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Navijalne žice - Preskusne metode - 3. del: Mehanske lastnosti

Winding wires - Test methods - Part 3: Mechanical properties

Wickeldrähte - Prüfverfahren - Teil 3: Mechanische Eigenschaften

Fils de bobinage - Méthodes d'essai - Partie 3: Propriétés mécaniques

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TITLE:

Winding wires - Test methods - Part 3: Mechanical properties

PROPOSED STABILITY DATE: 2025

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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WINDING WIRES – TEST METHODS

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127

Part 3: Mechanical properties

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FOREWORD

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163 IEC 60851-3 has been prepared by IEC technical committee 55: Winding wires. It is an
164 International Standard.

165 This fourth edition cancels and replaces the third edition published 2009-01-28, Amendment
166 1:2013 and Amendment 2:2019. This edition constitutes a technical revision.

167 This edition includes the following significant technical changes with respect to the previous
168 edition:

169 a) Clarification of the distance measurement for determining loss of adhesion in 5.5.2, 5.5.3
170 for fibre-covered wires and 5.5.4 for tape-covered wires
171

172 The text of this International Standard is based on the following documents:

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

173

174 Full information on the voting for its approval can be found in the report on voting indicated in
175 the above table.

176 The language used for the development of this International Standard is English.

177 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
178 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
179 at https://www.iec.ch/members_experts/refdocs. The main document types developed by IEC
180 are described in greater detail at <https://www.iec.ch/standardsdev/publications>.

181 The committee has decided that the contents of this document will remain unchanged until the
182 stability date indicated on the IEC website under webstore.iec.ch in the data related to the
183 specific document. At this date, the document will be

- 184 • reconfirmed,
- 185 • withdrawn,
- 186 • replaced by a revised edition, or
- 187 • amended.

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INTRODUCTION

190 The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed
191 that compliance with this document may involve the use of a patent. IEC takes no position
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198 subject of patent rights other than those in the patent database. IEC shall not be held
199 responsible for identifying any or all such patent rights.

200 This part of IEC 60851 forms an element of a series of standards, which deals with insulated
201 wires used for windings in electrical equipment. The series has three groups describing

- 202 a) winding wires – Test methods (IEC 60851);
- 203 b) specifications for particular types of winding wires (IEC 60317);
- 204 c) packaging of winding wires (IEC 60264).

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WINDING WIRES – TEST METHODS

Part 3: Mechanical properties

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213 **1 Scope**

214 This part of IEC 60851 specifies the following methods of test for winding wires:

- 215 – Test 6: Elongation;
- 216 – Test 7: Springiness;
- 217 – Test 8: Flexibility and adherence;
- 218 – Test 11: Resistance to abrasion;
- 219 – Test 18: Heat bonding.

220 For definitions, general notes on methods of test and the complete series of methods of test for
221 winding wires, IEC 60851-1 applies.

222 **2 Normative references**

223 The following documents are referred to in the text in such a way that some or all of their content
224 constitutes requirements of this document. For dated references, only the edition cited applies.
225 For undated references, the latest edition of the referenced document (including any
226 amendments) applies.

- 227 IEC 60851-1, *Winding wires – Test methods – Part 1: General*
- 228 IEC 60851-2:2009 *Winding wires – Test methods – Part 2: Determination of dimensions*
- 229 ISO 178:2001, *Plastics – Determination of flexural properties*
230 Amendment 1:2004

231 **3 Test 6: Elongation**

232 **3.1 Elongation at fracture**

233 Elongation is the increase in length expressed as a percentage of the original length.

234 A straight piece of wire shall be elongated to the point of fracture of the conductor at a rate of
235 (5 ± 1) mm/s with an elongation tester or with tensile testing equipment with a free measuring
236 length of between 200 mm and 250 mm. The linear increase at fracture shall be calculated as a
237 percentage of the free measuring length.

238 Three specimens shall be tested. The three single values shall be reported. The mean value
239 represents elongation at fracture.

240 **3.2 Tensile strength**

241 Tensile strength is the ratio of the force at fracture to initial cross-section.

242 A straight piece of wire shall be elongated to the point of fracture of the conductor at a rate of
 243 (5 ± 1) mm/s with tensile testing equipment with a free measuring length of between 200 mm
 244 and 250 mm and which records the force at fracture.

245 Three specimens shall be tested. The initial cross-section and the three single values of the
 246 force at fracture shall be reported. The mean value of the ratio of the force at fracture and the
 247 initial cross-section represents the tensile strength.

248 4 Test 7: Springiness

249 Springiness is the recoil measured in degrees after the wire is wound in the form of a helical
 250 coil or bent through an angle.

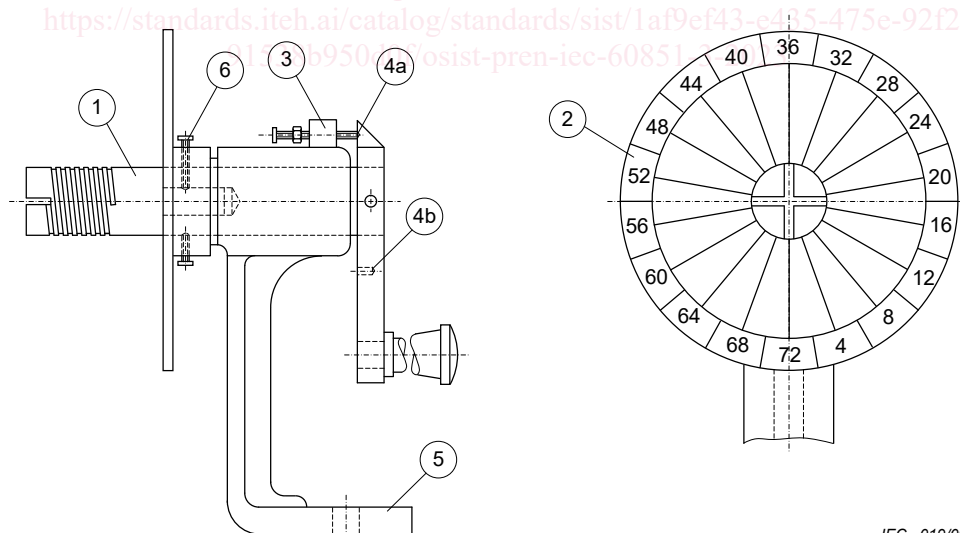
251 4.1 Round wire with a nominal conductor diameter from 0,080 mm up to 252 and including 1,600 mm

253 4.1.1 Principle

254 A straight piece of wire is wound five times around a mandrel with a diameter and under a
 255 tension applied to the wire as specified in the relevant standard. The reading of the angle by
 256 which the end of the five turns recoils is the measure of springiness.

257 4.1.2 Equipment

258 Figure 1 shows an example of the test equipment with details of the mandrel given in Figure 2
 259 and Table 1. Figure 2 indicates a helical groove, which may be used to facilitate winding. The
 260 provision of this groove, however, is not mandatory. The dial is marked with 72 equally spaced
 261 divisions so that with five turns of the wire the reading corresponds to the number of degrees
 262 that each turn springs back.



IEC 019/09

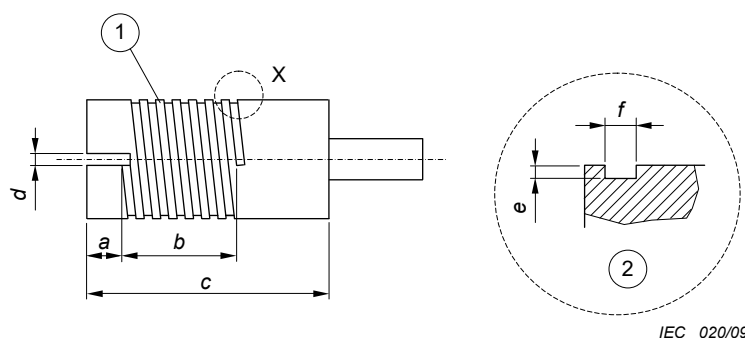
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264 Key

- 265 1 mandrel
 266 2 dial
 267 3 locking device
 268 4 locking device
 269 5 base-plate
 270 6 mandrel-fixing screw

271

Figure 1 – Test equipment to determine springiness



IEC 020/09

272

273 **Key**

274 1 7 threads

275 2 part X enlarged

276 **Figure 2 – Construction and details of the mandrel (see Table 1)**

277

Table 1 – Mandrels for springiness

Mandrel diameter ^a mm	Dimensions ^b mm					
	a	b	c	d	e	f
5	6,0	7,5	32	0,30	0,05	0,13
7	6,0	9,0	34	0,40	0,07	0,18
10	6,0	9,0	34	0,60	0,10	0,25
12,5	6,0	9,0	40	0,80	0,14	0,35
19	10,0	11,0	45	1,20	0,20	0,50
25	12,5	12,5	45	2,00	0,28	0,70
37,5	12,5	14,5	47	2,40	0,40	1,00
50	12,5	17,5	50	3,00	0,80	2,00

^a At the bottom of the groove, if provided.

^b See Figure 2.

278

279 **4.1.3 Procedure**

280 The specified mandrel shall be mounted and locked in position with its axis horizontal and with
 281 the slot or hole for fastening the wire corresponding with the zero of the dial. The mandrel shall
 282 be dusted with powdered talc (French chalk) to prevent the wire clinging to the mandrel.

283 A tension shall be applied to a straight piece of wire of about 1 m in length by attaching the
 284 specified load to one end of the wire. The handle to rotate the mandrel shall be unlatched. The
 285 other end of the wire shall be inserted into the slot or hole so that sufficient wire projects on the
 286 other side of the mandrel and the wire is in firm contact with the mandrel. The weight shall be
 287 slowly lowered with the wire suspended vertically below the mandrel and with the dial zero and
 288 the slot or hole pointing downwards.

289 With the free end of the wire being held securely, the mandrel shall be rotated for five complete
 290 turns counterclockwise (looking at the face of the dial) and further until the zero on the dial is
 291 vertically upwards. The handle shall then be latched in this position. The load shall be removed
 292 while the wire is held in position, and the wire shall then be cut about 25 mm beyond the end
 293 of the fifth turn. This end of the wire shall be bent into a vertical position in line with the dial
 294 zero to act as a pointer.

295 A pencil or similar tool shall be placed to the left of this end of the wire to prevent any sudden
296 springback. The coil shall then be allowed to unwind slowly and without jerking.

297 NOTE If the wire springs back suddenly, erroneous results may be obtained.

298 The mandrel and the dial shall then be unlatched and rotated clockwise to bring the pointer
299 back into a vertical position. The springback angle is equal to the reading on the dial in line with
300 the pointer. With very springy wires, the pointer may recoil more than one complete revolution.
301 If this is the case, 72 shall be added to the dial reading for each complete revolution of recoil.

302 Three specimens shall be tested. The three single values shall be reported. The mean value
303 represents springiness.

304 **4.2 Round wire with a nominal conductor diameter over 1,600 mm** 305 **and rectangular wire**

306 **4.2.1 Principle**

307 A straight piece of wire shall be bent through an angle of 30°. After removing the force, the
308 reading of the angle by which the wire springs back is the measure of springiness.

309 **4.2.2 Equipment**

310 Figure 3 shows an example of the test equipment basically consisting of two jaws, one of which
311 is fixed (2) and one is movable (1), and a sector graduated in degrees (5) with the 0° to 10°
312 sector of the scale graduated in 0,5° increments. The graduated sector is an arc placed in a
313 plane at 90° to the clamp faces. Its centre is located at the outer edge of the fixed jaw (3). The
314 lever arm with its fulcrum placed at the centre of the arc can move over the graduated sector in
315 the vertical plane.

316 The lever arm shall have a pointer or marker to provide a proper reading of the springback
317 angle. On the lever arm with approximately 305 mm length scaled off in millimetres with the
318 origin at the centre of the arc, is a slider (4) with a knife edge. 3-2023

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