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Responsible committee: CPL/116 Safety of motor-operated electric tools

Interested committees:

Title: Draft BS EN IEC 62841-1 ED2 Electric motor-operated hand-held tools, transportable tools and lawn and garden machinery - Safety. Part 1: General requirements.

Please notify the secretary if you are aware of any keywords that might assist in classifying or identifying the standard or if the content of this standard

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

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This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

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Full document details: 25/30509725 DC

Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/ Figure/Table/Note	Type of comment	Comment (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



116/875/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 62841-1 ED2

DATE OF CIRCULATION:

2025-03-21

CLOSING DATE FOR VOTING:

2025-06-13

SUPERSEDES DOCUMENTS:

116/874/RR

IEC TC 116 : SAFETY OF MOTOR-OPERATED ELECTRIC TOOLS

SECRETARIAT:

United States of America

SECRETARY:

Ms Heather Darrah

OF INTEREST TO THE FOLLOWING COMMITTEES:

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

Safety

☐ SUBMITTED FOR CENELEC PARALLEL VOTING

☒ NOT SUBMITTED FOR CENELEC PARALLEL VOTING

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

Recipients of this document are invited to submit, with their comments, notification of any relevant "In Some Countries" clauses to be included should this proposal proceed. Recipients are reminded that the CDV stage is the final stage for submitting ISC clauses. (SEE [AC/22/2007](#) OR [NEW GUIDANCE DOC](#)).

TITLE:

Electric motor-operated hand-held tools, transportable tools and lawn and garden machinery - Safety - Part 1: General requirements

PROPOSED STABILITY DATE: 2031

NOTE FROM TC/SC OFFICERS:

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CONTENTS

1		
2	FOREWORD.....	6
3	1 Scope.....	8
4	2 Normative references	9
5	3 Terms and definitions	14
6	4 General requirements	27
7	5 General conditions for the tests	27
8	6 Radiation, toxicity and similar hazards.....	29
9	7 Classification.....	30
10	8 Marking and instructions.....	30
11	9 Protection against access to live parts.....	42
12	10 Starting	42
13	11 Input and current.....	42
14	12 Heating	42
15	13 Resistance to heat and fire.....	42
16	14 Moisture resistance	43
17	15 Safety critical functions	43
18	16 Overload protection of transformers and associated circuits	50
19	17 Endurance.....	50
20	18 Abnormal operation	50
21	19 Mechanical hazards.....	52
22	20 Mechanical strength	54
23	21 Construction.....	56
24	22 Internal wiring	71
25	23 Components.....	73
26	24 Supply connection and external flexible cords	75
27	25 Terminals for supply cords	76
28	26 Provisions for protective earthing	76
29	27 Screws and connections.....	76
30	28 Creepage distances, clearances and distances through insulation.....	77
31	Annex A (normative) Mains-operated tools	78
32	Annex B (normative) Battery tools and battery packs	136
33	Annex C (normative) Battery tools and battery packs provided with mains connection or non-	
34	isolated sources	190
35	Annex D (informative) Determination of applicable requirements for tools dependent on the	
36	power source.....	198
37	Annex E (normative) Tools and battery charging systems powered by a USB power source	
38	.....	199
39	Annex F (normative) Tethering requirements for hand-held tools	202
40	Annex G (normative) Motors not isolated from the supply mains and having basic insulation	
41	not designed for the rated voltage of the tool.....	209
42	Annex H (normative) Determination of a low-power circuit	211
43	Annex I (informative) Measurement of noise and vibration emissions.....	212
44	Annex J (normative) Testing with artificial source and artificial load.....	227

45	Annex K (normative) Leakage current	231
46	Annex L (normative) Electric strength	236
47	Annex M (informative) Hardware reliability without fault analysis	238
48	Annex N (normative) Software evaluation	241
49	Annex O (normative) Requirements for protective electronic devices that are relied upon to	
50	pass overstress tests.....	248
51	Annex P (normative) Aging test for gaskets, o-rings, seals and tubing used for moisture	
52	resistance	250
53	Annex Q (normative) Resistance to rusting test	251
54	Annex R (normative) Reliability evaluation of SCF circuits with $PL_r=d$	252
55	Annex S (informative) Methods of applying ISO 13849-1 to power tools.....	255
56	Annex T (normative) Remote communication through public networks	257
57	Annex U (informative) Methods to estimate the average probability of dangerous failure per	
58	hour caused by remote communication through public networks	261
59	Annex V (normative) Measurement of creepage distances and clearances	264
60	Annex W (informative) Isolation and disabling during user maintenance	269
61	Annex X (informative) Rules for routine tests	270
62	Bibliography	272
63		
64	Figure 1 – Example of durability test for labels with adhesive backing	37
65	Figure 2 – Small part	43
66	Figure 3 – Method of assessing safety critical functions.....	45
67	Figure 4 – Measurement of handle gripping length.....	61
68	Figure 5 – Measurement of handle gripping length.....	62
69	Figure 6 – Measurement of handle gripping length for a handle with finger grips or similar	
70	superimposed profiles.....	62
71	Figure 7 – Example of a lock-off device that is located within the grasping surface of a handle	
72	63	
73	Figure 8 – Application of steel rod when rotated around the handle	63
74	Figure 9 – Application of steel rod when applied in the direction perpendicular to the handle	
75	axis 64	
76	Figure 10 – Test fingernail	66
77	Figure 11 – Measurement of flange height	68
78	Figure A.1 – Overload test of a class II armature	102
79	Figure A.2 – Flexing test apparatus	121
80	Figure B.1 – Examples of pre-conditioned cell positions in a parallel arrangement of series	
81	clusters of cells.....	138
82	Figure B.2 – Symbol illustrating “OK to use in rain”	142
83	Figure B.3 – Example of a barrel (coaxial power) connector	177
84	Figure B.4 – Example of a phone (audio) plug	177
85	Figure B.5 – Measurement of clearances relied upon for protection against electric shock..	187
86	Figure D.1 - Example of how to determine applicable requirements for tools dependent on the	
87	power source	198
88	Figure F.1 – Test setup for tools where the maximum length of the tool lanyard is specified in	
89	accordance with F.8.12.3 a) 202).....	205
90	Figure F.2 – Test setup for tools where a specific energy absorbing tool lanyard is specified by	
91	the tool manufacturer in accordance with F.8.12.3 a) 203)	206

92	Figure G.1 – Simulation of fault conditions.....	210
93	Figure H.1 – Example of an electronic circuit with low-power points.....	211
94	Figure I.1 – Positions of a hand-held power tool and microphones for the hemispherical /	
95	cylindrical measurement surface.....	213
96	Figure I.2 – Microphone positions on a cubic measurement surface.....	214
97	Figure I.3 – Test bench.....	217
98	Figure I.4 – Directions of vibration measurement.....	221
99	Figure J.1 – Examples of using single or multiple artificial sources for a range of battery packs	
100	229	
101	Figure K.1 – Diagram for leakage current measurement for single-phase connection and three-	
102	phase tools suitable for single-phase supply.....	234
103	Figure K.2 – Diagram for leakage current measurement for three-phase connection.....	235
104	Figure K.3 – Circuit of the leakage current meter.....	235
105	Figure U.1 – Flow of information for a remotely communicated software update.....	262
106	Figure U.2 – Flow of information for a power tool with a wireless connection between power	
107	switch and control unit.....	263
108	Figure V.1 – Clearance and creepage distance for parallel sided and V-shaped groove.....	265
109	Figure V.2 – Clearance and creepage distance for rib and uncemented joint with groove....	266
110	Figure V.3 – Clearance and creepage distance for uncemented joint and diverging-sided	
111	groove.....	267
112	Figure V.4 – Clearance and creepage distance between wall and screw.....	268
113	Figure W.1 – Flowchart for isolation and disabling during user maintenance.....	269
114		
115	Table 1 – Label temperature and test temperature.....	36
116	Table 2 – Maximum outside surface temperature rises.....	42
117	Table 3 – SCF minimum performance levels and test requirements ^b	47
118	Table 4 – Impact energies.....	55
119	Table 5 – Actuating member (switch trigger) force.....	59
120	Table 6 – Torque for testing screws and nuts.....	76
121	Table 7 – IEC 60664-3:2016 test parameters.....	77
122	Table A.1 – Maximum normal temperature rises (1 of 2).....	91
123	Table A.2 – Maximum winding temperature.....	103
124	Table A.3 – Test torques.....	106
125	Table A.4 – Minimum cross-sectional area and AWG sizes of supply cords.....	118
126	Table A.4 – Minimum cross-sectional area of supply cords.....	118
127	Table A.5 – Pull force and torque value.....	122
128	Table A.6 – Quick-connect terminals for earthing conductors.....	127
129	Table A.6 – Quick-connect terminals for earthing conductors.....	128
130	Table A.7 – Minimum creepage distances and clearances.....	132
131	Table B.1 – Tool moisture resistance classification and marking.....	139
132	Table B.2 – Battery pack moisture resistance classification and marking.....	142
133	Table B.3 – Permissible contact area for terminals.....	151
134	Table B.4 – Pull and torque values for external flexible cables or cords connecting tools to	
135	separable battery packs.....	181
136	Table B.5 – Pull and torque values for interconnection cords.....	181

137	Table B.6 – Minimum creepage distances and clearances between parts of different potential	
138	184	
139	Table B.7 – Minimum total sum of creepage distances and clearances to accessible surfaces	
140	188	
141	Table F.1 – Sample conditioning and number of drops	205
142	Table L.1 – Test voltages	236
143	Table M.1 – Mission profile for power tools	239
144	Table M.2 – Value of terms for mission profiles.....	239
145	Table N.1 – Examples of techniques/measures for semi-formal methods	242
146	Table N.2 – Examples of techniques/measures for software architecture specification	242
147	Table N.3 – Examples of techniques/measures for module design specification.....	243
148	Table N.4 – Examples of techniques/measures for design and coding standards	243
149	Table N.5 – Examples of techniques/measures for software module testing.....	245
150	Table N.6 – Examples of techniques/measures for software safety validation	246
151	Table P.1 – Accelerated aging test.....	250
152	Table T.1 – Transmission errors and examples of acceptable measures	258
153	Table X.1 – Test voltages for the electric strength test.....	271
154		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**ELECTRIC MOTOR-OPERATED HAND-HELD TOOLS, TRANSPORTABLE
TOOLS AND LAWN AND GARDEN MACHINERY –
SAFETY –****Part 1: General requirements****FOREWORD**

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International Standard IEC 62841-1 has been prepared by IEC technical committee 116: Safety of motor-operated electric tools.

This second edition is scheduled to cancel and replace the first edition published in 2014, of which it constitutes a technical revision. It introduces a new structure with the requirements organized dependent on the power source and includes the following significant technical changes with respect to the first edition of IEC 62841-1:

- the maximum **fully charged battery** input voltage for tools and **battery** packs has been increased from 75 V d.c. to 250 V d.c. in the scope of Annex B;
- restructuring and revision of Clause 18, Clause A.18 and Clause B.18;
- new requirements in Annex B for permitting the use of **battery**-operated tools in the rain, cleaning **battery**-operated tools with low-pressure water and immersion of **battery**-operated tools in water to a depth of up to 1 m for cleaning;
- revised Annex C; and
- new Annexes D, J, M, N, O, P, Q and R.

212 The text of this document is based on the following documents:

FDIS	Report on voting
116/xxx/FDIS	116/xxx/RVD

213

214 Full information on the voting for the approval of this standard can be found in the report on voting
215 indicated in the above table.

216 This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

217 This Part 1 is to be used in conjunction with the appropriate parts of IEC 62841-2, IEC 62841-3 or
218 IEC 62841-4 which contain clauses that supplement or modify the corresponding clauses in Part 1 to
219 provide the relevant requirements for each type of product.

220 Individual countries may wish to consider the application of this Part 1 of IEC 62841, so far as is
221 reasonable, to tools not mentioned in an individual part of IEC 62841-2, IEC 62841-3 or IEC 62841-4
222 and to tools designed on new principles.

223 NOTE 1 In this document, the following print types are used:

224 – requirements: in roman type

225 – *test specification: in italic type*

226 – Notes: in smaller roman type

227 Words in **bold** in the text are defined in Clause 3. When a definition concerns an adjective, the adjective and the associated
228 noun are also in bold.

229 NOTE 2 In Annexes A, B, F, G, J and R, subclauses and notes which are additional to those in the main body of the document
230 are numbered starting from 201.

231 A list of all parts of the IEC 62841 series, under the general title: *Electric motor-operated hand-held*
232 *tools, transportable tools and lawn and garden machinery – Safety*, can be found on the IEC website.

233 The committee has decided that the contents of this publication will remain unchanged until the stability
234 date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific
235 publication. At this date, the publication will be

236 – • reconfirmed,

237 – • withdrawn,

238 – • replaced by a revised edition, or

239 – • amended.

240 The National Committees are requested to note that for this publication the stability date is 2030.

241 THIS TEXT IS INCLUDED FOR THE INFORMATION OF THE NATIONAL COMMITTEES AND WILL BE DELETED AT THE
242 PUBLICATION STAGE.

243 NOTE 3 The attention of National Committees is drawn to the fact that equipment manufacturers and testing organizations
244 may need a transitional period following publication of a new, amended or revised IEC publication in which to make products
245 in accordance with the new requirements and to equip themselves for conducting new or revised tests.

246 It is the recommendation of the committee that the content of this publication be adopted for implementation nationally not
247 earlier than 36 months from the date of publication.

248 NOTE 4 In Europe (EN IEC 62841-1), the following additional paragraph applies:

249 When a relevant Part 2, 3, or 4 does not exist, this document can be used to support the risk assessment process in order to
250 establish requirements for the tool.

251

252

ELECTRIC MOTOR-OPERATED HAND-HELD TOOLS, TRANSPORTABLE TOOLS AND LAWN AND GARDEN MACHINERY – SAFETY –

Part 1: General requirements

1 Scope

This International Standard deals with the safety of electric motor-operated and magnetically driven:

- **hand-held tools** (IEC 62841-2);
- **transportable tools** (IEC 62841-3);
- **lawn and garden machinery** (IEC 62841-4).

The above listed categories are hereinafter referred to as “tools” or “machines”.

This document deals with the hazards presented by tools which are encountered in the **normal use** and reasonably foreseeable misuse of the tools.

Tools with supplemental electric heating elements are within the scope of this standard.

Requirements for motor-operated and magnetically driven tools in the main body of this document are supplemented, dependent on the power source as applicable, by the requirements of

- Annex A for mains-operated tools;
- Annex B for rechargeable **battery**-operated tools and the **battery** packs for such tools;
- Annex C for tools that are also operated and/or charged directly from the mains or a **non-isolated source**, including tools provided with integral **battery chargers**.

Annex D gives guidance regarding the assembly of the applicable requirements of the main body and those dependent on the power source.

Annex E provides requirements for tools or **battery charging systems** powered by a Universal Serial Bus (USB) power source.

Annex F provides requirements for **hand-held tools** intended to be used **at height** and provided with an **attachment point** for a **tool lanyard** which is either **integral** to the tool or specially designed by the original tool manufacturer for mounting to the tool.

Hand-held electric tools, which can be mounted on a support or working stand for use as fixed tools without any alteration of the tool itself, are within the scope of this standard and such combination of a **hand-held tool** and a support is considered to be a **transportable tool** and thus covered by the relevant Part 3.

This document does not apply to:

- tools intended to be used in the presence of explosive atmosphere (dust, vapour or gas);
- tools used for preparing and processing food;
- tools for medical purposes;

NOTE 1 IEC 60601 series covers a variety of tools for medical purposes.

- tools intended to be used with cosmetics or pharmaceutical products;
- heating tools;

NOTE 2 IEC 60335-2-45 covers a variety of heating tools.

293 – electric motor-operated household and similar electrical appliances;

294 NOTE 3 The IEC 60335 series covers a variety of electric motor-operated household and similar electrical appliances.

295 – electrical equipment for industrial machine-tools;

296 NOTE 4 IEC 60204 series deals with electrical safety of machinery.

297 – small low voltage transformer operated bench tools intended for model making, e.g. the making of
298 radio-controlled model aircraft or cars, etc.

299 NOTE 5 In the United States of America, the following conditions apply:

300 This document deals with tools used in non-hazardous locations in accordance with the National Electrical Code, NFPA 70.

301 NOTE 6 In Canada, the following conditions apply:

302 This document deals with tools used in non-hazardous locations in accordance with the Canadian Electric Code, Part 1,
303 CSA C22.1, and General Requirements – Canadian Electrical Code, Part II, CAN/CSA-C22.2 No. 0.

304 2 Normative references

305 The following documents, in whole or in part, are normatively referenced in this document and are
306 indispensable for its application. For dated references, only the edition cited applies. For undated
307 references, the latest edition of the referenced document (including any amendments) applies.

308 IEC 60065:2014, *Audio, video and similar electronic apparatus – Safety requirements*

309 IEC 60068-2-75:2014, *Environmental testing – Part 2-75: Tests – Test Eh: Hammer tests*

310 IEC 60085:2007, *Electrical insulation – Thermal evaluation and designation*

311 IEC 60112:2020, *Method for the determination of the proof and comparative tracking indices of solid*
312 *insulating materials*

313 IEC 60127-1:2023, *Miniature fuses - Part 1: Definitions for miniature fuses and general requirements*
314 *for miniature fuse-links*

315 IEC 60227-1:2007, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*
316 *- Part 1: General requirements* **Sec. Note: This standard has been withdrawn.**

317 IEC 60227-5:2011, *Polyvinyl chloride insulated cables of rated voltages up to and including 450/750 V*
318 *- Part 5: Flexible cables (cords)* **Sec. Note: This standard has been withdrawn.**

319 IEC 60245-1:2003, *Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 1:*
320 *General requirements*
321 *Amendment 1:2007*

322 IEC 60245-4:2011, *Rubber insulated cables - Rated voltages up to and including 450/750 V - Part 4:*
323 *Cords and flexible cables*

324 IEC 60252-1:2010, *AC motor capacitors – Part 1: General – Performance, testing and rating – Safety*
325 *requirements – Guidance for installation and operation*¹
326 *Amendment 1:2013*

327 IEC 60309-1:2021, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial*
328 *purposes - Part 1: General requirements*

¹ A consolidated version exists (Edition 2.1:2013) which includes IEC 60252-1:2010 and its Amendment 1 (2013).

- 329 IEC 60309-2:2021, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial*
330 *purposes - Part 2: Dimensional compatibility requirements for pin and contact-tube accessories*
- 331 IEC 60309-4:2021, *Plugs, fixed or portable socket-outlets and appliance inlets for industrial*
332 *purposes - Part 4: Switched socket-outlets with or without interlock*
- 333 IEC 60309-5:2017, *Plugs, socket-outlets and couplers for industrial purposes - Part 5: Dimensional*
334 *compatibility and interchangeability requirements for plugs, socket-outlets, ship connectors and ship*
335 *inlets for low-voltage shore connection systems (LVSC)*
- 336 IEC 60320-1:2021, *Appliance couplers for household and similar general purposes - Part 1: General*
337 *requirements*
- 338 IEC 60320-2-1:2018, *Appliance couplers for household and similar general purposes - Part 2-1: Sewing*
339 *machine couplers*
- 340 IEC 60320-2-3:2018, *Appliance couplers for household and similar general purposes - Part 2-3:*
341 *Appliance couplers with a degree of protection higher than IPX0*
- 342 IEC 60320-2-4:2018, *Appliance couplers for household and similar general purposes - Part 2-4:*
343 *Couplers dependent on appliance weight for engagement*
- 344 IEC 60320-3:2014, *Appliance couplers for household and similar general purposes - Part 3: Standard*
345 *sheets and gauges*
346 Amendment 1:2018
347 Amendment 2:2022
- 348 IEC 60384-14:2023, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification*
349 *– Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*
- 350 IEC 60384-16:2019, *Fixed capacitors for use in electronic equipment – Part 16: Sectional specification*
351 *– Fixed metallized polypropylene film dielectric DC capacitors*
- 352 IEC 60417, *Graphical symbols for use on equipment*, available at [http://www.graphical-](http://www.graphical-symbols.info/graphical-symbols/equipment/db1.nsf/$enHome?OpenForm)
353 [symbols.info/graphical-symbols/equipment/db1.nsf/\\$enHome?OpenForm](http://www.graphical-symbols.info/graphical-symbols/equipment/db1.nsf/$enHome?OpenForm)
- 354 IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*²
355 Amendment 1:1999
356 Amendment 2:2013
- 357 IEC 60664-1:2020, *Insulation coordination for equipment within low-voltage systems – Part 1:*
358 *Principles, requirements and tests*
- 359 IEC 60664-3:2016, *Insulation coordination for equipment within low-voltage systems – Part 3: Use of*
360 *coating, potting or moulding for protection against pollution*
- 361 IEC 60664-4:2005, *Insulation coordination for equipment within low-voltage systems – Part 4:*
362 *Consideration of high-frequency voltage stress*
- 363 IEC 60695-2-11:2021, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-*
364 *wire flammability test method for end-products*

² A consolidated version exists (Edition 2.2:2013) which includes IEC 60529:1989 and its Amendment 1 (1999) and Amendment 2 (2013).

- 365 IEC 60695-2-12:2021, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods - Glow-*
366 *wire flammability index (GWFI) test method for materials*
- 367 IEC 60695-2-13:2021, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-*
368 *wire ignition temperature (GWIT) test method for materials*
- 369 IEC 60695-10-2:2014, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test*
- 370 IEC 60695-11-10:2013, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical*
371 *flame test methods*
- 372 IEC 60730-1:2022, *Automatic electrical controls for household and similar use – Part 1: General*
373 *requirements*
- 374 IEC 60747-5-5:2020, *Semiconductor devices - Discrete devices - Part 5-5: Optoelectronic devices -*
375 *Photocouplers*
- 376 IEC 60825-1:2014, *Safety of laser products – Part 1: Equipment classification and requirements*
- 377 IEC 60906-1:2009, *IEC system of plugs and socket-outlets for household and similar purposes – Part 1:*
378 *Plugs and socket-outlets 16 A 250 V a.c.*
- 379 IEC 60906-2:2011, *IEC system of plugs and socket-outlets for household and similar purposes – Part 2:*
380 *Plugs and socket-outlets 15 A 125 V a.c. and 20 A 125 V a.c.*
- 381 IEC 60990:2016, *Methods of measurement of touch current and protective conductor current*
- 382 IEC 60998-2-1:2002, *Connecting devices for low-voltage circuits for household and similar*
383 *purposes – Part 2-1: Particular requirements for connecting devices as separate entities with screw-*
384 *type clamping units*
- 385 IEC 60998-2-2:2002, *Connecting devices for low-voltage circuits for household and similar*
386 *purposes – Part 2-2: Particular requirements for connecting devices as separate entities with*
387 *screwless-type clamping units*
- 388 IEC 60999-1:1999, *Connecting devices – Electrical copper conductors – Safety requirements for*
389 *screw-type and screwless-type clamping units – Part 1: General requirements and particular*
390 *requirements for clamping units for conductors from 0,2 mm² up to 35 mm² (included)*
- 391 IEC 61000-4-2:2008, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement*
392 *techniques – Electrostatic discharge immunity test*
- 393 IEC 61000-4-3:2020, *Electromagnetic compatibility (EMC) – Part 4-3: Testing and measurement*
394 *techniques – Radiated, radio-frequency, electromagnetic field immunity test*
- 395 IEC 61000-4-4:2012, *Electromagnetic compatibility (EMC) – Part 4-4: Testing and measurement*
396 *techniques – Electrical fast transient/burst immunity test*
- 397 IEC 61000-4-5:2014, *Electromagnetic compatibility (EMC) – Part 4-5: Testing and measurement*
398 *techniques – Surge immunity test*³
399 *Amendment 1:2017*
- 400 IEC 61000-4-6:2023, *Electromagnetic compatibility (EMC) – Part 4-6: Testing and measurement*
401 *techniques – Immunity to conducted disturbances, induced by radio-frequency fields*

³ A consolidated version exists (Edition 3.1:2017) which includes IEC 61000-4-5:2014 and its Amendment 1 (2017).

- 402 IEC 61000-4-11:2020, *Electromagnetic compatibility (EMC) – Part 4-11: Testing and measurement*
403 *techniques – Voltage dips, short interruptions and voltage variations immunity tests*
- 404 IEC 61008-1:2010, *Residual current operated circuit-breakers without integral overcurrent protection*
405 *for household and similar uses (RCCBs) – Part 1: General rules*⁴
406 Amendment 1:2012
407 Amendment 2:2013
- 408 IEC 61032:1997, *Protection of persons and equipment by enclosures – Probes for verification*
- 409 IEC 61058-1:2016, *Switches for appliances – Part 1: General requirements*
- 410 IEC 61058-1-1:2016, *Switches for appliances – Part 1-1: Requirements for mechanical switches*
- 411 IEC 61058-1-2:2016, *Switches for appliances – Part 1-2: Requirements for electronic switches*
- 412 IEC 61058-2-6:2018, *Switches for appliances – Part 2-6: Particular requirements for switches used in*
413 *electric motor-operated hand-held tools, transportable tools and lawn and garden machinery*
- 414 IEC 61210:2010, *Connecting devices – Flat quick-connect terminations for electrical copper conductors*
415 *– Safety requirements*
- 416 IEC 61508-2:2010, *Functional safety of electrical/electronic/programmable electronic safety-related*
417 *systems – Part 2: Requirements for electrical/electronic/programmable electronic safety-related*
418 *systems*
- 419 IEC 61540:1997, *Electrical accessories – Portable residual current devices without integral overcurrent*
420 *protection for household and similar use (PRCDs)*⁵
421 Amendment 1:1998
- 422 IEC 61558-1:2017, *Safety of power transformers, power supplies, reactors and similar products – Part*
423 *1: General requirements and tests*
- 424 IEC 61558-2-4:2021, *Safety of transformers, reactors, power supply units and similar products for*
425 *supply voltages up to 1 100 V – Part 2-4: Particular requirements and tests for isolating transformers*
426 *and power supply units incorporating isolating transformers*
- 427 IEC 61558-2-6:2021, *Safety of transformers, reactors, power supply units and similar products for*
428 *supply voltages up to 1 100 V – Part 2-6: Particular requirements and tests for safety isolating*
429 *transformers and power supply units incorporating safety isolating transformers*
- 430 IEC 61558-2-16:2021, *Safety of transformers, reactors, power supply units and similar products for*
431 *supply voltages up to 1 100 V – Part 2-16: Particular requirements and tests for switch mode power*
432 *supply units and transformers for switch mode power supply units*
- 433 IEC 61984:2008, *Connectors – Safety requirements and tests*
- 434 IEC 62133-1:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes –*
435 *Safety requirements for portable sealed secondary cells, and for batteries made from them, for use in*
436 *portable applications – Part 1: Nickel systems*
- 437 IEC 62133-2:2017, *Secondary cells and batteries containing alkaline or other non-acid electrolytes -*
438 *Safety requirements for portable sealed secondary lithium cells, and for batteries made from them, for*
439 *use in portable applications – Part 2: Lithium systems*

⁴ A consolidated version exists (Edition 3.2:2013) which includes IEC 61008-1:2010 and its Amendment 1 (2012) and Amendment 2 (2013).

⁵ A consolidated version exists (Edition 1.1:1999) which includes IEC 61540:1997 and its Amendment 1 (1998).

- 440 Amendment 1:2021
- 441 IEC 62471:2006, *Photobiological safety of lamps and lamp systems*
- 442 IEC 62471-5:2015, *Photobiological safety of lamps and lamp systems – Part 5: Image projectors*
- 443 ISO 37:2017, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*
- 444 ISO 1463:2021, *Metallic and oxide coatings – Measurement of coating thickness – Microscopical*
445 *method*
- 446 ISO 2178:2016, *Non-magnetic coatings on magnetic substrates – Measurement of coating thickness –*
447 *Magnetic method*
- 448 ISO 2768-1:1989, *General tolerances – Part 1: Tolerances for linear and angular dimensions without*
449 *individual tolerance indications*
- 450 ISO 3744:2010, *Acoustics – Determination of sound power levels and sound energy levels of noise*
451 *sources using sound pressure – Engineering methods for an essentially free field over a reflecting*
452 *plane*
- 453 ISO 3864-2:2016, *Graphical symbols – Safety colours and safety signs – Part 2: Design principles for*
454 *product safety labels*
- 455 ISO 3864-3:2012, *Graphical symbols – Safety colours and safety signs – Part 3: Design principles for*
456 *graphical symbols for use in safety signs*
- 457 ISO 4871:1996, *Acoustics – Declaration and verification of noise emission values of machinery and*
458 *equipment*
- 459 ISO 5349-1:2001, *Mechanical vibration – Measurement and evaluation of human exposure to hand-*
460 *transmitted vibration – Part 1: General requirements*
- 461 ISO 5349-2:2001, *Mechanical vibration – Measurement and evaluation of human exposure to hand-*
462 *transmitted vibration – Part 2: Practical guidance for measurement in the workplace*
- 463 ISO 7000:2019, *Graphical symbols for use on equipment – Index and synopsis*
- 464 ISO 7010:2019, *Graphical symbols – Safety colours and safety signs – Registered safety signs*
- 465 ISO 8041-1:2017, *Human response to vibration – Measuring instrumentation*
- 466 ISO 9772:2020, *Cellular plastics – Determination of horizontal burning characteristics of small*
467 *specimens subjected to a small flame*
- 468 ISO 9773:1998, *Plastics – Determination of burning behaviour of thin flexible vertical specimens in*
469 *contact with a small-flame ignition source*
470 Amendment 1:2003
- 471 ISO 11201:2010, *Acoustics – Noise emitted by machinery and equipment – Determination of emission*
472 *sound pressure levels at a work station and at other specified positions in an essentially free field over*
473 *a reflecting plane with negligible environmental corrections*
- 474 ISO 11203:1995, *Acoustics – Noise emitted by machinery and equipment – Determination of emission*
475 *sound pressure levels at a work station and at other specified positions from the sound power level*
476 Amendment 1:2020

- 477 ISO 13849-1:2023, *Safety of machinery – Safety-related parts of control systems – Part 1: General*
478 *principles for design*
- 479 ISO 13849-2:2012, *Safety of machinery – Safety-related parts of control systems – Part 2: Validation*
- 480 ISO 13850:2015, *Safety of machinery – Emergency stop – Principles for design*
- 481 ISO 16063-1:1998, *Methods for the calibration of vibration and shock transducers – Part 1: Basic*
482 *concepts*
483 Amendment 1:2016
- 484 EN 12096:1997, *Mechanical vibration – Declaration and verification of vibration emission values*
- 485 UL 969, *Standard for marking and labeling systems*
- 486 NOTE 1 In the United States of America, the following normative reference applies:
487 United States Code of Federal Regulations (CFR) Title 21, *Food and Drugs*.
- 488 NOTE 2 In Canada, the following normative reference applies:
489 C.R.C., c. 1370, Radiation Emitting Devices Regulations
- 490 NOTE 3 In Europe (EN IEC 62841-1), the following normative references apply:
491 CR 1030-1:2000, *Hand-arm vibration – Guidelines for vibration hazards reduction – Part 1: Engineering methods by design of*
492 *machinery*
- 493 EN ISO 11688-1:2009, *Acoustics – Recommended practice for the design of low-noise machinery and equipment – Part 1:*
494 *Planning (ISO/TR 11688-1)*

495 3 Terms and definitions

496 For the purposes of this document, the following terms and definitions apply.

497 Where the terms voltage and current are used, they imply the r.m.s. values, unless otherwise specified.

498 Where in this standard the expressions “with the aid of a tool” and “without the aid of a tool” are used,
499 the word “tool” means a hand tool, for example a screwdriver or a coin, which may be used to operate
500 a screw or other fixing means.

501 Where the terms “earth”, “earthed” or “earthing” are used, they refer to a protective earth and not to a
502 **functional earth**.

503 3.1 504 accessible

505 part or surface that can be touched by means of the test probe B of IEC 61032:1997

506 3.2 507 accessory

508 device that is attached only to the output mechanism of the tool

509 Note 1 to entry: Examples of **accessories** include tool bits, grinding wheels and saw blades.

510 3.3 511 adjustable guard

512 **guard** which is adjustable as a whole or which incorporates adjustable part(s)

513 Note 1 to entry: For manually **adjustable guards**, the adjustment remains fixed during a particular operation.

- 514 **3.4**
515 **all-pole disconnection**
516 disconnection of all supply conductors except the protective earthing (grounding) conductor by a single
517 initiating action
- 518 **3.5**
519 **anchor**
520 point of a structure at which a **tool lanyard** is attached
- 521 **3.6**
522 **appliance inlet**
523 device which is incorporated in the enclosure of the tool for insertion of an electrical plug connection
524 to the mains supply
- 525 **3.7**
526 **artificial load**
527 passive (resistor) or active (electronic) load intended to simulate the current that may be drawn by the
528 tool from a **battery** pack
- 529 Note 1 to entry: It is possible that a representative tool sample could qualify as an **artificial load**.
- 530 **3.8**
531 **artificial source**
532 d.c. power source, consisting of either a d.c. power supply or a specially constructed **battery**, which
533 connects to the tool in the same manner as the intended or anticipated range of **battery** packs to be
534 used with the tool and which is used to facilitate testing of the tool
- 535 Note 1 to entry: It is possible that a representative **battery** sample could qualify as an **artificial source**.
- 536 **3.9**
537 **at height**
538 for tasks undertaken on a walking or working surface at least 1,8 meters above the ground or above a
539 lower level
- 540 Note 1 to entry: Some national regulations require a height of less than at least 1,8 m above the ground or above a lower
541 level.
- 542 **3.10**
543 **attachment**
544 device attached to the housing or other component of the tool and which may or may not be attached
545 to the output mechanism and does not modify the **normal use** of the tool within the scope of this
546 standard
- 547 Note 1 to entry: Examples of **attachments** include auxiliary handles and dust extraction systems.
- 548 **3.11**
549 **attachment point**
550 feature that is either **integral** to the tool or specially designed by the original tool manufacturer for
551 mounting to the tool and which provides a location to attach a **tool lanyard**
- 552 **3.12**
553 **attachment point rating**
554 maximum mass specified by the manufacturer that can be applied to the **attachment point**, including
555 the tool, **attachments**, **accessories** and **detachable battery packs**
- 556 **3.13**
557 **authentication**
558 provision for confirming that the **entity** sending or receiving a **message** is what or who it claims to be

- 559 **3.14**
560 **authorization**
561 means to ensure that the authenticated **entity** requesting access to information, functions or services
562 has the required authority
- 563 **3.15**
564 **basic insulation**
565 insulation applied to **live parts** to provide protection against electric shock
- 566 Note 1 to entry: Insulation applied to **live parts** not intended to provide electric shock protection is considered to be insulation
567 for functional purposes, such as for lacquered or enamelled windings
- 568 **3.16**
569 **battery**
570 assembly of one or more **cells** intended to provide electrical current to the tool
- 571 **3.17**
572 **battery system**
573 combination of a **battery**, the **charging system**, the tool and the interfaces between them as existing
574 during operation of the tool or during charging
- 575 Note 1 to entry: This is equal to the C_5 capacity divided by 5 h where C_5 is measured in accordance with IEC 61960-3:2017,
576 IEC 61960-4:2020, IEC 61951-1:2017 and IEC 61951-1:2017/AMD1:2023 or IEC 61951-2:2017 and
577 IEC 61951-2:2017/AMD1:2022.
- 578 **3.18**
579 **C_5 rate**
580 current, in amperes, that a **cell** or **battery** can be discharged at for 5 h to the voltage cut-off point
581 specified by the **cell** manufacturer
- 582 currents for a wide range of tools, without the need for conducting the test(s) with each individual tool.
- 583 **3.19**
584 **C_{max}**
585 capacity of an **artificial source** greater than or equal to the highest capacity of a range of **battery**
586 packs intended to be used with the tool
- 587 **3.20**
588 **cell**
589 basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container,
590 terminals, and usually separators, that is a source of electrical energy by direct conversion of chemical
591 energy
- 592 **3.21**
593 **charger**
594 part or all of the **charging system** contained in a separate enclosure. As a minimum, the **charger**
595 includes some of the power conversion circuitry. Not all **charging systems** include a separate **charger**
596 as in the case where a tool may be charged utilizing a mains **supply cord** or may incorporate a plug
597 for attachment to a mains receptacle
- 598 **3.22**
599 **charging system**
600 combination of circuitry intended to charge, balance and/or maintain the state of charge of the **battery**
- 601 **3.23**
602 **charring**
603 condition in which tissue paper or untreated 100 % cotton medical gauze is blackened by combustion
604 of the gauze or tissue paper

- 605 Note 1 to entry: Discolouration of tissue paper or untreated 100 % cotton medical gauze caused by smoke is considered not
606 to be **charring**, since there is no combustion of the gauze or tissue paper.
- 607 **3.24**
608 **class I tool**
609 tool in which protection against electric shock does not rely on basic, double or **reinforced insulation**
610 only, but which includes an additional safety precaution in that conductive **accessible** parts or
611 intermediate conductive parts are connected to the protective earthing conductor in the fixed wiring of
612 the installation in such a way that conductive **accessible** parts cannot become live in the event of a
613 failure of the **basic insulation**
- 614 Note 1 to entry: Also considered as **class I tools** are tools with **double insulation** and/or **reinforced insulation** throughout,
615 but also having an earthing terminal or earthing contact.
- 616 **3.25**
617 **class II tool**
618 tool in which protection against electric shock does not rely on **basic insulation** only, but in which
619 additional safety precautions, such as **double insulation** or **reinforced insulation**, are provided, there
620 being no provision for protective earthing or reliance upon installation conditions
- 621 **3.26**
622 **class III tool**
623 tool in which protection against electric shock relies on supply at **safety extra-low voltage**, and in
624 which voltages higher than those of **safety extra-low voltages** are not generated
- 625 **3.27**
626 **class II construction**
627 part of a tool for which protection against electric shock relies upon **double insulation** or **reinforced**
628 **insulation**
- 629 **3.28**
630 **class III construction**
631 part of a tool for which protection against electric shock relies upon **safety extra-low voltage**, and in
632 which voltages higher than those of **safety extra-low voltages** are not generated
- 633 **3.29**
634 **clearance**
635 shortest distance between two conductive parts, or between a conductive part and the outer surface of
636 the enclosure, considered as though metal foil were pressed into contact with **accessible** surfaces of
637 insulating material, measured through air
- 638 Note 1 to entry: Examples of **clearances** are given in Annex V.
- 639 **3.30**
640 **control device**
641 device operated by the user to adjust and/or regulate an electrical or mechanical function of the tool
- 642 **3.31**
643 **creepage distance**
644 shortest path between two conductive parts, or between a conductive part and the outer surface of the
645 enclosure, considered as though metal foil were pressed into contact with **accessible** surfaces of
646 insulating material, measured along the surface of the insulating material
- 647 Note 1 to entry: Examples of creepage distances are given in Annex V.
- 648 **3.32**
649 **cryptographic technique**
650 calculation of output data using a mathematical algorithm to encode input data with a key as a
651 parameter

- 652 **3.33**
653 **data integrity protection**
654 protection that enables the tool to confirm the data has not been altered, lost or destroyed
- 655 **3.34**
656 **demand rate**
657 frequency in which an event occurs that requires the correct operation of an **SCF** taking into account
658 the **normal operation** of the tool over a typical work period
- 659 Note 1 to entry: For the particular purpose of power tools, the **demand rate** can be identified with the rate of events, where
660 harm would occur without intervention of the **SCF**. This rate can be lower than an actual rate of triggering the **SCF** during
661 operation.
- 662 **3.35**
663 **detachable battery pack**
664 **battery** which is contained in a separate enclosure from the tool and can be removed from the tool for
665 charging purposes
- 666 **3.36**
667 **detachable part**
668 part, other than externally **accessible** brush caps, where either:
- 669 a) its removal is possible without the aid of a tool and it is not fixed in a reliable manner; or
670 b) its removal is intended during **normal use**, excluding parts removed only for **user maintenance**.
- 671 Note 1 to entry: The determination whether a part is fixed in a reliable manner is specified in 21.18.
- 672 **3.37**
673 **diagnostic coverage (DC)**
674 measure of the effectiveness of the monitoring of faults expressed as a percentage
- 675 Note 1 to entry: **Diagnostic coverage** may be determined quantitatively as the ratio between the failure rate of detected
676 dangerous failures and the failure rate of total dangerous failures or qualitatively considering various design features of the
677 system.
- 678 Note 2 to entry: ISO 13849-1:2023, Annex S provides estimates of **diagnostic coverage**.
- 679 **3.38**
680 **disabling device**
681 component of tools with **integral batteries**, designed to prevent hazardous moving parts from being
682 driven
- 683 **3.39**
684 **double insulation**
685 insulation system comprising both **basic insulation** and **supplementary insulation**
- 686 **3.40**
687 **electronic circuit**
688 circuit incorporating at least one **electronic component**
- 689 **3.41**
690 **electronic component**
691 part in which conduction is achieved principally by electrons moving through a vacuum, gas or
692 semiconductor, with the exclusion of neon indicators
- 693 Note 1 to entry: Examples of **electronic components** are diodes, transistors, triacs and monolithic integrated circuits.
694 Resistors, capacitors and inductors are not considered **electronic components**.
- 695 **3.42**
696 **energy absorbing tool lanyard**
697 **tool lanyard** that extends without a distinct stopping point when stretching in order to dissipate the
698 kinetic energy generated when a tool is falling from a height

- 699 Note 1 to entry: **Energy absorbing tool lanyards** are also known as shock absorbing lanyards.
- 700 **3.43**
701 **entity**
702 person, device, tool, **battery**, **charging system**, or service that interacts with a tool, **battery** or
703 **charging system**
- 704 **3.44**
705 **explosion**
706 failure that occurs, when an enclosure opens violently and major components are forcibly expelled in
707 a manner that could result in injury
- 708 **3.45**
709 **fault condition**
710 actual or simulated failure of a component or sub-system which is not an **overstress** condition
- 711 **3.46**
712 **fixed guard**
713 **guard** affixed in such a manner (e.g. by screws, nuts, welding) that it can only be opened or removed
714 with the use of tools or by destruction of the affixing means
- 715 **3.47**
716 **fully charged (battery/cell)**
717 **cell** or **battery** charged to the maximum state of charge permitted by the **charging system** intended
718 for use with the tool
- 719 **3.48**
720 **fully discharged (battery/cell)**
721 **battery** or **cell** that has been discharged at **C₅ rate** until one of the following conditions occurs:
722 discharge terminates due to the control_circuitry, or the **battery** (or **cell**) reaches a total voltage with
723 an average voltage per **cell** equal to the end-of-discharge voltage for the **cell** chemistry being used,
724 unless a different end-of-discharge voltage is specified by the manufacturer
- 725 Note 1 to entry: The end-of-discharge voltages for common **cell** chemistries are provided in B.5.210.
- 726 **3.49**
727 **functional earth**
728 earthing of a point in equipment or in a system, which is necessary for a purpose other than safety
- 729 **3.50**
730 **general purpose battery**
731 **battery** or **cell** available from a variety of manufacturers, through a variety of outlets intended for a
732 variety of different manufacturers' products
- 733 Note 1 to entry: 12 V automotive **batteries** and AA, C and D alkaline **cells** are examples of **general purpose batteries**.
- 734 **3.51**
735 **guard**
736 physical barrier, designed as part of the tool, to provide protection
- 737 **3.52**
738 **hand-held tool**
739 tool intended to do mechanical work, with or without provisions for mounting on a support, and so
740 designed that the motor and the machine form an assembly which can easily be brought to the place
741 of operation, and which is either held or supported by hand or suspended during operation
- 742 Note 1 to entry: **Hand-held tools** include tools provided with a flexible shaft, the motor being either fixed or portable.

743 **3.53**744 **hazardous voltage**

745 voltage between parts

- 746 – for tools classified in accordance with B.7.1 or **detachable battery packs** and **separable battery**
747 **packs** classified in accordance with B.7.2 as “Use in rain is permitted” or “Immersion in water to a
748 depth of up to 1 m for cleaning is permitted”, having
- 749 • an average value exceeding 30 V d.c.; or
 - 750 • a peak value exceeding 21,2 V when the peak-to-peak ripple exceeds 10 % of the average
751 value; or
- 752 – for other tools, **detachable battery packs** and **separable battery packs**, having
- 753 • an average value exceeding 60 V d.c.; or
 - 754 • a peak value exceeding 42,4 V when the peak-to-peak ripple exceeds 10 % of the average
755 value.

756 Note 1 to entry: For tools classified in accordance with B.7.1 or **detachable battery packs** and **separable battery packs**
757 classified in accordance with B.7.2 as “Use in rain is permitted”, it is assumed that the operator’s hands are wet during
758 operation of the tool.

759 Note 2 to entry: For tools classified in accordance with B.7.1 or **detachable battery packs** and **separable battery packs**
760 classified in accordance with B.7.2 as “Immersion in water to a depth of up to 1 m for cleaning is permitted”, it is assumed
761 that the operator’s hands are wet during tool cleaning while immersed in water.

762 **3.54**763 I_{sc} 764 measured short circuit current of a **battery** pack765 **3.55**766 $I_{sc(max)}$

767 short circuit current of an **artificial source** representing a short circuit current greater than or equal to
768 the highest short circuit current capability of a range of **battery** packs recommended to be used with
769 the tool

770 **3.56**771 $I_{sc(min)}$

772 short circuit current of an **artificial source** representing a short circuit current less than or equal to the
773 lowest short circuit current capability of a range of **battery** packs recommended to be used with the
774 tool

775 **3.57**776 **independent hardware watchdog**

777 **electronic circuit** that has a timebase that is independent of the timebase of the microcontroller and
778 is intended to force the tool into a **safe state** if there is a dangerous loss of program control of the
779 microcontroller

780 Note 1 to entry: This definition also includes so called “on-chip” watchdog circuits that are located on the same substrate as
781 the microcontroller.

782 **3.58**783 **inherent operating cycle**

784 repetitive operation of a tool designed in such a way that the complete cycle duration cannot be altered
785 by the operator

786 **3.59**787 **insulation touch current**

788 electric current which flows through a person upon contact with **accessible** parts of a **battery**-operated
789 tool with a **working voltage** that is a **hazardous voltage**

- 790 **3.60**
791 **integral**
792 designed as part of the tool by the manufacturer and not intended to be removed during **normal use**
- 793 **3.61**
794 **integral battery**
795 **battery** which is contained within the tool and is not removed from the tool for charging purposes
- 796 Note 1 to entry: A battery that is removed from the tool for replacement, disposal or recycling purposes is considered to be
797 an **integral battery**.
- 798 **3.62**
799 **interchangeable part**
800 working part(s) provided by a manufacturer that is intended to permit the user to reconfigure the tool,
801 such that the reconfigured tool is not within the scope of the same standard
- 802 Note 1 to entry: An example of an **interchangeable part** is a working part(s) that permits an extended-reach hedge trimmer
803 to be reconfigured into a lawn trimmer.
- 804 Note 2 to entry: Examples of a tool not employing **interchangeable parts** are
805 – an angle grinder that is intended to be used with multiple **accessories** in combination with different **guards**; and
806 – a grass trimmer that can be converted into a brush cutter or a brush saw by only changing the cutting **accessory** and the
807 **guard**.
- 808 **3.63**
809 **interconnection cord**
810 external flexible cord provided for electrical connections between two parts of a tool
- 811 **3.64**
812 **isolation device**
813 component of tools with **integral batteries**, designed to cut off power from current carrying parts
- 814 **3.65**
815 **lawn and garden machinery**
816 machine for garden maintenance or similar purposes
- 817 Note 1 to entry: **Lawn and garden machinery** includes manually portable forest machinery.
- 818 **3.66**
819 **liquid system**
820 system that employs water or a water-based liquid from an external or **integral** supply that is used in
821 the operation of the tool
- 822 **3.67**
823 **live part**
824 any conductor or conductive part intended to be energized in **normal use**, but not by a **safety extra-**
825 **low voltage** source
- 826 Note 1 to entry: Conductive parts which are not insulated from a **live part** by either **basic insulation** or **reinforced**
827 **insulation** are also considered to be **live parts**.
- 828 Note 2 to entry: **Live parts** are normally conductively coupled to a mains supply, including a neutral conductor, where there
829 is a presumed risk of electric shock due to a potential between these parts and earth.
- 830 **3.68**
831 **maximum charging current**
832 highest current that a lithium-ion **cell** is permitted to pass during charging for a specified range of
833 temperatures as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133:2017
834 or IEC 62133-2:2017 and IEC 62133:2017/AMD1:2021

- 835 **3.69**
836 **mean time to dangerous failure**
837 **MTTF_d**
838 expectation of the mean time to dangerous failure
- 839 **3.70**
840 **momentary power switch**
841 **power switch** that does not remain in the “on” position when the actuating member is released
- 842 **3.71**
843 **message**
844 data which is transmitted from a sender (data source) to one or more receivers (data sink)
- 845 **3.72**
846 **non-self-resetting thermal cut-out**
847 **thermal cut-out** which requires a manual operation for resetting, or replacement of a part, in order to
848 restore the current
- 849 Note 1 to entry: Manual operation for resetting also includes operating the power switch to the “off” position.
- 850 **3.73**
851 **non-isolated source**
852 voltage source contained in a separate enclosure in which the output is not isolated from the mains
853 supply by means of an isolating transformer
- 854 **3.74**
855 **normal operation**
856 conditions under which the tool is operated in **normal use** when it is connected to the power source
- 857 **3.75**
858 **normal use**
859 use of a tool for which it is designed, taking into account the manufacturer’s instructions
- 860 Note 1 to entry: **Normal use** is also known as intended use as defined in ISO 12100:2010.
- 861 **3.76**
862 **overstress**
863 condition where a system or one of its components or sub-systems is operated beyond its ratings or
864 under conditions associated with reasonably foreseeable misuse but not due to a **fault condition**
- 865 **3.77**
866 **pouch cell**
867 lithium-ion **cell** with a non-rigid case that is sealed from the atmosphere under normal conditions
- 868 Note 1 to entry: **Pouch cells** are capable of expanding their flexible casing due to the build-up of gases, which occurs during
869 **normal use** and aging.
- 870 **3.78**
871 **power switch**
872 device that electrically activates the primary function of the tool in the “on” position and deactivates the
873 same function of the tool in its “off” position as a result of the operation of the actuating member(s)
- 874 Note 1 to entry: The device is comprised of all primary and ancillary components (e.g. tactile switch, relays, power
875 semiconductor devices) of the electrical control circuit that activates the primary function of the tool.
- 876 **3.79**
877 **protective device**
878 device that is relied upon to fulfil the requirements of this document under abnormal operation

- 879 Note 1 to entry: An example of a **protective device** is a **thermal cut-out**, the failure of which in combination with a locked
880 rotor would result in motor winding temperatures in excess of the limits of A.18.1.3.1 and can result in an increased risk of
881 fire or electric shock.
- 882 Note 2 to entry: Devices which operate during tests other than abnormal tests (e.g. the heating test of Clause 12) are
883 considered not to be **protective devices**.
- 884 **3.80**
885 **protective electronic device**
886 electronic device or **electronic circuit** acting as a **protective device**
- 887 **3.81**
888 **protective impedance**
889 impedance connected between **live parts** and **accessible** conductive parts, and of value so that the
890 current is limited to a safe level
- 891 **3.82**
892 **public network**
893 network carrying digital data or analogue signals or both where access to the data and signals is not
894 restricted by the physical space within the-use environment of the tool, **battery** or **charging system**
- 895 Note 1 to entry: Determination of confinement to the physical space includes consideration of the network's range of
896 communication, configuration, or construction.
- 897 Note 2 to entry: For the purposes of this document, examples of **public networks** include, but are not limited to:
- 898 – PAN (personal area network);
- 899 – LAN (local area network) connected devices which may or may not be connected to a gateway, such as BLE (Bluetooth
900 Low Energy), Bluetooth or WLAN (wireless local area network);
- 901 – PLC (power line communication);
- 902 – SRD (short range devices); and
- 903 – WAN (wide area network).
- 904 Note 3 to entry: For the purposes of this document, examples of networks which are not considered as being **public**
905 **networks** include, but are not limited to:
- 906 – NFC (near field communication);
- 907 – optical communication with line of sight (infra-red rays or visual rays); and
- 908 – hardwired configurations constructed of physical media
- 909 without connection to a **public network**.
- 910 **3.83**
911 **rated current**
912 current assigned to the tool by the manufacturer
- 913 **3.84**
914 **rated frequency**
915 frequency assigned to the tool by the manufacturer
- 916 **3.85**
917 **rated frequency range**
918 frequency range assigned to the tool by the manufacturer, expressed by its lower and upper limits
- 919 **3.86**
920 **rated input**
921 input in watts assigned to the tool by the manufacturer
- 922 **3.87**
923 **rated no-load speed**
924 highest no-load speed assigned to the tool by the manufacturer

- 925 **3.88**
926 **rated voltage**
927 voltage assigned to the tool by the manufacturer. For three-phase supply, it is the voltage between
928 phases
- 929 **3.89**
930 **rated voltage range**
931 voltage range assigned to the tool by the manufacturer, expressed by its lower and upper limits
- 932 **3.90**
933 **reinforced insulation**
934 insulation of **live parts** which provides a degree of protection against electric shock equivalent to
935 **double insulation**
- 936 Note 1 to entry: Examples of **reinforced insulation** are a single layer or several layers which cannot be tested singly as
937 **basic insulation** or **supplementary insulation**.
- 938 **3.91**
939 **remote communication**
940 transmission of data between the tool, **battery** or **charging system** and an **entity** that can be initiated
941 out of sight of the tool, **battery** or **charging system** using communication means such as radio wave
942 modulation, sound wave modulation or bus systems
- 943 Note 1 to entry: Examples of transmission of data include, but are not limited to, remote monitoring, software downloading
944 or control parameter modifications.
- 945 Note 2 to entry: Transmission of data can be one-way (simplex) or two-way (duplex).
- 946 **3.92**
947 **residual current device**
948 **RCD**
949 device intended to detect a diversion of current from a circuit in a way and of a magnitude that may
950 expose the user to an electric shock; under such conditions the device opens the circuit
- 951 Note 1 to entry: Such a device is also known as portable **residual current device** (PRCD), ground fault circuit interrupter
952 (GFCI) or earth leakage circuit breaker (ELCB).
- 953 Note 2 to entry: An **RCD** is not considered to be a **protective device**.
- 954 **3.93**
955 **restart prevention**
956 function that prevents operation of the tool upon voltage recovery following interruption of the supply,
957 when the **power switch** is locked or maintained in the "on" position
- 958 **3.94**
959 **safe state**
960 condition in which the tool is rendered inoperable and presents no increased risk of electric shock, fire
961 or mechanical hazard
- 962 **3.95**
963 **safety critical function**
964 **SCF**
965 function provided by an **electronic circuit**, under **normal operation**, the failure of which would cause
966 non-compliance with this document and would expose a user to an unacceptable increase in the risk
967 of injury
- 968 Note 1 to entry: Examples of **safety critical functions** are given in Table 3.
- 969 Note 2 to entry: Acceptable limits for **safety critical functions** in Table 3 can be different than those required under **normal**
970 **operation**.

- 971 **3.96**
972 **safety extra-low voltage**
973 **SELV**
974 voltage between conductors and between conductors and earth not exceeding
- 975 – 60 V d.c. with less than 10 % peak-to-peak ripple; or
976 – 42,4 V peak
977 and if obtained from the mains supply, provided by
- 978 – a safety isolating transformer; or
979 – a converter with separate windings, the insulation of which complies with **double insulation** or
980 **reinforced insulation** requirements
- 981 **3.97**
982 **self-resetting thermal cut-out**
983 **thermal cut-out** which automatically restores the current after the relevant part of the tool has cooled
984 down to a given value
- 985 **3.98**
986 **separable battery pack**
987 **battery** which is contained in a separate enclosure from the tool and is connected to the tool by an
988 external flexible cord
- 989 **3.99**
990 **signal level device**
991 electrical device that indirectly controls functions of the tool by activating an **electronic circuit** or
992 another electrical device in response to a physical actuation
- 993 Note 1 to entry: A **signal level device** can be part of another device or circuit, such as a **power switch**.
- 994 **3.100**
995 **specified operating region**
996 range of permissible operation of lithium-ion **cells**, expressed by **cell** parameter limits
- 997 **3.101**
998 **specified operating region for charging**
999 conditions for voltage and current during charging in which the lithium-ion **cell** is permitted to operate
1000 as evaluated in accordance with IEC 62133-2:2017 and IEC 62133:2017/AMD1:2021
- 1001 Note 1 to entry: The conditions for voltage and current depend on the **cell** temperature during charging.
- 1002 **3.102**
1003 **supplementary insulation**
1004 independent insulation applied in addition to the **basic insulation**, in order to provide protection against
1005 electric shock in the event of a failure of the **basic insulation**
- 1006 **3.103**
1007 **supply cord**
1008 flexible cord, for supply purposes, which is fixed to the tool
- 1009 **3.104**
1010 **switched circuit**
1011 circuit that is a low-power circuit when the **power switch** is in the “off” position
- 1012 Note 1 to entry: The requirements for a low-power circuit are given in Annex H.

- 1013 **3.105**
1014 **temperature limiter**
1015 temperature-sensing device, the operating temperature of which may be either fixed or adjustable, and
1016 which, during **normal operation**, operates by opening or closing a circuit when the temperature of the
1017 controlled part reaches a predetermined value
- 1018 **3.106**
1019 **test rate**
1020 frequency of tests to detect faults in an **SCF**
- 1021 **3.107**
1022 **tether**
1023 action of securing a power tool using an **attachment point**, a **tool lanyard** and an **anchor** to prevent
1024 a tool from falling when used **at height**
- 1025 **3.108**
1026 **thermal cut-out**
1027 **protective device** which, during abnormal operation, limits the temperature of the controlled part by
1028 automatically opening the circuit, or by reducing the current, the setting of which cannot be altered by
1029 the user
- 1030 **3.109**
1031 **thermal link**
1032 **thermal cut-out** which operates only once, and then requires partial or complete replacement
- 1033 **3.110**
1034 **thermostat**
1035 temperature-sensing device, the operating temperature of which may be either fixed or adjustable; and
1036 which, during **normal operation**, keeps the temperature of the controlled part between certain limits
1037 by automatically opening and closing a circuit
- 1038 **3.111**
1039 **tool lanyard**
1040 length of material with at least one connector on each end that will **tether** a tool to an **anchor** point
- 1041 **3.112**
1042 **transportable tool**
1043 tool that has the following characteristics:
- 1044 a) intended to be taken to various designated working areas. The tool performs work on the material
1045 that is either brought to the tool, the tool is mounted to the workpiece or the tool is placed in
1046 proximity of the workpiece;
- 1047 b) intended to be moved by one or two people, with or without simple devices to facilitate
1048 transportation, e.g. handles, wheels and the like;
- 1049 c) used in a stationary position set up on a bench, table, floor or incorporating a device that performs
1050 the function of a bench or table, with or without fixing, e.g. fast clamping devices, bolting and the
1051 like, or mounted to the workpiece;
- 1052 d) used under the control of an operator;
- 1053 e) either the workpiece or the tool is fed or introduced manually;
- 1054 f) not intended for continuous production or production line use
- 1055 **3.113**
1056 **type X attachment**
1057 method of attachment of the **supply cord** specified by the manufacturer so that it can easily be replaced

- 1058 **3.114**
1059 **type Y attachment**
1060 method of attachment of the **supply cord** such that any replacement is intended to be made by the
1061 manufacturer, its service agent or similar qualified person
- 1062 **3.115**
1063 **upper limit charging voltage**
1064 highest voltage that a lithium-ion **cell** is permitted to attain during normal charging for a specified range
1065 of temperatures as specified by the **cell** manufacturer and evaluated in accordance with IEC 62133-
1066 2:2017 and IEC 62133:2017/AMD1:2021
- 1067 **3.116**
1068 **user maintenance**
1069 maintenance operation(s) which are intended to be carried out by the user in accordance with the
1070 instruction manual
- 1071 **3.117**
1072 **venting**
1073 condition that occurs, when a **cell** releases excessive internal pressure intended by design to preclude
1074 **explosion**
- 1075 Note 1 to entry: **Venting** can cause the **cell** to release gases and/or liquids.
- 1076 Note 2 to entry: Cylindrical and prismatic **cells** typically have rigid walls and employ a mechanical vent to release excessive
1077 build-up of gases that can occur during abuse and abnormal conditions.
- 1078 Note 3 to entry: **Pouch cells** typically do not employ a mechanical vent as rigid walled **cells**, but instead have a seal at one
1079 edge to release excessive build-up of gases that can occur during abuse and abnormal conditions and are functionally
1080 equivalent to the vent on a rigid-walled **cell**.
- 1081 **3.118**
1082 **working voltage**
1083 highest measured r.m.s. value of the a.c. or d.c. voltage, without the effect of transient voltages, across
1084 any insulation or between any parts of different potential, including **live parts** to earth
- 1085 Note 1 to entry: **Working voltage** takes resonant voltages into account.
- 1086 **4 General requirements**
- 1087 Tools shall be so constructed that they operate safely so as to cause no danger to persons or
1088 surroundings.
- 1089 Tools that have separate modes of operation shall comply separately with the requirements applicable
1090 to each specific mode of operation.
- 1091 Tools that employ **interchangeable parts** that convert the tool into configurations that are covered by
1092 more than one relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 shall comply separately with
1093 the applicable parts of IEC 62841-2, IEC 62841-3 or IEC 62841-4. Any other hazards due to the
1094 combination of functions shall be taken into account.
- 1095 *Compliance is checked by fulfilling the relevant requirements and carrying out the relevant tests of this*
1096 *document.*
- 1097 **5 General conditions for the tests**
- 1098 **5.1 Tests according to this standard are type tests. General test conditions in Clause 5 apply unless**
1099 *otherwise specified in this standard.*
- 1100 NOTE Annex X shows an example of routine tests.

- 1101 **5.2** Each test may be conducted on a separate sample.
- 1102 The cumulative stress resulting from successive tests on **electronic circuits** is to be avoided. It may
1103 be necessary to replace components or to use additional samples.
- 1104 If several tests are conducted on a single sample, then the results shall not be affected by previous
1105 tests.
- 1106 **5.3** If it is evident from the construction of the tool that a particular test is not applicable, the test is
1107 not made.
- 1108 **5.4** For the test conditions regarding the position of the tools see A.5.4 and B.5.4.
- 1109 **5.5** Electronic speed **control devices** are set to the highest speed.
- 1110 NOTE An example of other controls or switching devices is a mode switch.
- 1111 Tools provided with other controls or switching devices are tested with these controls or switching
1112 devices adjusted to their most unfavourable settings, if the setting(s) is
- 1113 – **accessible** without the aid of a tool; or
- 1114 – **not accessible** without the aid of a tool but is intended to be altered by the user in accordance with
1115 8.12.3 a).
- 1116 Sealing is regarded as preventing alteration of the setting(s) by the user.
- 1117 **5.6** The tests are made in a draught-free location and at an ambient temperature of $(20 \pm 5) ^\circ\text{C}$.
- 1118 If the temperature attained by any part is limited by a temperature sensitive device, the ambient
1119 temperature is, in case of doubt, maintained at $(23 \pm 2) ^\circ\text{C}$.
- 1120 **5.7** For the test conditions related to the power supply see A.5.7 and B.5.7.
- 1121 **5.8** When alternative heating elements or **attachments** are made available for the tool by its
1122 manufacturer, the tool is tested with those heating elements or recommended **attachments** in
1123 accordance with 8.12.3 a) 2) which give the most unfavourable results.
- 1124 **5.9** When testing **electronic circuits**, the supply is to be free from those perturbations from external
1125 sources that can influence the results of the tests.
- 1126 **5.10** If, in **normal use**, a heating element, if any, cannot be operated unless the motor is running, the
1127 element is tested with the motor running. If the heating element can be operated without the motor
1128 running, the element is tested with or without the motor running, whichever is the more unfavourable.
- 1129 **5.11** For tools employing **interchangeable parts** that convert the tool into a configuration covered by
1130 another relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4, the tests are made in accordance
1131 with that relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.
- 1132 **5.12** If a requirement is based upon the mass of the tool, the mass shall be determined without the
1133 **supply cord**, if any, and without **accessories**, but with all **attachments** needed for **normal use**. Details
1134 of the required **attachments** and **interchangeable parts** are specified in 8.12.3 a) 2) and may also be
1135 given in the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4, as applicable.
- 1136 If the tool is intended to be used with more than one **attachment** or **interchangeable part**, the heaviest
1137 configuration shall be used to determine the mass.
- 1138 All mass measurements shall be made with an accuracy of $\pm 5 \%$.

- 1139 **5.13** *If linear and angular dimensions are specified without a tolerance, ISO 2768-1:1989, class “c” is*
1140 *applicable.*
- 1141 **5.14** *All test parameter settings shall be made with a tolerance of $\pm 2\%$.*
- 1142 NOTE Examples of test parameter settings include voltage, current, torque and time period.
- 1143 *All electrical measurements shall be made with an instrument accuracy of $\pm 5\%$.*
- 1144 *Instruments for measuring voltage shall have an input resistance of at least $1\text{ M}\Omega$ with a maximum*
1145 *parallel capacitance of 150 pF .*
- 1146 **5.15** *Thermal equilibrium is considered achieved when the total deviation of three successive*
1147 *temperature rise readings, taken at 3 min intervals, does not exceed 4 K. For induction motors, a*
1148 *measurement time of 1 h is considered sufficient.*
- 1149 *For motors, thermal equilibrium may be evaluated by measuring the temperature of the stator*
1150 *laminations.*
- 1151 **5.16** *For tests to be performed at no-load, no **accessories** or **attachments** are installed on the output*
1152 *mechanism.*
- 1153 **5.17** *Each new sample is operated at no-load for 5 to 30 min and allowed to return to ambient*
1154 *temperature prior to its first test.*
- 1155 **5.18** *For any test which may be performed by cycling an external voltage supply on and off, any*
1156 ***restart prevention** function may be bypassed.*
- 1157 **5.19** *The tests are carried out on the tool as supplied. However, a tool constructed as a single tool,*
1158 *but supplied in a number of units, is tested after assembly in accordance with 8.12.3 a) 2).*
- 1159 **5.20** *For tests where the acceptance criteria include a requirement that there shall be no loss of **SCF**,*
1160 *the acceptance criteria for tests for the relevant **SCF** in Table 3 shall be used.*
- 1161 **5.21** *For tests that require a short circuit, the short circuit is made with a resistance not exceeding 10*
1162 *$\text{m}\Omega$.*
- 1163 **5.22** *For tests that require a short circuit, the inductance of the short circuit does not need to be taken*
1164 *into consideration.*
- 1165 **6 Radiation, toxicity and similar hazards**
- 1166 **6.1** Tools shall not emit harmful radiation, or present a toxic or similar hazard.
- 1167 *Compliance is checked by the test, given in the relevant part of IEC 62841-2, IEC 62841-3 or*
1168 *IEC 62841-4, where necessary.*
- 1169 NOTE Previous studies have shown that the level of electromagnetic fields (EMF) emitted by power tools and garden
1170 machinery, measured in accordance with IEC 62233:2005, is far below the applicable limits, provided the sole significant
1171 source of EMF is the motor, which is typically a universal, DC (with or without brushes), induction or solenoid motor. Therefore,
1172 a general measurement in accordance with IEC 62233:2005 was regarded as not necessary.
- 1173 **6.2** *If the tool is fitted with a laser to indicate a cutting line or the like, the laser class shall be 1 or 2*
1174 *in accordance with IEC 60825-1:2014.*
- 1175 *In addition, the tool shall be marked with the symbol(s) as required by IEC 60825-1:2014 for the*
1176 *relevant laser class.*

1177 *Compliance is checked by inspection.*

1178 **6.3** If a tool is fitted with non-coherent light sources, users of tools shall be cautioned as to the risk
1179 of potential photo-biological harm, if such harm exists in **normal use**.

1180 *Compliance is checked by the requirements of 6.4, 6.5 or 6.6, as applicable.*

1181 **6.4** Visible light indicators (pilot lamps) and infrared sources used for signalling and communication
1182 are considered to have no risk of photo-biological harm and require no marking.

1183 *Compliance is checked by inspection.*

1184 **6.5** Tools emitting visible light from electroluminescent, incandescent or LED sources are considered
1185 to be for short term, non-general light services use where exposure is both incidental and intermittent.

1186 Tools emitting light from these sources shall be marked with one of the following:

- 1187 – “**CAUTION** Do not stare at operating lamp”, or
- 1188 – symbol IEC 60417-6041:2010-08.

1189 The marking may be omitted, if it can be demonstrated that the emitted light presents no reasonable
1190 risk of harm. The emitted light is considered to present no reasonable risk of harm, if either

- 1191 – the light emission, at a distance of (200 ± 5) mm along any direction of the light exit, is below
1192 500 Lux with an instrument accuracy of $\pm 5\%$; or
- 1193 – the luminance light emission is less than 10 000 cd/m² in the range of visible light; or
- 1194 – the light source (if not focused by external optics) is in Risk Group 1 or lower evaluated by the
1195 methods of IEC 62471:2006; or
- 1196 – the tool itself is evaluated by the methods of IEC 62471:2006 and found to be in Risk Group 1 or
1197 lower.

1198 *Compliance is checked by measurement and by the methods specified in IEC 62471:2006.*

1199 **6.6** For light derived by sources other than those mentioned in 6.5, the product shall be evaluated by
1200 the methods of IEC 62471:2006 and the markings shall be guided by IEC 62471-5:2015, Table 9.

1201 *Compliance is checked by inspection and by the methods specified in IEC 62471:2006.*

1202 **7 Classification**

1203 Classification requirements are specified in Clauses A.7 and B.7.

1204 **8 Marking and instructions**

1205 **8.1** Tools shall be marked with **rated no-load speed**, in min⁻¹, if specified in the relevant part of
1206 IEC 62841-2, IEC 62841-3 or IEC 62841-4. For tools where no relevant part of IEC 62841-2,
1207 IEC 62841-3 or IEC 62841-4 exists, **rated no-load speed**, in min⁻¹ shall be marked if the mounting of
1208 an **accessory(ies)** with a speed rating lower than the **rated no-load speed** of the tool is likely to result
1209 in a hazard.

1210 *Compliance is checked by inspection.*

1211 **8.2** Tools shall be marked with a safety warning in one of the following versions:

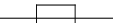
- 1212 – “ **WARNING** – To reduce the risk of injury, user must read instruction manual”, or

- 1213 – safety sign M002 of ISO 7010:2019, or
1214 – the appropriate product safety labels stated in the relevant part of IEC 62841-2, IEC 62841-3 or
1215 IEC 62841-4.
- 1216 If used, the word “WARNING” shall be in capital letters not less than 2,4 mm high and shall not be
1217 separated from either the cautionary statement or the symbol ISO 7000:2019-0434A or
1218 ISO 7000:2019-0434B.
- 1219 If used, the statement, if in English, shall be verbatim and in any other language it shall be equivalent,
1220 except the term “operator’s manual” or “user guide” may be used for the term “instruction manual”.
- 1221 NOTE 1 In Canada, the following additional requirement applies:
1222 For all warnings, an equivalent French version shall also be provided.
- 1223 An example of an equivalent French version of the warning in the first dash above is “MISE EN GARDE – Pour réduire le
1224 risque de blessures, l'utilisateur doit lire le manuel d'instructions» ou se référer au symbole M002 de l'ISO 7010 :2019”.
- 1225 NOTE 2 In the United States of America, the following additional requirement applies:
1226 For tools sold in the United States of America, safety warnings marked on the product shall be written in English.
- 1227 If additional product safety labels are used, they shall be designed in accordance with
1228 ISO 3864-2:2016 or ISO 3864-3:2012, except that the colour requirements of these standards are not
1229 required.
- 1230 Cautionary statements having the same signal word such as “ WARNING” may be combined into one
1231 paragraph under one signal word. If cautionary statements are combined into one paragraph under one
1232 signal word, the order of statements shall be markings required by IEC 62841-1, markings required by
1233 the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 and then any optional markings.
- 1234 For tools employing **interchangeable parts**, the cautionary markings in accordance with the relevant
1235 part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 may be on any of the **interchangeable parts**. The
1236 cautionary markings shall not give rise to misunderstandings.
- 1237 *Compliance is checked by inspection and by measurement.*
- 1238 **8.3** Tools shall be marked with additional information as follows:
- 1239 – the business name and address of the manufacturer and/or the authorised representative. Any
1240 address shall be sufficient to ensure contact. Country or state, city and postal code (if any) are
1241 deemed sufficient for this purpose;
- 1242 – designation of the tool,
1243 designation of the tool may be achieved by a code that is any combination of letters, numbers or
1244 symbols, providing that this code is explained by giving the general designation such as “drill”,
1245 “planer” etc. in the instructions supplied with the tool;
- 1246 NOTE 1 An example of such code is “A123-B”.
- 1247 – designation of series or type,
1248 allowing the technical identification of the product. This may be achieved by a combination of letters
1249 and/or numbers and may be combined with the designation of the tool;
- 1250 NOTE 2 The term “designation of series or type” is also known as model number.
- 1251 – the year of manufacture;
- 1252 – the month of manufacture or a date code identifying at least the month of the date of
1253 manufacture. The date code may be any code that can be interpreted by the manufacturer;
- 1254 – for tools manufactured such that its parts are shipped separately for assembly by the end user,
1255 each part shall be provided with an identifying marking on the part or the package which can be
1256 used for assembly. This identifying marking is not required to comply with 8.12;
- 1257 – if the mass of the tool is greater than 25 kg: “> 25 kg” or the mass of the tool in kg.

- 1258 If additional markings are used, they shall not give rise to misunderstanding.
- 1259 For tools employing **interchangeable parts**:
- 1260 – the business name and address of the manufacturer and/or the authorised representative;
 - 1261 – designation of series or type;
 - 1262 – the year of manufacture;
 - 1263 – the month of manufacture or a date code identifying at least the month of the date of manufacture;
 - 1264 and
 - 1265 – when the mass of the **interchangeable part** is over 25 kg, “m > 25 kg”
- 1266 shall be marked on each **interchangeable part**. This requirement is not applicable for **interchangeable**
1267 **parts** that are provided with the tool.
- 1268 NOTE 3 In Europe (EN IEC 62841-1), the following additional requirement applies:
- 1269 Tools shall be additionally marked with the website, e-mail address or other digital contact at which the manufacturer can be
1270 contacted. Where the size or nature of the tool does not allow the marking on the product, the required information shall be
1271 provided on the packaging or in an accompanying document.
- 1272 For tools where the instruction manual is provided only in a digital format, the tool shall be marked with information on how to
1273 access the digital instructions. Where the size or nature of the tool does not allow the marking on the product, the required
1274 information shall be provided on the packaging or in an accompanying document.
- 1275 *Compliance is checked by inspection.*
- 1276 **8.4** Markings specified in A.8.1, B.8.1, 8.2 and 8.3 shall not be on a **detachable part** of the tool.
1277 **Interchangeable parts** are not considered to be **detachable parts**.
- 1278 Markings specified in 8.2 and 8.3 shall be clearly discernible without removal of any cover.
- 1279 Other markings on the tool may be visible after removal of any cover, provided the location of the
1280 marking is readily accessible.
- 1281 Indications for switches and controls shall be placed on or in the vicinity of these components; they
1282 shall not be placed on parts which can be repositioned, or positioned in such a way that the marking is
1283 misleading.
- 1284 *Compliance is checked by inspection.*
- 1285 **8.5** Requirements for mains-operated tools that can be adjusted to suit different **rated voltages** are
1286 given in A.8.203.
- 1287 **8.6** For units the following shall be used:
- 1288 V volts
 - 1289 A amperes
 - 1290 Ah ampere-hours
 - 1291 mAh milliampere-hours
 - 1292 mm millimetres
 - 1293 Hz hertz
 - 1294 W watts
 - 1295 kW kilowatts
 - 1296 l litres
 - 1297 g grams

1298	kg	kilograms
1299	bar	bars
1300	Pa	pascals
1301	h	hours
1302	min.....	minutes
1303	s	seconds
1304	.../min or ...min ⁻¹	revolutions or reciprocations per minute (rpm)

1305 For symbols the following shall be used:

	or d.c.	[symbol IEC 60417-5031:2002-10] direct current
	or a.c.	[symbol IEC 60417-5032:2002-10] alternating current
	.....	three-phase alternating current
	.....	three-phase alternating current with neutral
	.....	rated current of the appropriate fuse-link in amperes
	.....	miniature fuse-link where X is the symbol for the time/current characteristic, as given in IEC 60127-1:2023
	.....	[symbol IEC 60417-5019:2006-08] protective earth
	.....	[symbol IEC 60417-5018:2011-07] functional earthing
	.....	[symbol IEC 60417-6092:2013-03] class II equipment with functional earthing
	.....	[symbol IEC 60417-5172:2003-02] class II equipment
	.....	[symbol IEC 60417-5180:2003-02] class III equipment
IPXX	.....	Ingress Protection (IP) Code in accordance with IEC 60529:1989 and IEC 60529:1989/AMD2:2013
	.....	[symbol ISO 7000:2019-0434A or ISO 7000-0434B (2004-01) or ISO 7010:2019 W001] caution
	.....	[symbol M002 of ISO 7010:2019] refer to instruction manual/ booklet
	.....	[symbol IEC 60417-5008:2002-10] OFF (power)
	.....	[symbol IEC 60417-5012:2002-10] lamp

NOTE This symbol is used to identify switches which control light sources.



.....[symbol IEC 60417-6041:2010-08]
visible radiation



.....[Symbol W012 of ISO 7010:2019]
Warning; Electricity

Ø

.....diameter

Li-Ion

.....lithium-ion battery

NiCd

.....nickel-cadmium battery

NiMH

.....nickel-metal hydride battery

m

.....mass

n_0

.....**rated no-load speed**

1306 If additional symbols are used, they shall not give rise to misunderstanding and shall be explained in
1307 the instructions.

1308 When other units are used, the units and their symbols shall be those of the international standardized
1309 system.

1310 *Compliance is checked by inspection.*

1311 **8.7** Controls and switches, other than **power switches**, which may give rise to a hazard when
1312 operated shall be

1313 – marked with their function; or

1314 – so placed as to indicate clearly which part of the tool they control.

1315 *Compliance is checked by inspection.*

1316 **8.8** The “off” position of a multi-stable **power switch** shall be indicated; the indication shall be the
1317 figure O, as given by symbol IEC 60417-5008:2002-10. A **momentary power switch** which can be
1318 locked in the “on” position is not considered as a multi-stable switch.

1319 Push-buttons used only for the “off” function shall be indicated by marking the button/position with the
1320 figure O and the colour of the button shall be red or black.

1321 The figure O shall not be used for any other indication.

1322 NOTE 1 The figure O can, for example, also be used on a digital programming keyboard.

1323 For **transportable tools**, a **power switch** actuating member or its cover shall not have a colour of
1324 yellow background in combination with a red actuator as specified for an emergency stop in accordance
1325 with ISO 13850:2015.

1326 NOTE 2 This document does not cover emergency stop requirements since most tools and machines covered by this
1327 document do not require an emergency stop. Any emergency stop requirements will be covered by a relevant part of
1328 IEC 62841-3 or IEC 62841-4.

1329 When a flap or cover is provided and covers only the start button, the colour of the flap or cover shall
1330 not be black, red or yellow.

1331 When a flap or cover is provided and covers the stop button, such flap or cover shall be transparent,
1332 red or black.

1333 *Compliance is checked by inspection.*

1334 **8.9 Control devices** intended to be adjusted in accordance with 8.12.3 during operation, shall be
1335 provided with an indication for the direction of adjustment to increase or to decrease the value of the
1336 characteristic being adjusted. An indication of + and – is considered to be sufficient for this requirement.

1337 The requirement does not apply to **power switches** where the speed depends on the degree to which
1338 the actuator is depressed.

1339 If figures are used for indicating the different positions, the “off” position shall be indicated by the
1340 figure ○ as given by symbol IEC 60417-5008:2002-10 and the other positions shall be indicated by
1341 figures reflecting the greater output, input, speed, etc.

1342 The indication for the different positions of the operating means of a **control device** shall be placed
1343 on the device itself, or adjacent to the operating means.

1344 *Compliance is checked by inspection.*

1345 **8.10** Markings required by the standard shall be legible and durable. Product safety labels shall be in
1346 contrast such as colour, texture, or relief, to their background such that the information or instructions
1347 provided by the product safety labels are clearly legible when viewed with normal vision from a distance
1348 of (500 ± 50) mm. Product safety labels need not be in accordance with the colour requirements of
1349 ISO 3864-2:2016. If markings or product safety labels are embossed, stamped, etched, engraved or
1350 moulded, contrasting colours are not required.

1351 *Compliance is checked by inspection and, for markings that employ printed ink, by rubbing the marking*
1352 *by hand for 15 s with a piece of cloth soaked with water and again for 15 s with a piece of cloth soaked*
1353 *with petroleum spirit.*

1354 *The petroleum spirit to be used for the test shall be a reagent grade heptane or hexane with a minimum*
1355 *of 85 % n-heptane or n-hexane.*

1356 *After the test, the marking shall be clearly legible.*

1357 NOTE The designations “n-heptane” and “n-hexane” are the chemical nomenclatures for “normal” or straight chain
1358 hydrocarbons. Examples of these petroleum spirits are known as certified ACS (American Chemical Society) reagent grade
1359 heptane (CAS #142-82-5) and hexane (CAS #110-54-3). It has been shown that n-heptane is less toxic than n-hexane.

1360 If the marking has an adhesive backing, the adhesive backing shall be durable.

1361 *Compliance is checked by either meeting the requirements for indoor use in UL 969 under the*
1362 *conditions*

- 1363 – *appropriate for the surface material to which it is applied, provided the radius of the surface*
1364 *curvature is at least 12 mm and in one direction only;*
1365 – *suitable for the temperature that the label is exposed to during the test of Clause 12;*
1366 – *water immersion; and*
1367 – *lubricating oil*

1368 *or by the following tests a) to c).*

1369 a) *Three labels applied to the tool(s) or a panel(s) of the test surface material are placed in an oven*
1370 *at a temperature and a minimum time period in accordance with Table 1. Following the exposure,*
1371 *the samples are then allowed to cool to ambient temperature for a minimum of 1 h.*

1372 b) *Three additional labels applied to the tool(s) or a panel(s) of the test surface material are placed in*
1373 *a controlled atmosphere maintained at 21 °C to 30 °C with a relative humidity of minimum 45 % for*
1374 *at least 24 h. After this conditioning, the labels are immersed in water at a temperature of 21 °C to*
1375 *30 °C for 48 h. The samples are then removed from the water, and allowed to drain for 5 min.*

1376 c) *Three additional labels applied to the tool(s) or a panel(s) of the test surface material are placed in*
1377 *a controlled atmosphere maintained at 21 °C to 30 °C with a relative humidity of minimum 45 % for*

at least 24 h. After this conditioning, the labels are immersed in IRM 903 oil at a temperature of 21 °C to 30 °C for 48 h. The samples are then removed from the oil, and allowed to drain for 5 min.

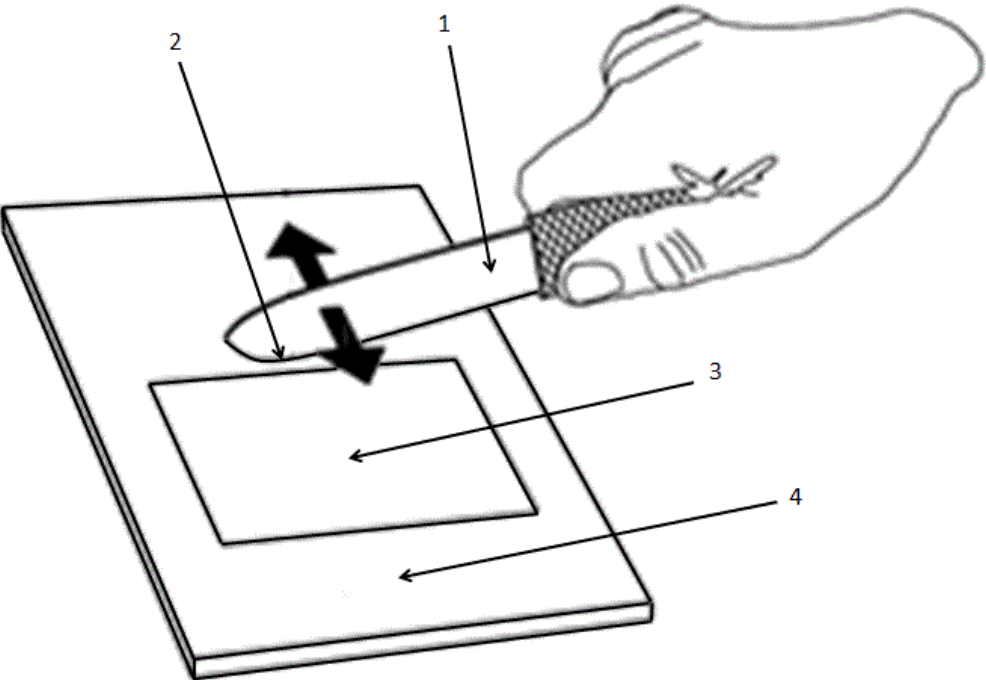
Table 1 – Label temperature and test temperature

Label temperature (°C) ^a	Test temperature (°C) ^b			
	Test duration of 240 h	Test duration of 120 h	Test duration of 60 h	Test duration of 30 h
40	60 ± 2	70 ± 2	80 ± 2	90 ± 2
60	87 ± 2	97 ± 2	107 ± 2	117 ± 3
80	105 ± 3	115 ± 3	125 ± 3	135 ± 3
100	121 ± 3	131 ± 4	141 ± 4	151 ± 4
125	150 ± 4	160 ± 4	170 ± 4	180 ± 4
150	180 ± 4	190 ± 4	200 ± 4	210 ± 4

^a This is the temperature that is at least 40°C greater than the temperature rise of the surface to which the label is exposed to during the test of Clause 12.

^b These temperatures are based on the values in UL 969. The other accelerated test durations are based on the application of the Arrhenius principle.

After each test a) to c), the label shall show no signs of curling and it shall not be easy to remove the label by scraping the label back and forth ten times across printed areas and edges with a downward force of between 7,2 and 9 N using the edge of a 1,6 to 2,5 mm thick steel blade held at a right angle to the test surface. The portion of the blade contacting the test surface shall have a radius of curvature of 25,4 to 33,0 mm and the edges of the blade shall be rounded to a radius of (0,41 ± 0,08) mm. See Figure 1.



- Key**
- 1 blade
 - 2 radii of curvature and edges
 - 3 label
 - 4 panel (surface)

Figure 1 – Example of durability test for labels with adhesive backing

8.11 If compliance with this document depends upon the operation of a replaceable **thermal link** or fuse-link, the reference number or other means for identifying the link shall be marked in a place that it is clearly visible after the link has opened, when the tool has been dismantled to the extent necessary for replacing the link.

This requirement does not apply to links which can only be replaced together with a part of the tool.

Compliance is checked by inspection.

8.12 Instruction manual and safety instructions**8.12.1 General**

An instruction manual and safety instructions shall be provided with the tool in such a way that is noticed by the user when the tool is removed from the packaging.

Compliance is checked by inspection.

An explanation of the symbols required by this standard and used on the tool shall be provided in either the instruction manual or the safety instructions. This requirement is not applicable for symbols of units in 8.6.

The instruction manual and the safety instructions shall be written in the official language(s) of the country in which the tool is sold.

NOTE 1 In Europe (EN IEC 62841-1), the following additional requirement applies:

The words "Original instructions" shall appear on the language version(s) verified by the manufacturer or his authorised representative. Where no "Original instructions" exist in the official language(s) of the country where the tool is to be used, a translation into that/those language(s) shall be provided by the manufacturer or his authorised representative or by the person bringing the tool into the language area in question. The translations shall bear the words "Translation of the original instructions", and they shall be accompanied by a copy of the "Original instructions".

NOTE If the instruction manual is provided only in digital format, the following information is regarded as essential for putting the tool into use and using the tool in a safe way in accordance with Regulation (EU) 2023/1230:

- safety warnings in accordance with 8.12.2; and
- instructions in accordance with 8.12.3 a), 8.12.3 b) and 8.12.3 d), as applicable.

NOTE 2 In the United States of America, the following requirement applies:

The instruction manual and safety instructions shall be written in English.

The instruction manual and the safety instructions shall be legible and contrast with the background.

The instruction manual and the safety instructions shall include the business name and address of the manufacturer and, where applicable, his authorised representative. Any address shall be sufficient to ensure contact. Country or state, city and postal code (if any) are deemed sufficient for this purpose.

Also, the designation of the tool and series or type as required by 8.3 shall be included, together with the general designation of the machine such as "drill", "planer" etc.

8.12.2 Safety instructions

8.12.2.1 The subjects of safety instructions are the general safety warnings referenced in 8.12.2.2, the specific tool safety warnings of the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4 and any additional safety warning statements deemed necessary by the manufacturer. The general safety warnings and the specific tool safety warnings, if in English, shall be verbatim and in any other language equivalent. The numbering of the safety instructions, as given below, is not mandatory and may be

- 1435 omitted or replaced by other sorting means such as bullets. The general safety warnings may be
1436 separate from the instruction manual.
- 1437 As the term "power tool" or "tool" is not appropriate for **lawn and garden machinery**, for these products
1438 an appropriate term such as "machine" may be used.
- 1439 The term verbatim means word-for-word but permits the differences in spelling between English-
1440 speaking countries.
- 1441 The format of all safety warnings shall differentiate by font, highlighting or similar means as shown in
1442 8.12.2.1 to 8.12.2.3.
- 1443 All notes in the safety instructions shall not be printed, as they are information for the designer of the
1444 manual.
- 1445 *Compliance is checked by inspection.*
- 1446 **8.12.2.2** The safety warnings for mains-operated tools covered by a relevant part of IEC 62841-2 or
1447 IEC 62841-3 are specified in A.8.12.2.1.201. The safety warnings for mains-operated **lawn and garden**
1448 **machinery** covered by a relevant part of IEC 62841-4 are specified in A.8.12.2.1.202.
- 1449 The safety warnings for **battery**-powered tools covered by a relevant part of IEC 62841-2 or IEC 62841-
1450 3 are specified in B.8.12.2.1.201. The safety warnings for **battery**-powered **lawn and garden**
1451 **machinery** covered by a relevant part of IEC 62841-4 are specified in B.8.12.2.1.202.
- 1452 *Compliance is checked by inspection.*
- 1453 **8.12.2.3** The order of the safety warnings shall be in accordance with either item A) or B) and in
1454 accordance with item C):
- 1455 A) The IEC 62841-1 warnings are followed by the relevant part of IEC 62841-2, IEC 62841-3 or
1456 IEC 62841-4 warnings. The order of the warnings within IEC 62841-1 and the IEC 62841-2,
1457 IEC 62841-3 or IEC 62841-4 warnings shall remain as given above and in the relevant part of
1458 IEC 62841-2, IEC 62841-3 or IEC 62841-4.
- 1459 B) The IEC 62841-1 and the IEC 62841-2, IEC 62841-3 or IEC 62841-4 warnings may be divided into
1460 the sections defined by the numbered subtitles and the associated warnings below the numbered
1461 subtitle. The order of warnings within each section shall remain as given above and in the relevant
1462 part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.
- 1463 When warnings are presented in this manner, the title of the IEC 62841-1 "General Power Tool
1464 Safety Warnings" shall be omitted and the 1st sentence of the warnings in A.8.12.2.1.201,
1465 A.8.12.2.1.202, B.8.12.2.1.201, B.8.12.2.1.202 and 8.12.2.3, if applicable, shall be modified as
1466 follows:
- 1467  **WARNING** Read all safety warnings designated by the  symbol and all instructions.
- 1468 The sections of the safety warnings shall be presented in the related topic of the instruction manual.
- 1469 The instruction manual section titles for IEC 62841-1 warnings shall have a format:
- 1470  **General Power Tool Safety Warnings – [Section subtitle]**
- 1471 Example:
- 1472  **General Power Tool Safety Warnings – Personal Safety**
- 1473 The instruction manual section titles for IEC 62841-2, IEC 62841-3 or IEC 62841-4 warnings shall
1474 have a format:
- 1475  **[Tool category name] Safety Warnings – [Section subtitle]**
- 1476 Example:

Circular Saw Safety Warnings – Cutting Procedures

If particular IEC 62841-2, IEC 62841-3 or IEC 62841-4 warnings do not have a numbered subtitle, then all warnings required by the particular IEC 62841-2, IEC 62841-3 or IEC 62841-4 shall be presented in the given order and the formatting rule above shall be followed without the [Section subtitle].

- C) Any additional warnings deemed necessary by the manufacturer, shall not be inserted within any of the IEC 62841-1 or IEC 62841-2, IEC 62841-3 or IEC 62841-4 warnings. They may be either appended to the section(s) of the IEC 62841-1 or IEC 62841-2, IEC 62841-3 or IEC 62841-4 in accordance with the topic of the safety warnings or located in any other part of the instruction manual.

8.12.2.4 If the safety instructions are separate from the instruction manual, then the following warnings shall be included in the instruction manual. These warnings, if in English, shall be verbatim and in any other language equivalent.

 **WARNING Read all safety warnings, instructions, illustrations and specifications provided with this power tool.** *Failure to follow all instructions listed below may result in electric shock, fire and/or serious injury.*

Save all warnings and instructions for future reference.

For tools employing **interchangeable parts** that are not provided with the tool,

- the safety instructions for all **interchangeable parts** shall be provided with the tool; or
- the specific safety instructions shall be provided with the **interchangeable part**. For this case, the following warning shall be included with the specific safety instructions for the **interchangeable part**:

 **WARNING Read all safety warnings, instructions, illustrations and specifications provided with the tool and the attachment.** *Failure to follow all instructions may result in electric shock, fire and/or serious injury.*

NOTE 1 The text “tool” in the warning above can be replaced with alternate text, such as “power head”.

NOTE 2 The text “attachment” in the warning above can be replaced with alternate text describing the **interchangeable part**, such as “hedge trimmer attachment”.

8.12.3 Instruction manual

The instruction manual shall be provided with the following, if appropriate.

For tools employing **interchangeable parts** that are not provided with the tool,

- the instructions for all **interchangeable parts** shall be provided with the tool; or
- the specific instructions shall be provided with the **interchangeable part**. For this case, there shall be a cross-reference to other relevant instructions that are required in order to cover the complete tool.

a) Instructions for putting into use

- 1) For power tools which can be mounted on a support or fixed to a bench or the floor: instruction on how to set up or fix the power tool in a stable position;
- 2) Instruction on how to assemble the power tool, including any recommended **attachments** or **interchangeable parts**. Alternatively, instruction on how to assemble a recommended **attachment** may be provided separately with the **attachment** or **interchangeable part**;
- 3) Illustrated description of functions;
- 4) Information on limitations of ambient conditions;
- 5) Information on how to fit and adjust the **guards** required by 19.1;

- 1521 6) Instruction on how to disassemble and reassemble the power tool, if applicable for
1522 transportation and/or use;
- 1523 7) For **hand-held tools** and **transportable tools** that produce a considerable amount of dust in
1524 accordance with 21.26, instructions how to properly connect the dust extraction system to the
1525 tool including any associated devices.
- 1526 b) Operating instructions
- 1527 1) Instruction for setup for specific operations;
- 1528 2) Instruction on how to change **accessories**;
- 1529 3) Instruction on how to clamp the workpiece;
- 1530 4) Information on the limits on size and material of the workpiece;
- 1531 5) Instructions for the intended use and operation of the power tool;
- 1532 6) Identification of handle(s) and location of grasping surface(s) required by 19.4;
- 1533 7) For tools with electronic speed or load regulators that reduce the output spindle torque of the
1534 tool during a stalled condition and will increase the output spindle torque after the stalled
1535 condition is removed: a warning that the tool will resume **normal operation** immediately after
1536 the stalled condition is removed;
- 1537 8) For **transportable tools** only: instruction on lifting and transportation;
- 1538 9) For tools equipped with **restart prevention**, information on how the tool operates after a loss
1539 of supply voltage;
- 1540 10) For tools marked with an IP rating in accordance with 8.1.3, an explanation of the usage of the
1541 tool based on the marking, in accordance with its classification in A.7.2 and B.7.1; **Sec. Note:**
1542 **there is no subclause 8.1.3 in this document.**
- 1543 NOTE 1 Examples of usage of the tool based on the marking are “use of the tool in rain is permitted” or “cleaning
1544 the tool with low-pressure water is permitted”.
- 1545 11) For tools that contain removable button-type **cells** and **batteries** as in 21.28:
- 1546 – information on the hazard of ingestion of button-type **cells** and **batteries**;
- 1547 – instruction to keep button-type **cells** and **batteries** out of the reach of children;
- 1548 – instruction to seek immediate medical attention if button-type **cells** or **batteries** are ingested;
1549 and
- 1550 – instruction how to handle button-type **cells** and **batteries** properly during use, including
1551 replacement and storage.
- 1552 12) For **hand-held tools** only: information on whether the tool is intended to be used **at height**.
- 1553 NOTE 2 Tethering requirements for **hand-held tools** used **at height** are specified in Annex F.
- 1554 c) Maintenance and servicing instructions
- 1555 1) Instruction on **user maintenance**, such as cleaning, sharpening, lubricating, servicing and/or
1556 replacing of parts;
- 1557 2) Information on required service by manufacturer or agent;
- 1558 3) Information on how to obtain replacement parts;
- 1559 4) Information on special tools which may be required;
- 1560 5) For power tools with **type Y attachment**: instruction that a damaged **supply cord** must be
1561 replaced by the manufacturer, its service agent or similarly qualified person in order to avoid a
1562 safety hazard;
- 1563 6) For **hand-held tools** and **transportable tools** that produce a considerable amount of dust as
1564 specified in 21.26:
- 1565 – information when to empty, change or maintain an **integral** dust collection/suction device,
1566 if any, in order to keep its effectiveness; and
- 1567 – information to read the maintenance instructions of the connected external suction device,
1568 if any, in order to keep its effectiveness.
- 1569 d) For tools with a **liquid system**, the substance of the following, as appropriate:

1) Instructions for

- the connection to the liquid supply;
- the use of the liquid and the use of fittings, if any, required to comply with A.14.3 or B.14.3, as applicable, in order to avoid the tool being affected by the liquid;
- the inspection of hoses and other critical parts which could deteriorate;
- the maximum permitted pressure of the liquid supply;

2) Instruction to keep liquid away from parts of the tool not intended to be exposed to liquid, if any, and away from persons in the working area.

NOTE 3 In Europe (EN IEC 62841-1), the following additional requirements apply:

8.12.3 Za)

Noise emissions:

1) The noise emission, measured in accordance with I.2, as follows:

- A-weighted emission sound pressure level L_{pA} and its uncertainty K_{pA} , where L_{pA} exceeds 70 dB(A). Where L_{pA} does not exceed 70 dB(A), this fact shall be indicated, either by a statement or by listing the actual measured value;
- A-weighted sound power level L_{WA} and its uncertainty K_{WA} , where the A-weighted sound pressure level L_{pA} exceeds 80 dB(A);
- C-weighted peak emission sound pressure value $L_{pC,peak}$, where this exceeds 130 dB in relation to 20 µPa.

2) Recommendation for the operator to wear hearing protection.

Continuous vibration:

3) For **hand-held tools** and **lawn and garden machinery** where Clause I.3 is applicable, the following applies: The vibration total value and its uncertainty measured in accordance with I.3.

Information and warnings on noise and vibration emissions:

4) The following information:

- that the declared vibration total value and declared noise emission values have been measured in accordance with a standard test method and may be used for comparing one tool with another;
- that the declared vibration total value and declared noise emission value may also be used in a preliminary assessment of exposure.

5) A warning:

- that the vibration emission and noise emission during actual use of the power tool can differ from the declared total value depending on the ways in which the tool is used; and
- of the need to identify safety measures to protect the operator that are based on an estimation of exposure in the actual conditions of use (taking account of all parts of the operating cycle such as the times when the tool is switched off and when it is running idle in addition to the trigger time).

8.12.3 Zb)

Declaration of vibration values for **hand-held tools** and **lawn and garden machinery** where Clause I.3 is applicable:

1) The vibration total value (continuous vibration) and its uncertainty measured in accordance with I.3 shall be given in the instructions.

2) The mean value of the peak amplitude of the acceleration from repeated shock vibrations and its uncertainty shall be given in the instructions.

8.12.3 Zc)

Hazardous dust emissions:

1) For tools equipped with dust outlet(s) to connect an external suction device as specified in 21.26, information indicating the characteristics and at least the recommended filtration efficiency of the external suction device considering the **normal use** of the tool.

NOTE: Examples for characteristics to connect an external suction device to the tool are the appropriate connecting dimensions for the suction hose, the minimum required volume flow in m³/h and the resulting underpressure (negative pressure) at the tool interface with the external suction device in hPa necessary for **normal use**.

2) For tools equipped with a **liquid system** for suppressing the released dust, information indicating the required technical characteristics of the **liquid system**.**8.12.3 Zd)**

Mass:

Information about the mass of the tool shall be provided in the instructions. An explanatory note shall be given regarding which **attachments** or **interchangeable parts** in accordance with 8.12.3 a) 2) have been used to determine the mass.

9 Protection against access to live parts

Requirements are specified in Clauses A.9 and B.9.

10 Starting

Requirements are specified in Clause A.10.

11 Input and current

Requirements are specified in Clause A.11.

12 Heating

Requirements are specified in Clauses A.12 and B.12.

The following Table 2 applies in both Clauses A.12 and B.12:

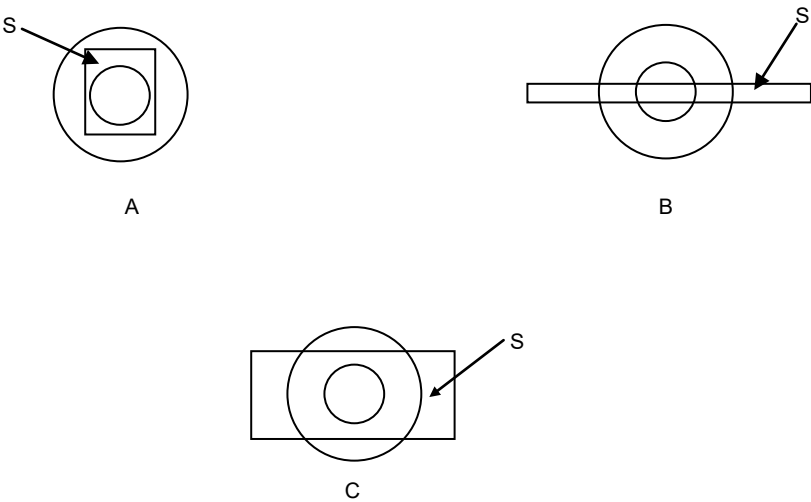
Table 2 – Maximum outside surface temperature rises

Parts	Temperature rise K
External enclosure, except handles held in normal use ^a	60
Handles, knobs, grips, and the like which, in normal use , are continuously held in accordance with 8.12.3.b):	
– of metal	30
– of porcelain or vitreous material	40
– of moulded material, rubber or wood	50
Handles, knobs, grips, and the like which, in normal use , are contacted or held for short periods only (e.g. switches, adjustments or transport handles):	
– of metal	35
– of porcelain or vitreous material	45
– of moulded material, rubber or wood	60
^a The temperature-rise limit specified for the external enclosure does not apply to external surfaces which are unlikely to be inadvertently contacted during use.	

13 Resistance to heat and fire

Requirements are specified in Clauses A.13 and B.13.

The following Figure 2 applies in both Clauses A.13 and B.13:



IEC 985/10

Key

- A example of a small part
 - B example of a small part
 - C example of a part that is not a small part
 - S surface
- NOTE The small and large circles in examples A, B and C are 8 mm and 15 mm in diameter respectively.

Figure 2 – Small part

14 Moisture resistance

Requirements are specified in Clauses A.14 and B.14.

15 Safety critical functions

15.1 Electronic circuits providing safety critical functions

15.1.1 General

Electronic circuits, other than **protective electronic devices**, the failure of which would cause the tool to not comply with a requirement of this document and which would expose a user to an unacceptable increase in the risk of injury, shall meet the requirements for **electronic circuits** providing **safety critical functions**.

NOTE 1 Requirements for **protective electronic devices** are specified in Annex O.

Typical **SCFs** are indicated in Table 3. Specific **SCFs** for a particular tool are specified by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4.

Electronic circuits that provide **safety critical functions** shall

- not be susceptible to loss of a **safety critical function** due to the exposure to electromagnetic environmental phenomena encountered in anticipated environments; and
- possess a reliability and a design commensurate with the risk that is represented by the loss of the **SCF**; and
- become effective within 1 s after the actuation of the **power switch**, unless otherwise specified in Table 3.

- 1665 Any design that only alerts the user of the loss of the **SCF** is not considered sufficient to fulfil any
1666 required performance level (PL).
- 1667 *Compliance is checked by the following tests and evaluations.*
- 1668 All **electronic circuits** providing an **SCF** shall fulfil the tests of 15.2, exposing these **electronic**
1669 **circuits** to the electromagnetic environmental phenomena expected to be encountered in use. Methods
1670 of assessing **SCF** performance are provided in Table 3 for some common **SCFs**.
- 1671 Furthermore, **electronic circuits** providing an **SCF** shall fulfil either the requirements of 15.1.2 or
1672 15.1.3 for all parts of the **electronic circuit**. The **electronic circuit** may be evaluated such that some
1673 sections are evaluated to 15.1.2 and other sections are evaluated to 15.1.3.
- 1674 NOTE 2 Subclause 15.1.2 provides an assessment of the fault tolerance of an **electronic circuit** providing an **SCF** which
1675 usually is achieved with a design which contains two mutually independent functional means to execute specified operations
1676 or alternatively puts the tool into a **safe state**. Subclause 15.1.3 evaluates the reliability of an **electronic circuit** providing an
1677 **SCF** which usually is achieved with a single channel design using the methods of **MTTF_d** for assessing hardware and Annex N
1678 for assessing software.
- 1679 NOTE 3 The flowchart of Figure 3 depicts the method of this subclause.
- 1680 The tests are carried out with the tool supplied at **rated voltage** or the mean value of the **rated voltage**
1681 **range**, unless the difference between the upper and lower limit of the **rated voltage range** is greater
1682 than 20 % of the mean value of the range, in which case the test is conducted at both the upper and
1683 lower limits of the **rated voltage range**.

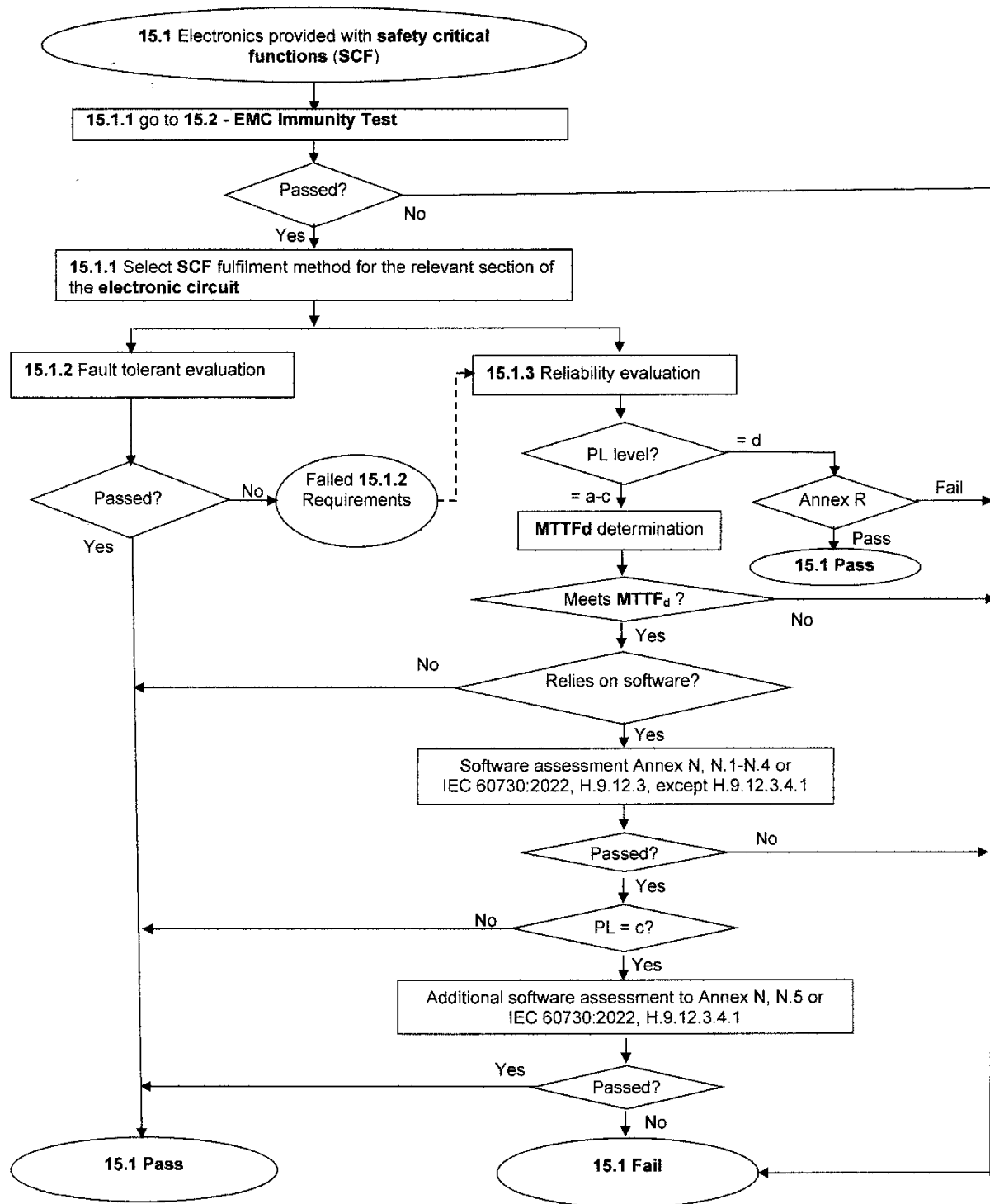


Figure 3 – Method of assessing safety critical functions

15.1.2 Evaluation of fault tolerant SCF circuits

Electronic circuits providing an **SCF** using a fault tolerant design shall be evaluated using the following **fault conditions** a) to e), applied one at a time, without a loss of the **SCF** or the tool shall be in a **safe state** while the **fault condition** is present. Evaluation may be accomplished through circuit analysis, or by introduction of the **fault condition** into the circuit, in either case, the **fault condition** is applied in the de-energized state and then the tool is energized, unless otherwise specified in Table 3.

a) open-circuit at the terminal of any component;

b) short circuit of capacitors, unless they comply with IEC 60384-14:2023;

c) short circuit of any two terminals of an **electronic component**, other than a monolithic integrated circuit. This fault is not applied between the two circuits of an optocoupler;

d) failure of triacs in the diode mode. This may be evaluated by replacing the triac with a diode in each direction one at a time;

e) failure of an integrated circuit, including programmable integrated circuits, that cannot be assessed by the **fault conditions** a) to d). All possible output signals are considered under **fault conditions** within the integrated circuit that would impair an **SCF**, unless it can be shown that a particular output signal is unlikely to occur. Where multiple dies are included in a common package of an integrated circuit, each die shall be treated as an individual integrated circuit.

NOTE 1 Examples of output signals in item e) above that are unlikely to occur are

- dynamic output signals of integrated circuits without a clock and with only static logic states as inputs. These are presumed to produce only static logic states during failure. This applies to combinatorial logic (typically SSI [small scale integration] or MSI [medium scale integration]), drivers, multiplexers, demultiplexers, etc.;
- non-linear output signals of integrated arrays of passive components such as resistors, capacitors and inductors;
- output signals of operational amplifiers other than high impedance, positive supply voltage or negative supply voltage.

NOTE 2 Examples of erroneous output signals in item e) above that are not unlikely to occur are those generated by MCUs, counters, etc. These more complex integrated circuits generally require consideration for all possible output conditions that could affect the proper function of **SCFs** under states of internal failure that would include changing logic conditions due to sequential logic or software execution.

Components such as thyristors and triacs are not subjected to **fault condition e)**.

Positive temperature coefficient resistors (PTC's) and negative temperature coefficient resistors (NTC's) are not short-circuited if they are used within their manufacturer's declared specification.

The tests are conducted in accordance with Table 3 until test failure occurs or until one of the following occurs to end the test:

- the tool no longer draws supply current; or
- a test period of 5 min has elapsed, after which the tool is re-evaluated to determine if the **SCF** is maintained or that the tool remains in a **safe state**.

15.1.3 Reliability evaluation of SCF circuits

Electronic circuits providing **SCFs** for PL=a through PL=c shall be evaluated by the methods of ISO 13849-1:2023, Annex L or an equivalent method to determine the **MTTF_d** of the portion of the circuit that is relied upon for providing the **SCF**.

Typical **SCFs** are indicated in Table 3. Required performance levels (PL's) for applicable **SCFs** are specified by the relevant part of IEC 62841-2, IEC 62841-3 or IEC 62841-4. The required minimum **MTTF_d** for each PL level shall be as follows:

NOTE 1 Annex M provides guidance in applying ISO 13849-1:2023 for the calculation of **MTTF_d**.

- 1729 – $PL = a$: $MTTF_d = 5$ years;
 1730 – $PL = b$: $MTTF_d = 20$ years;
 1731 – $PL = c$: $MTTF_d = 50$ years.

1732 For $PL = a$ through $PL = c$, software responsible for the correct operation of an **SCF** used in a
 1733 microcontroller or in other programmable devices shall comply with the requirements specified below.

1734 For $PL = a$ and $PL = b$, the requirements of

- 1735 – Clause N.1 through N.4; or
 1736 – IEC 60730-1:2022, H.9.12.3.1 for software class B, except for the requirements of
 1737 IEC 60730-1:2022, H.9.12.3.4.1;

1738 shall be fulfilled.

1739 For $PL = c$, the requirements of

- 1740 – Clause N.1 through N.5; or
 1741 – IEC 60730-1:2022, H.9.12.3.1 for software class B;

1742 shall be fulfilled.

1743 NOTE 2 The requirements of Annex N are derived from IEC 60730-1:2022, Annex H. Software that complies with software
 1744 class B of IEC 60730-1:2022, Annex H will meet the requirements of Annex N.

1745 **Electronic circuits** providing **SCFs** for $PL=d$ shall be evaluated by the requirements of Annex R.

1746 Alternatively, **electronic circuits** providing **safety critical functions**, which have been separately
 1747 evaluated in accordance with ISO 13849-1:2023 and ISO 13849-2:2012 for the required performance
 1748 level, are considered to fulfil the requirements of this subclause.

1749 **Table 3 – SCF minimum performance levels and test requirements^b**

Type and purpose of SCF	Minimum performance level (PL) ^c	Conditions for tests ^a	Acceptance criteria for the tests of 15.1.2, 15.1.3 and 15.2	Measurement method ^d
Power switch – prevent unwanted switch-on	See footnote b	The power switch is in the "off" position.	After conditioning, the tool shall not operate with the power switch in the "off" position. Whilst the power switch is off, there shall be - less than 0,5 s of motion that is driven, typically by a motor, and can be determined by measuring the driving current; or - less than 10 s of motion where the driving current cannot be determined. For EMC testing, the evaluation is also made during the application of the EMC stimuli.	Observation and/or video recording. Measurement.
Power switch – provide desired switch-off	See footnote b	The tool is operated at no-load.	After conditioning, it shall be demonstrated that the output of the tool begins stopping no more than 3 s after the power switch is	Observation and measurement.

Type and purpose of SCF	Minimum performance level (PL) ^c	Conditions for tests ^a	Acceptance criteria for the tests of 15.1.2, 15.1.3 and 15.2	Measurement method ^d
			switched to the “off” position. The output of the tool shall ultimately come to a stop.	Examples of the measurement method for demonstrating that the output of the tool begins stopping are current monitoring or marking the output of the tool and making a video recording.
Limit inrush current as required by A.10.2	Not an SCF			
For tools covered by 19.6: Prevent output speed from exceeding 130% of rated no-load speed without accessories mounted	See footnote b	The tool is operated at no-load.	After conditioning, the speed of the tool shall not exceed a speed greater than 130 % of rated no-load speed , using the method of 19.6, for more than 10 s. For EMC testing ,the evaluation is also made during the application of the EMC stimuli.	Measurement. The use of optical, audible or other non-contact means is recommended.
For tools other than those covered by 19.6 or with output speed increases that do not exceed 130 % of rated (no-load) speed: Any speed limiting device	Not an SCF			
For tools covered by 19.10: Provide desired direction of rotation of the tool output	See footnote b	The tool is operated at no-load.	During conditioning, the tool output shall rotate in the desired direction. Up to three energized rotations of 360° in the undesired_direction are permitted. After conditioning, the tool is stopped and restarted. The tool output shall rotate in the desired direction. Up to one partial energized rotation of 45° in the undesired direction is permitted.	Observation. The blade or shaft is marked and a video recording is made.
Lock-off function as required by 21.14	See footnote b	The tool is operated at no-load.	After conditioning, the tool is switched off. The function of the lock-off shall remain the same after the test as before the test.	Observation.
Function to fulfil the requirements of A.21.17 or B.21.17	Not an SCF			