen in close contact with the cylinder.

The test voltage shall be applied according to 4.1 between the conductor of the wire and the cylinder. The test shall be carried out at room temperature. Five specimens shall be tested. The five single values shall be reported.

Table 2.2 – Loads and diameters of test cylinders applied to wire

Nominal diameter mm	Nominal diameter mm	Load N	Diameter of test cylinder mm
Over	Up to and including		
-	0,040	0,080	25 ± 1
0,040	0,045	0,100	25 ± 1
0,045	0,050	0,130	25 ± 1
0,050	0,056	0,160	25 ± 1
0,056	0,063	0,200	25 ± 1
0,063	0,071	0,260	25 ± 1
0,071	0,080	0,330	25 ± 1
0,080	0,090	0,400	25 ± 1
0,090	0,100	0,500	25 ± 1
0,100	0,160	0,600	25 ± 1
0,160	0,250	0,850	25 ± 1
0,250	0,355	1,700	25 ± 1
0,355	0,500	3,400	25 ± 1
0,500	0,710	7,000	50 ± 2
0,710	1,060	13,500	50 ± 2
1,060	1,400	27,000	80 ± 3
1,400	1,600	54,000	80 ± 3

4.4 Enamelled round wire with a nominal conductor diameter over 0,100 mm up to and including 2,500 mm

Replace the existing title of Subclause 4.4 with the following new title:

4.4 Enamelled round wire with a nominal conductor diameter over 0,100 mm up to and including 2,500 mm, grade 1 to grade 3

5 Test 14: Continuity of insulation (applicable to enamelled round and tape wrapped round wire)

5.2 Low-voltage continuity (nominal conductor diameter up to and including 0,050 mm)

Replace the title of Subclause 5.2 with the following new title:

5.2 Low-voltage continuity (nominal conductor diameter up to and including 0,050 mm, grade 1 to grade 3)

5.3 High-voltage continuity (nominal conductor diameter over 0,050 mm up to and including 1,600 mm, grade 1 to grade 3, and over 0,035 mm, up to and including 1,600 mm, grade 3 of FIW 3 to FIW 9)

Replace the title of Subclause 5.3 with the following new title:

5.3 Off-line high-voltage continuity (nominal conductor diameter over 0,050 mm up to and including 1,600 mm)

5.3.2 Equipment

Replace the first dashed item in the list with the following new text:

- high voltage power supply providing a smooth filtered d.c. voltage with a ripple content less than 5 %, with an open circuit test voltage adjustable from 350 V to 3000 V with a short circuit current limited by internal series resistance to $25 \mu\text{A} \pm 5 \mu\text{A}$ at any test voltage with not more than 75 % drop in voltage in case of a 50 M Ω fault resistance;

Table 4 – Fault currents

Replace the existing Table 4 with the following new Table 4:

Table 4 – Off-line HVC fault currents

Test voltage (d.c.) V	Fault current μA
3 000	16
2 500	14
2 000	12
1 500	10
1 000	8
750	7
500	6
350	5

5.3.3 Procedure

Replace this existing text in Subclause 5.3.3 with the following new text:

A wire specimen of $30 \text{ m} \pm 1 \text{ m}$ shall be pulled with a speed of $(275 \pm 25) \text{ mm/s}$ over the high-voltage electrode pulley or through the graphite brush electrode mounted between the earthed guide pulleys with the conductor of the wire and the electrode connected to the electrical circuit, with the open-circuit d.c. test voltage adjusted according to Table 5.1 or Table 5.2, whichever applies, with a tolerance of $\pm 5 \%$ and with a positive polarity with respect to the earthed conductor of the wire.

Table 5 – Test voltages

Replace the existing Table 5 with the following new Tables 5.1 and 5.2:

Table 5.1 – Off-line HVC test voltages for grades 1 – 3

Type of conductor	Nominal conductor diameter		Voltage (d.c.)		
	mm		V		
	Over	Up to and including	Grade 1	Grade 2	Grade 3
Copper	0,050	0,125	350	500	750
	0,125	0,250	500	750	1000
	0,250	0,500	750	1000	1500
	0,500	1,600	1000	1500	2000
Aluminium	0,400	1,600	500	1500	

Table 5.2 – Off-line HVC test voltages for grade of FIW 3 – FIW 9

Type of conductor	Nominal conductor diameter		Test voltage d.c.							
	Over	Up to and incl.	Grade of FIW 3	Grade of FIW 4	Grade of FIW 5	Grade of FIW 6	Grade of FIW 7	Grade of FIW 8	Grade of FIW 9	
Copper	0,035	0,050	750	750	1000	2000	2000	2000	—	
	0,050	0,053	750	750	1000	2000	2000	2000	—	
	0,053	0,063	750	750	1000	2000	2000	3000	—	
	0,063	0,085	750	1000	2000	2000	2000	3000	3000	
	0,085	0,095	750	1000	2000	2000	3000	3000	3000	
	0,095	0,118	750	1000	2000	2000	3000	3000	3000	
	0,118	0,125	1000	2000	2000	3000	3000	3000	3000	
	0,125	0,170	1000	2000	2000	3000	3000	3000	3000	
	0,170	0,190	1000	2000	3000	3000	3000	3000	3000	
	0,190	0,250	2000	2000	3000	3000	3000	3000	3000	
	0,250	0,300	2000	2000	3000	3000	3000	3000	3000	
	0,300	0,375	2000	3000	3000	3000	3000	3000	3000	
	0,375	0,425	2000	3000	3000	3000	3000	3000	—	
	0,425	0,500	2000	3000	3000	3000	3000	—	—	
	0,500	0,600	2000	3000	3000	3000	3000	—	—	
	0,600	0,750	3000	3000	3000	3000	3000	—	—	
	0,750	1,060	3000	3000	3000	3000	—	—	—	
1,060	1,600	3000	3000	3000	—	—	—	—		
Aluminium	0,400	1,600	—	—	—	—	—	—	—	

Add the following new Subclause 5.4 as follows:

5.4 Inline high-voltage continuity (wires in accordance with grade of FIW 3 to FIW 10 with nominal conductor diameter over 0,035 mm up to and including 1,600 mm)

5.4.1 Principle

During the enameling process and just prior to the wire being taken up on the delivery drum, spool or reel, it is run over a “V”-grooved electrode (pulley) or through a graphite brush electrode. DC test voltage is applied between the electrode and earth (ground). The wire conductor is continuously connected to earth (ground). The wire run length and number of faults in the insulation are recorded by a counting device.

5.4.2 Equipment

The following equipment shall be used:

- high-voltage power supply providing a smooth filtered d.c. voltage with a ripple content less than 5 %, with an open circuit test voltage adjustable from 350 V to 3000 V with a short-circuit current limited by internal series resistance to $25 \mu\text{A} \pm 5 \mu\text{A}$ at any test voltage and with not more than 75 % drop in voltage in case of a 50 M Ω fault resistance;
- fault detection circuit which operates at a fault current as shown in Table 6 with a speed of response of $\leq 1,5$ ms;
- electrode pulley, graphite brush, or other contact configuration made of a conductive material and providing a wire contact length, giving a contact time of at least 2,25 ms (e.g. ≥ 25 mm at ≤ 667 m/min wire run speed);
- surge damping resistor of $4,7 \text{ M}\Omega \pm 10 \%$ installed in the high-voltage line.

NOTE The earth insulation for the high-voltage electrode should be a high-resistivity material, non-hygroscopic, non-tracking and easily cleanable, having a clearance for maintaining a continuous voltage of 3000 V. No shielding should be used on the high-voltage lead since a minimum capacitance to ground is required during switching and counting events.

5.4.3 Procedure

The enamelled wire shall be pulled continuously at the enamelling machine production speed over a high-voltage electrode pulley, a graphite brush electrode or other electrode configuration located before the delivery drum, spool or reel, with the conductor of the wire and the electrode connected to the electrical circuit, and the open-circuit d.c. test voltage adjusted according to Table 7 with a tolerance of $\pm 5 \%$ and with a positive polarity with respect to the earthed (grounded) conductor of the wire.

Table 6 – In-line HVC fault currents

Test voltage (d.c.) V	Fault current μA
3 000	18
2 000	14
1 000	10
750	9

Table 7 – In-line HVC test voltages

Type of conductor	Nominal diameter mm		Test voltage d.c.							
	Over	Up to and incl.	Grade of FIW 3	Grade of FIW 4	Grade of FIW 5	Grade of FIW 6	Grade of FIW 7	Grade of FIW 8	Grade of FIW 9	
Copper	0,035	0,050	750	750	1000	2000	2000	2000	3000	
	0,050	0,053	750	750	1000	2000	2000	2000	3000	
	0,053	0,063	750	750	1000	2000	2000	3000	3000	
	0,063	0,085	750	1000	2000	2000	2000	3000	3000	
	0,085	0,095	750	1000	2000	2000	3000	3000	3000	
	0,095	0,118	750	1000	2000	2000	3000	3000	3000	
	0,118	0,125	1000	2000	2000	3000	3000	3000	3000	
	0,125	0,170	1000	2000	2000	3000	3000	3000	3000	
	0,170	0,190	1000	2000	3000	3000	3000	3000	3000	
	0,190	0,250	2000	2000	3000	3000	3000	3000	3000	
	0,250	0,300	2000	2000	3000	3000	3000	3000	3000	
	0,300	0,375	2000	3000	3000	3000	3000	3000	3000	
	0,375	0,425	2000	3000	3000	3000	3000	3000	—	
	0,425	0,500	2000	3000	3000	3000	3000	—	—	
	0,500	0,600	2000	3000	3000	3000	3000	—	—	
	0,600	0,750	3000	3000	3000	3000	3000	—	—	
	0,750	1,060	3000	3000	3000	3000	—	—	—	
1,060	1,600	3000	3000	3000	—	—	—	—		
Aluminium	0,400	1,600	—	—	—	—	—	—	—	

5.4.4 Result

The run length and number of faults for the continuous wire wound onto delivery drums, spools or reels shall be recorded.

5.4.2 Equipment

Replace the second dash, as modified by Amendment 1, with the following new dash:

- fault detection circuit which operates at a fault current of 18 µA with a speed of response of ≤ 1,5 ms;

5.4.3 Procedure

Delete Table 6, as modified by Amendment 1.

Replace Table 7, as modified by Amendment 1, with the following new table:

Table 7 – In-line HVC test voltages

Type of conductor	Nominal diameter mm		Test voltage DC						
	Over	Up to and incl.	Grade of FIW 3	Grade of FIW 4	Grade of FIW 5	Grade of FIW 6	Grade of FIW 7	Grade of FIW 8	Grade of FIW 9
Copper	0,035	0,050	350	350	500	750	1 000	2 000	3 000
	0,050	0,053	350	350	500	1 000	1 500	2 000	3 000
	0,053	0,085	350	350	750	1 000	1 500	3 000	3 000
	0,085	0,095	350	500	750	1 000	2 000	3 000	3 000
	0,095	0,118	500	500	1 000	1 500	2 000	3 000	3 000
	0,118	0,125	500	500	1 000	2 000	3 000	3 000	3 000
	0,125	0,170	500	750	1 000	2 000	3 000	3 000	3 000
	0,170	0,190	750	750	1 000	2 000	3 000	3 000	3 000
	0,190	0,250	1 000	1 000	1 500	3 000	3 000	3 000	3 000
	0,250	0,300	1 500	1 500	2 000	3 000	3 000	3 000	3 000
	0,300	0,375	2 000	2 000	3 000	3 000	3 000	3 000	3 000
	0,375	0,425	2 000	3 000	3 000	3 000	3 000	3 000	–
	0,425	0,600	2 000	3 000	3 000	3 000	3 000	–	–
	0,600	0,750	3 000	3 000	3 000	3 000	3 000	–	–
	0,750	1,060	3 000	3 000	3 000	3 000	–	–	–
1,060	1,600	3 000	3 000	3 000	–	–	–	–	
Aluminium	0,400	1,600	–	–	–	–	–	–	–