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Date: 15 November 2019

Origin: International

Latest date for receipt of comments: 08 January 2020

Project No. 2018/01392

Responsible committee: MCE/3 Safeguarding of machinery

Interested committees:

Title: Draft BS EN IEC 60204-32 Safety of machinery - Electrical equipment of machines. Part 32: Requirements for hoisting machines.

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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 Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.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

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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	Commend (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.	



44/862/CD

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

IEC 60204-32 ED3

DATE OF CIRCULATION:

2019-11-15

CLOSING DATE FOR COMMENTS:

2020-02-07

SUPERSEDES DOCUMENTS:

44/822/RR

IEC TC 44 : SAFETY OF MACHINERY - ELECTROTECHNICAL ASPECTS

SECRETARIAT:

United Kingdom

SECRETARY:

Mrs Nyomee Hla-Shwe Tun

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:



Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☒ SAFETY

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

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TITLE:

Safety of machinery - Electrical equipment of machines - Part 32: Requirements for hoisting machines

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CONTENTS

2		
3	FOREWORD.....	7
4	INTRODUCTION.....	10
5	1 Scope.....	13
6	2 Normative references.....	14
7	3 Terms and definitions.....	16
8	4 General requirements.....	24
9	4.1 General considerations.....	24
10	4.2 Selection of equipment.....	25
11	4.3 Electrical supply.....	26
12	4.4 Physical environment and operating conditions.....	27
13	4.5 Transportation and storage.....	29
14	4.6 Provisions for handling.....	29
15	4.7 Installation.....	29
16	5 Incoming supply conductor terminations and devices for disconnecting and switching off.....	29
17	5.1 Incoming supply conductor terminations.....	29
18	5.2 Terminal for connection to the external protective earthing system.....	30
19	5.3 Supply disconnecting and switching devices.....	30
20	5.4 Devices for removal of power for prevention of unexpected start-up.....	37
21	5.5 Devices for isolating electrical equipment.....	37
22	5.6 Protection against unauthorized, inadvertent and/or mistaken connection.....	38
23	6 Protection against electric shock.....	38
24	6.1 General.....	38
25	6.2 Basic protection.....	38
26	6.3 Fault protection.....	40
27	6.4 Protection by the use of PELV.....	42
28	7 Protection of equipment.....	42
29	7.1 General.....	42
30	7.2 Overcurrent protection.....	43
31	7.3 Protection of motors against overheating.....	45
32	7.4 Protection against abnormal temperature.....	46
33	7.5 Protection against the effects of supply interruption or voltage reduction and	
34	subsequent restoration.....	46
35	7.6 Motor overspeed protection.....	46
36	7.7 Additional earth fault/residual current protection.....	46
37	7.8 Phase sequence protection.....	47
38	7.9 Protection against overvoltages due to lightning and to switching surges.....	47
39	7.10 Short-circuit current rating.....	47
40	8 Equipotential bonding.....	47
41	8.1 General.....	47
42	8.2 Protective bonding circuit.....	50
43	8.3 Functional bonding.....	53
44	8.4 Measures to restrict the effects of high leakage current.....	53
45	9 Control circuits and control functions.....	53
46	9.1 Control circuits.....	53
47	9.2 Control functions.....	54

48	9.3	Protective interlocks.....	58
49	9.4	Control functions in the event of failure	59
50	10	Operator interface and hoisting machine mounted control devices.....	67
51	10.1	General.....	67
52	10.2	Actuators	68
53	10.3	Indicator lights, displays and audible devices	70
54	10.4	Illuminated push-buttons	71
55	10.5	Rotary control devices.....	71
56	10.6	Start devices	71
57	10.7	Emergency stop devices.....	71
58	10.8	Emergency switching off devices.....	72
59	10.9	Enabling control device.....	72
60	11	Controlgear: location, mounting, and enclosures	73
61	11.1	General requirements	73
62	11.2	Location and mounting.....	73
63	11.3	Degrees of protection	74
64	11.4	Enclosures, doors and openings	75
65	11.5	Access to switchgear and to controlgear	76
66	12	Conductors and cables.....	76
67	12.1	General requirements	76
68	12.2	Conductors	77
69	12.3	Insulation.....	78
70	12.4	Current-carrying capacity in normal service	78
71	12.5	Conductor and cable voltage drop.....	79
72	12.6	Flexible cables.....	79
73	12.7	Conductor wires, conductor bars and slip-ring assemblies	80
74	13	Wiring practices	83
75	13.1	Connections and routing	83
76	13.2	Identification of conductors.....	85
77	13.3	Wiring inside enclosures.....	86
78	13.4	Wiring outside enclosures	87
79	13.5	Ducts, connection boxes and other boxes	89
80	14	Electric motors and associated equipment	91
81	14.1	General requirements	91
82	14.2	Motor enclosures	91
83	14.3	Motor dimensions.....	91
84	14.4	Motor mounting and compartments	91
85	14.5	Criteria for motor selection	92
86	14.6	Protective devices for mechanical brakes	92
87	14.7	Electrically operated mechanical brakes	92
88	15	Socket-outlets and lighting	92
89	15.1	Socket-outlets for accessories	92
90	15.2	Local lighting of the hoisting machine and of the equipment.....	93
91	16	Marking, warning signs and reference designations.....	94
92	16.1	General.....	94
93	16.2	Warning signs	94
94	16.3	Functional identification.....	94

95	16.4	Marking of enclosures of electrical equipment.....	95
96	16.5	Reference designations.....	95
97	17	Technical documentation	95
98	17.1	General	95
99	17.2	Information related to the electrical equipment.....	95
100	18	Verification	97
101	18.1	General	97
102	18.2	Verification of conditions for protection by automatic disconnection of supply	97
103	18.3	Insulation resistance tests	100
104	18.4	Voltage tests.....	101
105	18.5	Protection against residual voltages	101
106	18.6	Functional tests	101
107	18.7	Retesting.....	101
108	Annex A (normative)	Fault protection by automatic disconnection of supply.....	102
109	A.1	Fault protection for machines supplied from TN-systems.....	102
110	A.2	Fault protection for machines supplied from TT-systems	105
111	Annex B (informative)	Inquiry form for the electrical equipment of hoisting machines	109
112	Annex C (informative)	Current-carrying capacity and overcurrent protection of conductors and	
113		cables in the electrical equipment of machines	112
114	C.1	General operating conditions	112
115	C.2	Co-ordination between conductors and protective devices providing overload	
116		protection	114
117	C.3	Overcurrent protection of conductors	116
118	Annex D (informative)	Conductor selection for intermittent duty	117
119	D.1	General	117
120	D.2	Intermittent duty with 10-min cycle.....	117
121	D.3	Intermittent duty with any cycle time	118
122	D.4	Calculation of thermal equivalent current.....	119
123	Annex E (informative)	Explanation of emergency operation functions.....	121
124	Annex F (informative)	Comparison of typical conductor cross-sectional areas.....	122
125	Annex G (informative)	Measures to reduce the effects of electromagnetic influences	124
126	G.1	Definitions.....	124
127	G.2	General	124
128	G.3	Mitigation of electromagnetic interference (EMI)	125
129	G.4	Separation and segregation of cables	126
130	G.5	Power supply of a machine by parallel sources	129
131	G.6	Supply impedance where a Power Drive System (PDS) is used.....	129
132	G.7	Emission levels for electrical equipment for PDS	129
133	G.8	Conducted disturbances.....	131
134	G.9	Immunity requirements - Enclosure ports	131
135	Annex H (informative)	Documentation / Information.....	133
136	Bibliography.....		135
137	Index		137
138			
139	Figure 1 – Block diagram of combined working cranes in a typical material handling system in		
140	a seaport.....		11
141	Figure 2 – Block diagram of a typical crane and its associated electrical equipment.....		12

142	Figure 3 – Examples of electrical supply systems	32
143	Figure 4 – Disconnecter isolator	34
144	Figure 5 – Disconnecting circuit breaker.....	34
145	Figure 6 – Example of equipotential bonding for electrical equipment of a hoisting machine	49
146	Figure 7 – Symbol IEC 60417-5019: Protective earth	52
147	Figure 8 – Symbol IEC 60417-5020: Frame or chassis.....	53
148	Figure 9 – Method a) earthed control circuit fed by a transformer.....	62
149	Figure 10 – Method b1) Non-earthed control circuit fed by transformer	62
150	Figure 11 – Method b2) Non-earthed control circuit fed by transformer	63
151	Figure 12 – Method b3) Non-earthed control circuit fed by transformer	63
152	Figure 13 – Method c) Control circuits fed by transformer with an earthed centre-tap winding	64
153	Figure 14 – Method d1a) Control circuit without transformer connected between a phase and	
154	the neutral of an earthed supply system	65
155	Figure 15 – Method d1b) control circuit without transformer connected between two phases of	
156	an earthed supply system	65
157	Figure 16 – Method d2a) Control circuit without transformer connected between phase and	
158	neutral of a non-earthed supply system	66
159	Figure 17 – Method d2b) control circuit without transformer connected between two phases of	
160	a non-earthed supply system	66
161	Figure 18 – Limit of arm's reach in cases where the distance from the middle of the hoisting	
162	device-rail to the edge of the girder is less than 300 mm	81
163	Figure 19 – Limit of arm's reach in cases where the distance from the middle of the hoisting	
164	device-rail to the edge of the girder is at least 300 mm.....	81
165	Figure 20 – Limit of arm's reach in cases of using additional obstacles	82
166	Figure 21– Symbol IEC 60417-5019	85
167	Figure 22 – Symbol IEC 60417-5021	86
168	Figure 23 – Symbol ISO 7010-W012	94
169	Figure 24 – Symbol ISO 7010-W017	94
170	Figure A.1 – Typical arrangement for fault loop impedance (Z_S) measurement in TN systems.....	104
171	Figure A.2 – Typical arrangement for fault loop impedance (Z_S) measurement for power drive	
172	system circuits in TN systems	105
173	Figure A.3 – Typical arrangement for fault loop impedance (Z_S) measurement in TT systems	108
174	Figure A.4 – Typical arrangement for fault loop impedance (Z_S) measurement for Power Drive	
175	System circuits in TT systems	108
176	Figure C.1 – Methods of conductor and cable installation independent of number of	
177	conductors/cables	113
178	Figure C.2 – Parameters of conductors and protective devices	115
179	Figure D.1 – An example of current and time of the segments of the operating cycle of a	
180	variable speed AC hoist drive.....	119
181	Figure G.1 – By-pass conductor for screen reinforcement.....	126
182	Figure G.2 – Examples of vertical separation and segregation	127
183	Figure G.3 – Examples of horizontal separation and segregation	128
184	Figure G.4 – Cable arrangements in metal cable trays	128
185	Figure G.5 – Connections between metal cable trays or cable trunking systems	129
186	Figure G.6 – Interruption of metal cable trays at fire barriers	129

187		
188	Table 1 - Minimum cross-sectional area of the external protective copper conductor	30
189	Table 2 – Symbols for actuators (Power)	69
190	Table 3 – Symbols for actuators (Machine operation).....	70
191	Table 4 – Colours for indicator lights and their meanings with respect to the condition of the	
192	hoisting machine.....	70
193	Table 5 – Minimum cross-sectional areas of copper conductors.....	77
194	Table 6 – Classification of conductors.....	77
195	Table 7 – Examples of current-carrying capacity (I_Z) of PVC-insulated copper conductors or	
196	cables under steady-state conditions in an ambient air temperature of +40 °C for different	
197	methods of installation	78
198	Table 8 – Derating factors for cables wound on drums.....	80
199	Table 9 – Minimum permitted bending radii for the forced guiding of flexible cables.....	88
200	Table 10 – Application of the test methods for TN-systems	99
201	Table 11 – Examples of maximum cable length from each protective device to its load	100
202	Table A.1 – Maximum disconnecting times for TN systems	102
203	Table A.2 – Maximum disconnecting time for TT-systems	106
204	Table C.1 – Correction factors.....	112
205	Table C.2 – Derating factors from I_Z for grouping	114
206	Table C.3 – Derating factors from I_Z for multi-core cables up to 10 mm ²	114
207	Table C.4 – Maximum allowable conductor temperatures under normal and short-circuit	
208	conditions	116
209	Table D.1 – Correction factor for 10 min cycle	118
210	Table D.2 – Thermal time constant of conductors.....	118
211	Table F.1 – Comparison of conductor sizes	122
212	Table G.1 – Minimum separation distances using metallic containment as illustrated in Figure	
213	G.2.....	127
214	Table G.7.1 Limits for the interference voltage for the environments / categories.....	129
215	Table G.7.2 Limits for propagated electromagnetic disturbance.....	130
216	Table G.8.1 Limits for conducted disturbances.....	131
217	Table G.9.1 Immunity requirements - enclosure ports	132
218	Table H.1 – Documentation / Information that can be applicable.....	133
219		
220		

INTERNATIONAL ELECTROTECHNICAL COMMISSION

SAFETY OF MACHINERY –
ELECTRICAL EQUIPMENT OF MACHINES –

Part 32: Requirements for hoisting machines

FOREWORD

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International Standard IEC 60204-32 has been prepared by IEC technical committee 44: Safety of machinery – Electrotechnical aspects.

This third edition cancels and replaces the second edition published in 2008 and constitutes a technical revision.

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

- a) alignment to the IEC 60204-1 6th edition (2016) especially for:
 - requirements for earthing and bonding;
 - requirements for circuit protection;
 - consideration of use of Power Drive Systems;
 - protective bonding requirements and terminology;
 - requirements pertaining to safe torque off for PDS, emergency stop, and control circuit protection;
 - symbols for actuators of control devices;

- 273 b) reference for high voltage electrical equipment
 274 c) Cableless Control System requirements
 275 d) EMC requirements
 276 e) technical documentation requirements;
 277 f) general updating to current special national conditions, normative standards, and
 278 bibliographical references.

279

280 The text of this standard is based on the following documents:

FDIS	Report on voting
44/XX/FDIS	44/XX/RVD

281

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

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

285 The following differing practices of a less permanent nature exist in the countries indicated below:

286 4.3.1: The voltage characteristics of electricity supplied by public distribution systems in
 287 Europe are given in EN 50160:2010.
 288

289 5.1: Exception is not allowed (USA).

290 5.1: TN-C systems are not permitted in low-voltage installations in buildings (Norway)

291 5.2: Terminals for the connection of the protective earthing conductors may be identified by
 292 the colour green, the letters “G” or “GR” or “GRD” or “GND”, or the word “ground” or
 293 “grounding”, or with the graphical symbol IEC 60417 519 (DB: 2002-10) or any
 294 combination (USA).
 295

296 6.3.3 b),
 297 13.4.5 b),

298 18.2.1: TT power systems are not allowed (USA).
 299

300 6.3.3,
 301 18.2,

302 Annex A: TN systems are not used. TT systems are the national standard (Japan)
 303

304 6.3.3 b) The use of residual current protective devices with a rated residual operating
 305 current not exceeding 1 A is mandatory in TT systems as a means for fault
 306 protection by automatic disconnection of supply (Italy).
 307

308 7.2.3: Disconnection of the neutral conductor is mandatory in a TN-S system (France
 309 and Norway).
 310

311 7.2.3: Third paragraph: distribution of a neutral conductor with an IT system is not
 312 allowed (USA and Norway).
 313

314 7.10: For evaluation of short circuit ratings the requirements of UL 508A Supplement
 315 SB, may be used (USA).
 316

317 8.2.2: See IEC 60364-5-54:2011, Annex E List of notes concerning certain countries.
 318 Maximum nominal AC control circuit voltage is 120 V (USA).
 319

320

321

322

9.1.2: Only stranded conductors are allowed on machines, except for 0,2 mm² solid

323		conductors within enclosures (USA).
324		
325	12.2:	The smallest power circuit conductor allowed on machines is 0,82 mm ² (AWG 18)
326		
327	Table 5:	Cross-sectional area is specified in NFPA 79 using American Wire Gauge (AWG)
328		(USA). See Annex G.
329		
330	13.2.2:	For the protective conductor, the colour identification GREEN (with or without
331		YELLOW stripes) is used as equivalent to the bicolour combination GREEN-AND
332		YELLOW (USA and Canada).
333		
334	13.2.3:	The colour identification WHITE or GREY is used for earthed neutral conductors
335		instead of the colour identification BLUE (USA and Canada).
336		
337	15.2.2:	First paragraph: Maximum value between conductors 150 V (USA).
338		
339	15.2.2:	Second paragraph, 5th bullet: The full load current rating of lighting circuits does
340		not exceed 15 A (USA).
341		
342	16.4:	Nameplate marking requirements (USA).
343		
344	A.2.2.2:	The permissible maximum value of R_A is regulated (e.g. when $U_0 > 300\text{V}$, R_A
345		shall be less than $10 \square\square$, when $U_0 < 300\text{ V}$, R_A shall be less than $100 \square$, U_0 is the
346		nominal AC line to earth voltage in volts (V) (Japan).
347		
348	A.2.2.2:	The maximum permissible value of R_A is $83 \square$ (Netherlands)
349		

350 The committee has decided that the contents of this publication will remain unchanged until the
 351 maintenance result date¹ indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related
 352 to the specific publication. At this date, the publication will be

- 353 - reconfirmed,
- 354 - withdrawn,
- 355 - replaced by a revised edition, or
- 356 - amended.

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¹ The National Committees are requested to note that for this publication the maintenance result date is 2021.

366

367

INTRODUCTION

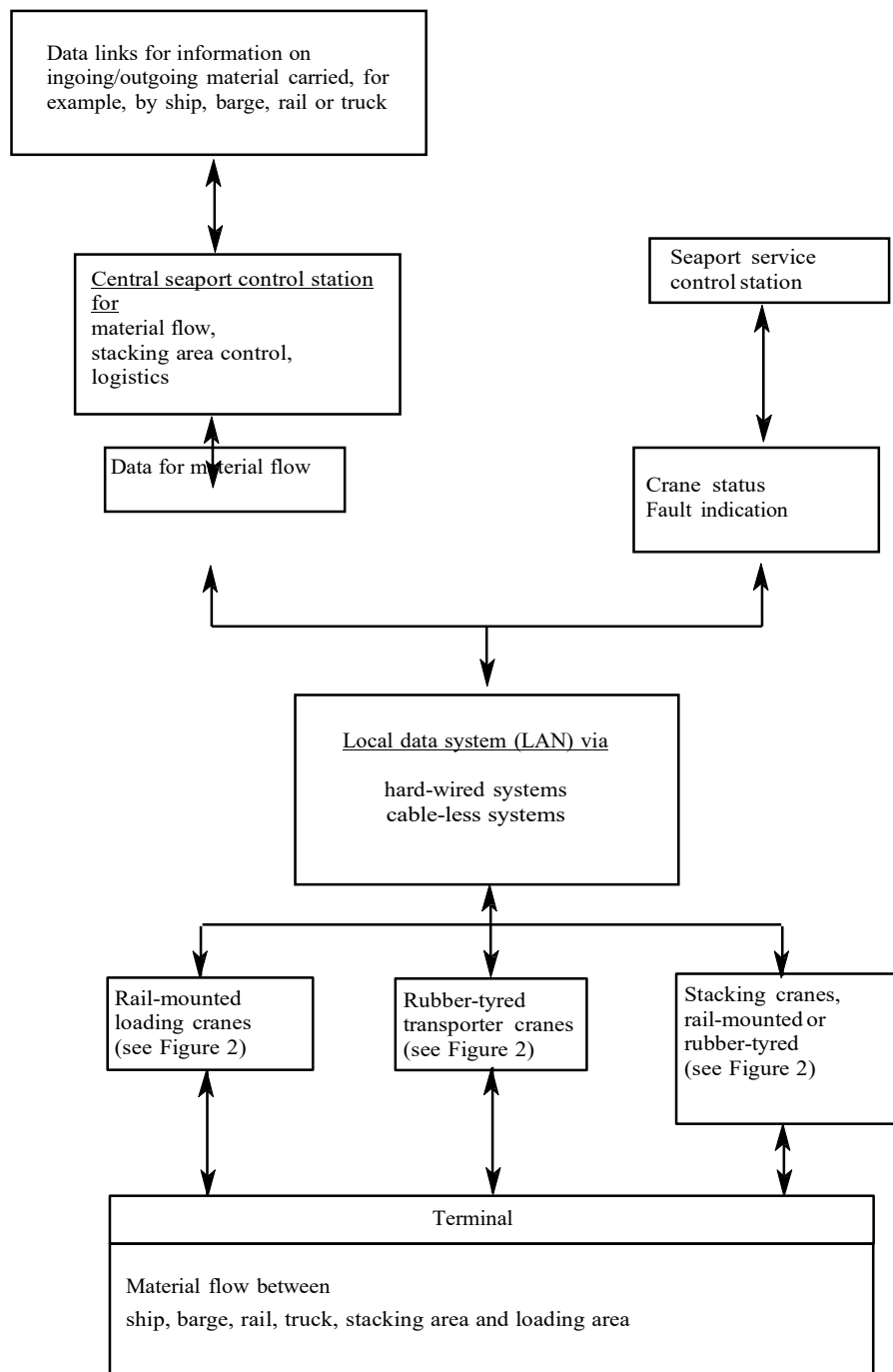
368 This part of IEC 60204 provides requirements and recommendations relating to the electrical equipment
369 of hoisting machines so as to promote

- 370 - safety of persons and property;
- 371 - consistency of control response;
- 372 - ease of operation and maintenance.

373 High performance is not to be obtained at the expense of the essential factors mentioned above.

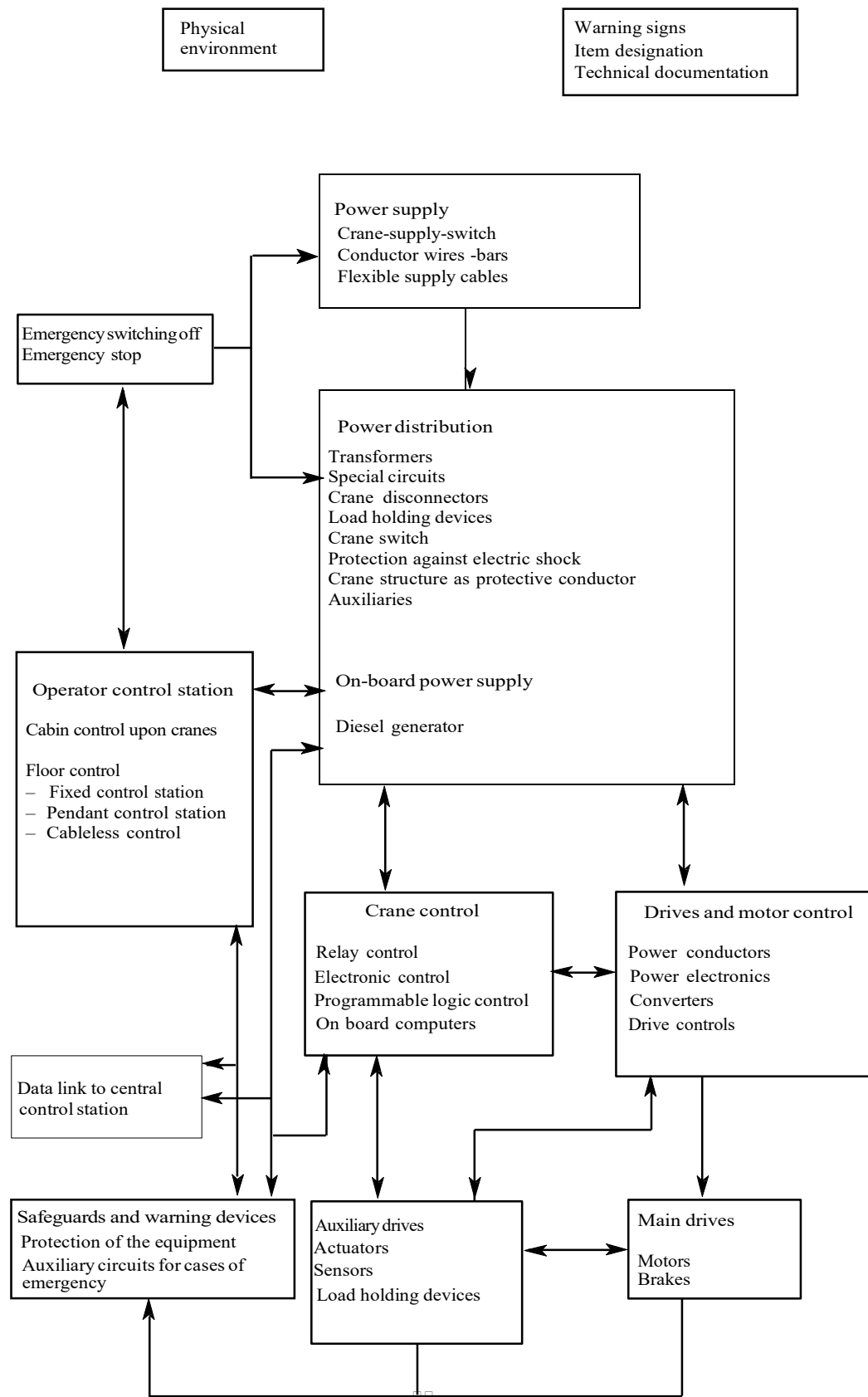
374 Figures 1 and 2 have been provided as an aid to understanding the interrelationship of the various
375 elements of a hoisting machine and its associated equipment. Figure 1 is an overall block diagram of a
376 typical material handling system (a group of cranes working together in a coordinated manner) and
377 Figure 2 is a block diagram of a typical crane and associated equipment showing the various elements
378 of the electrical equipment addressed in this standard.

379



IEC 1310/98

Figure 1 – Block diagram of combined working cranes in a typical material handling system in a seaport



IEC 1 311/98

Figure 2 – Block diagram of a typical crane and its associated electrical equipment

SAFETY OF MACHINERY – ELECTRICAL EQUIPMENT OF MACHINES –

Part 32: Requirements for hoisting machines

1 Scope

This part of IEC 60204 applies to electrical, electronic, programmable electronic equipment and systems to hoisting machines and related equipment, including a group of hoisting machines working together in a co-ordinated manner

NOTE 1 In this part of IEC 60204, the term “electrical” includes both electrical and electronic matters (i.e. “electrical equipment” means both the electrical, electronic and programmable electronic equipment).

NOTE 2 In the context of this part of IEC 60204, the term “person” refers to any individual and includes those persons who are assigned and instructed by the user or user’s agent(s) in the use and care of the hoisting machine in question.

The equipment covered by this part of IEC 60204 commences at the point of connection of the supply to the electrical equipment of the hoisting machine (crane-supply-switch) and includes systems for power supply and control feeders situated outside of the hoisting machine, for example, flexible cables or conductor wires or conductor bars (see Figure 3).

NOTE 3 The requirements for the electrical supply installation of electrical equipment of a hoisting machine are given in IEC 60364.

This standard is applicable to equipment or parts of equipment not exceeding 1 000 V AC or 1 500 V DC between lines and with nominal frequencies not exceeding 200 Hz.

Special requirements for electrical equipment of hoisting machines intended to be operated at higher voltages, see IEC 60204-11 (Annex D)

This part of IEC60204 does not cover all the requirements (for example guarding, interlocking, or control) that are needed or required by other standards or regulations in order to protect persons from hazards other than electrical hazards. Each type of hoisting machine has unique requirements to be accommodated to provide adequate safety. This part of 60204 doesn’t cover noise risks and vibration risks.

Additional and special requirements can apply to the electrical equipment of hoisting machines including those that

- handle or transport potentially explosive material (e.g. paint or sawdust);
- are intended for use in potentially explosive and/or flammable atmospheres;
- have special risks when transporting or moving certain materials
- are intended for use in mines.

For the purposes of this standard, hoisting machines include cranes of all types, winches of all types, and storage and retrieval machines. The following product groups are included:

- overhead travelling cranes;
- mobile cranes;
- tower cranes;
- slewing luffing cranes;
- gantry cranes;
- offshore cranes;
- floating cranes;
- winches of all types;
- hoists and accessories;
- loader cranes;

- 433 - cable cranes;
- 434 - load holding devices;
- 435 - storage and retrieval machines;
- 436 - monorail hoists;
- 437 - straddle carriers;
- 438 - rubber tyred gantry cranes (RTGs).

439 NOTE 5 Definition of the different crane types see ISO 4306-1

440 This standard does not cover individual items of electrical equipment other than their selection for use
441 and their erection.

442 2 Normative references

443 The following referenced documents are indispensable for the application of this document. For dated
444 references, only the edition cited applies. For undated references, the latest edition of the referenced
445 document (including any amendments) applies.

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454 Coding principles for indicators and actuators

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461 against overcurrent

462 IEC 60364-5-52:2009, Electrical installations of buildings – Part 5-52: Selection and erection of electrical
463 equipment – Wiring systems

464 IEC 60364-5-53:2015, Electrical installations of buildings – Part 5-53: Selection and erection of electrical
465 equipment – Isolation, switching and control

466 IEC 60364-5-54:2011, Electrical installations of buildings – Part 5-54: Selection and erection of electrical
467 equipment – Earthing arrangements, protective conductors and protective bonding conductors

468 IEC 60364-6:2016, Low-voltage electrical installations – Part 6: Verification

469 IEC 60417:2002, Graphical symbols for use on equipment

470 IEC 60445:2017, Basic and safety principles for man-machine interface, marking and identification –
471 Identification of equipment terminals and conductor terminations

472 IEC 60447:2004, Basic and safety principles for man-machine interface, marking and identification –
473 Actuating principles

- 474 IEC 60529:1989+AMD1:1999+AMD2:2013, Degrees of protection provided by enclosures (IP Code)
- 475 IEC 60664-1:2007, Insulation co-ordination for equipment within low-voltage systems – Part 1:
476 Principles, requirements and tests
- 477 IEC 60755:2017, General safety requirements for residual current operated protective devices
- 478 IEC 60947-1:2007+AMD1:2010+AMD2:2014, Low-voltage switchgear and controlgear – Part 1: General
479 rules
- 480 IEC 60947-2:2016, Low-voltage switchgear and controlgear – Part 2: Circuit-breakers
- 481 IEC 60947-3:2008+AMD1:2012+AMD2:2015, Low-voltage switchgear and controlgear – Part 3:
482 Switches, disconnectors, switch-disconnectors, and fuse-combination units
- 483 IEC 60947-4-1:2018, Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor –
484 starters – Electromechanical contactors and motor-starters
- 485 IEC 60947-5-1:2016, Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and
486 switching elements – Electromechanical control circuit devices
- 487 IEC 60947-5-5:1997+AMD1:2005+AMD2:2016, Low-voltage switchgear and controlgear - Part 5-5:
488 Control circuit devices and switching elements - Electrical emergency stop device with mechanical
489 latching function
- 490 IEC 60947-6-2:2002+AMD1:2007, Low-voltage switchgear and controlgear - Part 6-2: Multiple function
491 equipment - Control and protective switching devices (or equipment) (CPS)
- 492 IEC 61140:2016, Protection against electric shock – Common aspects for installation and equipment
- 493 IEC 61204-7:2016, Low-voltage switch mode power supplies - Part 7: Safety requirements
- 494 IEC 61310 (all parts), Safety of machinery – Indication, marking and actuation
- 495 IEC 61439-1:2011, Low-voltage switchgear and controlgear assemblies - Part 1: General rules
- 496 IEC 61557-3:2007, Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V
497 DC – Equipment for testing, measuring or monitoring of protective measures – Part 3: Loop impedance
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499 DC – Equipment for testing, measuring or monitoring of protective measures – Part 9: Equipment for
500 insulation fault detection in IT systems
- 501 IEC 61558-1:2017, Safety of power transformers, power supplies, reactors and similar products – Part
502 1: General requirements and tests
- 503 IEC 61558-2-2:2007, Safety of power transformers, power supplies, reactors and similar products - Part
504 2-2: Particular requirements and tests for control transformers and power supplies incorporating control
505 transformers
- 506 IEC 61558-2-6:2009, Safety of power transformers, power supply units and similar – Part 2-6: Particular
507 requirements for safety isolating transformers for general use
- 508 IEC 61558-2-16:2009+AMD1:2013, Safety of transformers, reactors, power supply units and similar
509 products for supply voltages up to 1 100 V - Part 2-16: Particular requirements and tests for switch mode
510 power supply units and transformers for switch mode power supply units
- 511 IEC 61800-3:2017, Adjustable speed electrical power drive systems - Part 3: EMC requirements and
512 specific test methods
- 513 IEC 61800-5-2:2017, Adjustable speed electrical power drive systems. - Part 5: Safety requirements.
514 Functional

- 515 IEC 61984:2008, Connectors – Safety requirements and tests
- 516 IEC 62020-1:2018 Electrical accessories - Residual current monitors for household and similar uses
517 (RCMs)
- 518 IEC 62023:2011, Structuring of technical information and documentation
- 519 IEC 62061:2005+AMD1:2012+AMD2:2015, Safety of machinery – Functional safety of safety-related
520 electrical, electronic and programmable electronic control systems
- 521 IEC 62745:2017, Safety of machinery - Requirements for cableless control systems of machinery
- 522 ISO 7000:2014, Graphical symbols for use on equipment – Index and synopsis
- 523 ISO 12100:2010, Safety of machinery — General principles for design — Risk assessment and risk
524 reduction
- 525 ISO 13849-1:2015, Safety of machinery – Safety-related parts of control systems – Part 1: General
526 principles for design
- 527 ISO 13849-2:2012, Safety of machinery – Safety-related parts of control systems – Part 2: Validation
- 528 ISO 13850:2015, Safety of machinery – Emergency stop – Principles for design
- 529 ISO 13851:2002, Safety of machinery – Two-hand control devices – Functional aspects and design
530 principles
- 531 ISO 13857:2008, Safety of machinery – Safety distances to prevent danger zones being reached by the
532 upper limbs

533

534 3 Terms and definitions

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

536 3.1

537 actuator

538 part of a device to which an external action is to be applied

539 NOTE 1 The actuator may take the form of a handle, knob, push-button, roller, plunger, etc.

540 NOTE 2 There are some actuating means that do not require an external actuating force but only an action, for example,
541 touchscreens.

542 NOTE 3 See also 3.46.

543 3.2

544 ambient temperature

545 temperature of the air or other medium where the equipment is to be used

546 3.3

547 barrier

548 part providing protection against contact with live parts from any usual direction of access

549 [IEV 826-12-23]

550 3.4

551 cabin-controlled hoisting machine

552 hoisting machine operated from a cabin permanently attached to the hoisting machine

553 3.5

554 cable tray

555 cable support consisting of a continuous base with raised edges and no covering

556 NOTE A cable tray may be perforated or non-perforated.

- 557 [IEV 826-15-08]
- 558 3.6
- 559 cable trunking system
- 560 system of closed enclosures comprising a base with a removable cover intended for the complete
- 561 surrounding of insulated conductors, cables, cords and for the accommodation of other electrical
- 562 equipment
- 563 3.7
- 564 concurrent
- 565 acting in conjunction; used to describe a situation wherein two or more control devices exist in an
- 566 actuated condition at the same time (but not necessarily synchronously)
- 567 3.8
- 568 conduit
- 569 part of a closed wiring system of generally circular cross-section for insulated conductors and/or cables
- 570 in electrical or communication installations, allowing them to be drawn in and/or replaced
- 571 NOTE Conduits should be sufficiently close-jointed so that the insulated conductors and/or cables can only be drawn in and not
- 572 inserted laterally.
- 573 [IEV 826-15-03]
- 574 3.9
- 575 control circuit (of a hoisting machine)
- 576 circuit used for the control, including monitoring, of a hoisting machine and the electrical equipment
- 577 3.10
- 578 control device
- 579 device connected into the control circuit and used for controlling the operation of the hoisting machine
- 580 (e.g. position sensor, manual control switch, relay, magnetically operated valve, speed sensor)
- 581 3.11
- 582 controlgear
- 583 switching devices and their combination with associated control, measuring, protective, and regulating
- 584 equipment, also assemblies of such devices and equipment with associated interconnections,
- 585 accessories, enclosures, and supporting structures, intended in principle for the control of electrical
- 586 energy consuming equipment
- 587 [IEV 441-11-03, modified]
- 588 3.12
- 589 control station
- 590 operator control station
- 591 assembly of one or more control actuators (see 3.1) fixed on the same panel or located in the same
- 592 enclosure
- 593 NOTE: A control station may also contain related equipment, for example, potentiometers, signal lamps, instruments, display
- 594 devices, etc.
- 595 3.13
- 596 controlled stop
- 597 stopping of a hoisting machine motion with electrical power to the machine actuators maintained during
- 598 the stopping process
- 599 3.14
- 600 crane
- 601 machine for hoisting/lowering and horizontally relocating suspended loads
- 602 3.15
- 603 crane-disconnector
- 604 disconnecting device installed on a hoisting machine for disconnecting (isolating) a supply circuit (e.g.
- 605 for repair or maintenance work)

- 606 3.16
607 crane-supply-switch
608 disconnecting (isolating) and switching device used to disconnect the hoisting machine from the
609 incoming supply
- 610 3.17
611 crane-switch
612 switching device designed to break the electrical power supply to the connected drives (e.g. for use in
613 cases of emergency stop)
- 614 3.18
615 (continuous) current-carrying capacity
616 ampacity (US)
- 617 maximum value of electric current which can be carried continuously by a conductor or an apparatus,
618 under specified conditions without its steady-state temperature exceeding a specified value
- 619 [IEV 826-11-13]
- 620 3.19
621 direct contact
622 contact of persons or livestock with live parts
- 623 [IEV 826-12-03] [SOURCE: IEC 60050-826:2004,826-12-03, modified]
- 624 3.20
625 direct opening action (of a contact element)
626 achievement of contact separation as the direct result of a specified movement of the switch actuator
627 through non-resilient members (e.g. not dependent upon springs)
- 628 [IEC 60947-5-1, K.2.2]
- 629 3.21
630 disconnecting device
631 device which provides, in the open position, an isolating distance in accordance with specified
632 requirements
- 633 3.22
634 duct
635 enclosed channel designed expressly for holding and protecting electrical conductors, cables, and
636 busbars
- 637 NOTE Conduits (see 3.8), cable trunking systems (see 3.6) and underfloor channels are types of duct.
- 638
- 639 3.23
640 electrical operating area
641 room or location for electrical equipment to which access is intended to be restricted to skilled or
642 instructed persons, by the opening of a door or the removal of a barrier without the use of a key or tool
643 and which is clearly marked by appropriate warning signs
- 644 3.24
645 electronic equipment
646 part of the electrical equipment containing circuitry dependent for its operation on electronic devices and
647 components
- 648 3.25
649 emergency stop device
650 manually actuated control device used to initiate an emergency stop function
- 651 [ISO 13850:2015, 3.2]
- 652 NOTE See Annex E.

- 653 3.26
654 emergency switching-off device
655 manually actuated control device used to switch off or to initiate the switching off of the supply of
656 electrical energy to all or a part of an installation where a risk of electric shock or another risk of electrical
657 origin is involved
- 658 NOTE See Annex E.
- 659 3.27
660 enclosed electrical operating area
661 room or location for electrical equipment to which access is intended to be restricted to skilled or
662 instructed persons by the use of a key or tool to open a door or remove a barrier, and which is clearly
663 marked by appropriate warning signs
- 664 3.28
665 enclosure
666 part providing protection of equipment against certain external influences and, in any direction, basic
667 protection as protection against direct contact
- 668 NOTE The definition taken from the existing IECV needs the following explanations within the scope of this standard.
- 669 a) Enclosures provide protection of persons or livestock against access to hazardous parts.
- 670 b) Barriers, shaped openings, or any other means suitable to prevent or limit the penetration of the specified test probes,
671 whether attached to the enclosure or formed by the enclosed equipment, are considered as part of the enclosure, except
672 where they can be removed without the use of a key or tool.
- 673 c) An enclosure may be
674 – a cabinet or box, either mounted on the hoisting machine or separate from the hoisting machine;
675 – a compartment consisting of an enclosed space within the hoisting machine structure (e.g. box girder).
- 676 3.29
677 Electrical equipment
678 items used in connection with the utilisation of electricity by machines or parts of machines, for example
679 material, fittings, devices, components, appliances, fixtures, apparatus, and similar
- 680 3.30
681 equipotential bonding
682 provision of electric connections between conductive parts, intended to achieve equipotentiality
- 683 [IEV 195-1-10]
- 684 3.31
685 exposed conductive part
686 conductive part of electrical equipment, which can be touched and which is not live under normal
687 operating conditions, but which can become live under fault conditions
- 688 [SOURCE: IEC 60050-826:2004, 826-12-10]
- 689 3.32
690 extraneous conductive part
691 conductive part not forming part of the electrical installation and liable to introduce an electric potential,
692 generally the earth potential of a local earth
- 693 [SOURCE: IEC 60050-195:1998, 195-06-11]
- 694 3.33
695 failure
696 termination of the ability of an item to perform a required function
- 697 NOTE 1 After failure the item has a fault.
- 698 NOTE 2 "Failure" is an event, as distinguished from "fault", which is a state.
- 699 NOTE 3 This concept as defined does not apply to items consisting of software only.
- 700 NOTE 4 In practice the terms "fault" and "failure" are often used synonymously.

701 [SOURCE: IEC 60050-191:1990, 191-04-01]

702 3.34

703 fault

704 state of an item characterized by inability to perform a required function, excluding the inability during
705 preventive maintenance or other planned actions, or due to lack of external resources

706 NOTE 1 A fault is often the result of a failure of the item itself, but may exist without prior failure.

707 NOTE 2 In English the term “fault” and its definition are identical with those given in IEV 191-05-01. In the field of machinery,
708 the French term “défaut” and the German term “Fehler” are used rather than the terms “Panne” and “Fehlzustand” that appear
709 with this definition.

710 3.35

711 fault protection

712 protection against electric shock under single-fault conditions

713 NOTE Previously referred to as “protection against indirect contact”

714 [SOURCE: IEC 60050-195:1998, 195-06-02, modified]

715 3.36

716 functional bonding

717 equipotential bonding necessary for proper functioning of electrical equipment

718 3.37

719 guard

720 part of a hoisting machine specifically used to provide protection by means of a physical barrier.
721 Depending on its construction, a guard may be called casing, cover, screen, door, enclosing guard, etc.

722 [ISO 12100:2010, 3.27, modified]

723 3.38

724 hand-held direct-control device

725 manually operated switching device, the enclosure of which is portable by hand during operation, acting
726 direct on a power circuit without a control circuit (See 9.1).

727 3.39

728 hazard

729 potential source of physical injury or damage to health

730 NOTE 1 The term “hazard” can be qualified in order to define its origin (e.g. mechanical hazard, electrical hazard) or the nature
731 of the potential harm (e.g. electric shock hazard, cutting hazard, toxic hazard, fire hazard).

732 NOTE 2 The hazard envisaged in this definition:

733 - either is permanently present during the intended use of the machine (e.g. motion of hazardous moving elements, electric arc
734 during a welding phase, unhealthy posture, noise emission, high temperature);

735 - or can appear unexpectedly (e.g. explosion, crushing hazard as a consequence of an unintended/unexpected start-up,
736 ejection as a consequence of a breakage, fall as a consequence of acceleration/deceleration).

737

738 [SOURCE ISO 12100:2010, 3.6, modified]

739 3.40

740 indirect contact

741 contact of persons or animals with exposed conductive parts which have become live under fault
742 conditions

743 [SOURCE: IEC 60050-826:2004, 826-12-04]

744

745 3.41

746 inductive power supply system

747 system of inductive power transfer, consisting of a track converter and a track conductor, along which
748 one or more pick-up(s) and associated pick-up converter(s) can move, without any galvanic or
749 mechanical contact, in order to transfer electrical power, for example, to a mobile hoisting machine

750 NOTE The track conductor and the pick-up are analogous to the primary and secondary of a transformer respectively.

- 751
752
753 3.42
754 (electrically) instructed person
755 person adequately advised or supervised by electrically skilled persons to enable him or her to perceive
756 risks and to avoid hazards which electricity can create
757 [SOURCE: IEC 826-18-02, modified]
758 3.43
759 interlock
760 arrangement of devices operating together to:
- 761 □ prevent hazardous situations,
 - 762 □ prevent damage to equipment or material,
 - 763 □ prevent specified operations,
 - 764 □ ensure correct operations
- 765 3.44
766 limiting device
767 device which prevents a hoisting machine or a hoisting machine element from exceeding a designed
768 limit (e.g. space limit, pressure limit)
769 [ISO 12100:2010, 3.28.8; modified]
770 3.45
771 live part
772 conductor or conductive part intended to be energized in normal operation, including a neutral
773 conductor, but by convention, not a PEN conductor
774 NOTE This concept does not necessarily imply a risk of electric shock.
775 [IEV 826-12-08]
776 3.46
777 machine actuator
778 power mechanism used to effect motion of the hoisting machine (for example, motor, solenoid,
779 pneumatic or hydraulic cylinder)
780 3.47
781 machinery
782 machine
783 assembly of linked parts or components, at least one of which moves, with the appropriate machine
784 actuators, control and power circuits, joined together for a specific application, in particular for the
785 processing, treatment, moving or packaging of a material.
786 NOTE 1: The term "machinery" also covers an assembly of machines which, in order to achieve the same target, are arranged
787 and controlled so that they function as an integral whole
788 NOTE 2 The term "component" is used here in a general sense and does not refer only to electrical components.
789 [ISO 12100:2010, 3.1, modified]
790 3.48
791 manually controlled hoisting machine
792 hoisting machine with continuous manual control of the load and with the load continuously visible to
793 the operator
794 3.49
795 marking
796 signs or inscriptions primarily for the purpose of identifying equipment, components and/or devices

- 797 3.50
798 neutral conductor N
799
800 conductor electrically connected to the neutral point and capable of contributing to the distribution of
801 electrical energy
- 802 [SOURCE: IEC 60050-195:1998, 195-02-06]
- 803 3.51
804 obstacle
805 part preventing unintentional direct contact with live parts, but not preventing direct contact by deliberate
806 action
- 807 [SOURCE: IEC 60050-195:1998, 195-06-16, modified – The words “(electrically) protective” have been
808 removed]
- 809 3.52
810 overcurrent
811 current exceeding the rated value
- 812 NOTE: For conductors, the rated value is considered as equal to the current-carrying capacity.
- 813 [SOURCE: IEC 60050-826:2004, 826-11-14]
- 814 3.53
815 overload
816 time/current relationship in a circuit which is in excess of the rated full load of the circuit when the circuit
817 is not under a fault condition
- 818 NOTE 1 “Overload” should not be used as a synonym for “overcurrent”.
- 819 NOTE 2 In hoisting machines the term "overload" is also used for mechanical overload, which may or may not cause an electrical
820 overload.
- 821 3.54
822 plug/socket combination
823 component and suitable mating component, appropriate to terminate conductors, intended for
824 connection or disconnection of two or more conductors
- 825 NOTE Examples of plug/socket combination include
- 826 – connectors which fulfil the requirements of IEC 61984;
- 827 – a plug and socket-outlet, a cable coupler, or an appliance coupler in accordance with IEC 60309-1;
- 828 – a plug and socket-outlet in accordance with IEC 60884-1 or an appliance coupler in accordance with IEC 60320-1.
- 829 3.55
830 power circuit
831 circuit that supplies power to units of equipment used for productive operation and to transformers
832 supplying control circuits
- 833 3.56
834 protective bonding
835 equipotential bonding for protection against electric shock
- 836 NOTE Measures for protection against electric shock can also reduce the risk of burns or fire.
- 837 3.57
838 protective bonding circuit
839 protective conductors and conductive parts connected together to provide protection against electric
840 shock in the event of insulation failure
- 841 3.58
842 protective conductor
843 conductor providing a primary fault current path from the exposed conductive parts of the electrical
844 equipment to a protective earthing (PE) terminal

- 845 3.59
846 redundancy
847 application of more than one device or system, or part of a device or system, with the objective of
848 ensuring that in the event of one failing to perform its function, another is available to perform that
849 function
- 850 3.60
851 reference designation
852 distinctive code which serves to identify an object in the documentation and on the equipment
- 853 3.61
854 risk
855 combination of the probability of occurrence of harm (i.e. physical injury or damage to health) and the
856 severity of that harm
- 857 [ISO 12100:2010, 3.12, modified – The text in parentheses has been added]
- 858 3.62
859 safeguard
860 guard or protective device provided as a means to protect persons from a hazard
- 861 3.63
862 safeguarding
863 protective measure using safeguards to protect persons from the hazards which cannot reasonably be
864 eliminated or from the risks which cannot be sufficiently reduced by inherently safe design measures
- 865 [ISO 12100:2010, 3.21]
- 866 3.64
867 safety function
868 function of a machine whose failure can result in an immediate increase of the risk(s)
- 869 [ISO 12100:2010, 3.30/IEC 62061:2005, 3.2.15]
- 870
- 871 3.65
872 servicing level
873 level on which persons stand when operating or maintaining the electrical equipment
- 874 3.66
875 short-circuit current
876 overcurrent resulting from a short circuit due to a fault or an incorrect connection in an electric circuit
- 877 [SOURCE: IEC 60050-441:1984, 441-11-07]
- 878 3.67
879 short-circuit current rating
880 value of prospective short-circuit current that can be withstood by the electrical equipment for the total
881 operating time (clearing time) of the short-circuit protective device (SCPD) under specified conditions
- 882 [SOURCE: IEC 61439-1: 2011, 3.8.9.4, modified – The word “rated” is removed from the term, and the
883 reference to “assembly” removed from the definition]
- 884 3.68
885 (electrically) skilled person
886 person with relevant training, education and experience to enable him or her to perceive risks and to
887 avoid hazards associated with electricity
- 888 [SOURCE: IEC 60050-826:2004, 826-18-01, modified]

3.69
 supplier
 entity (e.g. manufacturer, contractor, installer, integrator) who provides equipment or services
 associated with the hoisting machine

NOTE The user organization may also act in the capacity of a supplier to itself.

3.70
 switching device
 device designed to make and/or break the current in one or more electric circuits

[SOURCE: IEC 60050-441:1984, 441-14-01, modified]

3.71
 terminal
 part of an equipment or a component to which a conductor is attached, providing a re-usable connection

[IEV 442-06-05, modified]

3.72
 uncontrolled stop
 stopping of hoisting machine motion by removing electrical power to the machine actuators

NOTE This definition does not imply any particular state of other (e.g. non-electrical) stopping devices, for example, mechanical or hydraulic brakes that are outside the scope of this standard.

3.73
 user
 entity which utilizes the hoisting machine and its associated electrical equipment

Abbreviated Terms:

AWG	American Wire Gauge
AC	Alternating Current
r.m.s	Root Mean Square
BDM	Basic Drive Module
CCS	Cableless Control System
DC	Direct Current
EMC	Electro-Magnetic Compatibility
EMI	Electro-Magnetic Interference
IPLS	Insulation Fault Location System
PDS	Power Drive System
PELV	Protective Extra-Low Voltage
RCD	Residual Current protective Device
SCPD	Short-Circuit Protective Device
SELV	Safe Extra-Low Voltage
STO	Safe Torque Off

4 General requirements

4.1 General considerations

This standard is intended to apply to electrical equipment used with a wide variety of hoisting machines and with a group of hoisting machines working together in a co-ordinated manner.

The risks associated with the hazards relevant to the electrical equipment shall be assessed as part of the overall requirements for risk assessment of the hoisting machine. This will:

- identify the need for risk reduction; and
- determine adequate risk reductions; and

- 922 - determine the necessary protective measures
 923 for persons who can be exposed to those hazards, while still maintaining an acceptable level of
 924 performance of the hoisting machine and its equipment.
- 925 Hazardous situations can result from, but are not limited to, the following causes:
- 926 - failures or faults in the electrical equipment resulting in the possibility of electric shock or
 927 fire of electrical origin;
 - 928 - failures or faults in control circuits (or components and devices associated with those
 929 circuits) resulting in the malfunctioning of the hoisting machine;
 - 930 - disturbances or disruptions in power sources as well as failures or faults in the power circuits
 931 resulting in the malfunctioning of the hoisting machine;
 - 932 - loss of continuity of circuits
 - 933 - that can result in a failure of a safety function, for example those that depend on sliding or
 934 rolling contacts;
 - 935 - electrical disturbances for example, electromagnetic, electrostatic either from outside the
 936 electrical equipment or internally generated, resulting in the malfunctioning of the hoisting
 937 machine;
 - 938 - release of stored energy (either electrical or mechanical) resulting in, for example, electric
 939 shock, unexpected movement that can cause injury;
 - 940 - acoustic noise and mechanical vibration at levels that cause health problems to persons
 - 941 - surface temperatures that can cause injury.
 - 942 - Safety measures are a combination of the measures incorporated at the design stage and
 943 those measures required to be implemented by the user.
- 944 The design and development process shall identify hazards and the risks arising from them. Where the
 945 hazards cannot be removed and/or those risks that cannot be sufficiently reduced by inherently safe
 946 design measures, protective measures (for example safeguarding) shall be provided to reduce the risk.
 947 Additional means (for example awareness means, flashing beacons, warning notices or signs to raise
 948 of the risks) shall be provided where further risk reduction is necessary. In addition, working procedures
 949 that reduce risk can be necessary.
- 950 It is recommended that, where the user is known, Annex B be used to facilitate an exchange of
 951 information between the user and the supplier(s) on basic conditions and additional user specifications
 952 related to the electrical equipment. Those additional specifications are to:
- 953 - provide additional features that are dependent on the type of hoisting machine (or group of
 954 hoisting machines) and the application;
 - 955 - facilitate maintenance and repair; and
 - 956 - improve the reliability and ease of operation.
- 957 NOTE The use of Annex B may also be useful to determine if a catalogued hoisting machine is suitable for the intended use.
- 958 4.2 Selection of equipment
- 959 4.2.1 General
- 960 Electrical components and devices shall:
- 961 - be suitable for their intended use and
 - 962 - conform to relevant IEC standards where such exist; and
 - 963 - be applied in accordance with the supplier's instructions.
- 964 4.2.2 Selection of power contactors
- 965 The contactors with their associated short circuit protective devices shall have type "2"
 966 coordination in accordance with IEC 60947-4-1:2009, 8.2.5.1.

967 Contactors which perform the stopping function of motion drives, initiated by safety-related control
968 circuits, shall be selected and arranged with other equipment in such a way that contact welding either
969 will not occur or will not prevent the emergency stop function. The supplier's recommendations should
970 be followed (see also 7.2.9).

971 NOTE Contactors directly controlling motions and demanding a great number of contactor operations should have a mechanical
972 life of at least 3 million operating cycles.

973 4.2.3 Electrical equipment in compliance with the IEC 61439 series

974 In addition to the requirements of this part of IEC 60204, depending upon the hoisting machine, its
975 intended use and its electrical equipment, the designer may select parts of the electrical equipment of
976 the hoisting machine that are in compliance with relevant parts of the IEC 61439 series.

977 4.3 Electrical supply

978 4.3.1 General

979 The electrical equipment shall be designed to operate correctly with the conditions of the supply at the
980 point of supply (i.e. at the crane-supply-switch, see Figure 3):

- 981 - as specified in 4.3.2 or 4.3.3; or
- 982 - as otherwise specified by the user (see Annex B); or
- 983 - as specified by the supplier in the case of a special source of supply such as an on-board
984 generator in 4.3.4.

985

- 986 4.3.2 AC supplies
- 987 Voltage Steady-state voltage: 0,9 ... 1,1 of nominal voltage
- 988 NOTE For certain applications (e.g. large container cranes), and by agreement with the user, the voltage range may be reduced
989 to 0,95 ... 1,05 of nominal voltage at the point of supply (i.e. at the crane-supply-switch, see Figure 3).
- 990 Frequency 0,99 ... 1,01 of nominal frequency continuously;
991 0,98 ... 1,02 short time.
- 992 NOTE The short time value may be specified by the user (see Annex B).
- 993 Harmonics Harmonic distortion not to exceed 12 % of the total r.m.s. voltage between live
994 conductors for the sum of the 2nd through to the 30th harmonic.
- 995 Voltage unbalance Neither the voltage of the negative sequence component nor the voltage of the
996 zero-sequence component in three-phase supplies shall exceed 2 % of the positive sequence
997 component.
- 998 Voltage interruption Supply interrupted or at zero voltage for not more than 3 ms at any random time
999 in the supply cycle. There shall be more than 1 s between successive
1000 interruptions.
- 1001 NOTE 1 In some semiconductor converter drives with power feedback, voltage interruptions as short as 3 ms or less can cause
1002 conduction-through and fuse blowing.
- 1003 NOTE 2 The crane-switch can operate very frequently. All the components (e.g. charging circuitries) need to be selected to allow
1004 foreseen switching frequency including the use in commissioning phase.
- 1005 Voltage dips Voltage dips shall not exceed 20 % of the peak voltage of the supply for more
1006 than one cycle. There shall be more than 1 s between successive dips.
- 1007 4.3.3 DC supplies
- 1008 From batteries:
- 1009 Voltage 0,85 ... 1,15 of nominal voltage;
1010 0,7 ... 1,2 of nominal voltage in the case of battery-operated vehicles.
- 1011 Voltage interruption not exceeding 5 ms.
- 1012 From converting equipment:
- 1013 Voltage 0,9 ... 1,1 of nominal voltage.
- 1014 Voltage interruption Not exceeding 20 ms. There shall be more than 1 s between successive
1015 interruptions.
- 1016 Ripple (peak-to-peak) Not exceeding 0,15 of nominal voltage.
- 1017 NOTE This is a variation to IEC Guide 106 to ensure proper operation of electronic equipment.
- 1018
- 1019 4.3.4 Special supply systems
- 1020 For special supply systems (e.g. on-board generators, DC bus, etc.) the limits given in 4.3.2
1021 and 4.3.3 may be exceeded provided that the equipment is designed to operate correctly with
1022 those conditions
1023
- 1024 4.4 Physical environment and operating conditions
- 1025 4.4.1 General
- 1026 The electrical equipment shall be suitable for the physical environment and operating conditions of its
1027 intended use. The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating
1028 conditions of the majority of hoisting machines covered by this part of IEC 60204. When special
1029 conditions apply or the limits specified are exceeded, an agreement between user and supplier (see
1030 4.1) is recommended (see Annex B).

4.4.2 Electromagnetic compatibility (EMC)

The electrical equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended operating environment (see Annex G). In addition, the electrical equipment shall have a sufficient level of immunity to electromagnetic disturbances so that it can function in its intended environment.

Immunity and/or emission tests are required on the electrical equipment unless the following conditions are fulfilled:

- the incorporated devices and components comply with the EMC requirements for the intended EMC environment specified in the relevant product standard (or generic standard where no product standard exists), and;
- the electrical installation and wiring are consistent with the instructions provided by the supplier of the devices and components with regard to mutual influences, (cabling, screening, earthing etc.) or with informative Annex G if such instructions are not available from the supplier.

For electrical equipment of hoisting machines including PDS or part of PDS IEC 61800-3:2017 shall be applied (see Annex G).

NOTE 1 The generic EMC standards IEC 61000-6-1 or IEC 61000-6-2 and IEC 61000-6-3 or IEC 61000-6-4 give general EMC emission and immunity limits.

4.4.3 Ambient air temperature

Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. The minimum requirement for all electrical equipment is correct operation between air temperatures outside of enclosures (cabinet or box) between 0 °C and +40 °C. For very hot environments (e.g. hot climates, steel mills, paper mills) and for cold environments, additional measures are recommended (see Annex B).

4.4.4 Humidity

The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities are permitted at lower temperatures (e.g. 90 % at 20 °C).

Harmful effects of occasional condensation shall be avoided by proper design of the equipment or, where necessary, by additional measures (e.g. built-in heaters, air conditioners, drain holes).

4.4.5 Altitude

Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea-level.

For equipment to be used at higher altitudes, it is necessary to take into account the reduction of:

- the dielectric strength, and;
- the switching capability of the devices, and;
- the cooling effect of the air.

It is recommended that the manufacturer is consulted regarding the correction factors to be used where the factors are not specified in product data.

4.4.6 Contaminants

Electrical equipment shall be adequately protected against the ingress of solids and liquids (see 11.3).

The electrical equipment shall be adequately protected against contaminants (e.g. dust, acids, corrosive gases, salts) that can be present in the physical environment in which the electrical equipment is to be installed (see Annex B).

4.4.7 Ionizing and non-ionizing radiation

When equipment is subject to radiation (e.g. microwave, ultraviolet, lasers, X-rays), additional measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation. A special agreement is recommended between the supplier and the user (see Annex B).

4.4.8 Vibration, shock, and bump

Undesirable effects of vibration, shock and bump (including those generated by the hoisting machine and its associated equipment and those created by the physical environment) shall be avoided by the selection of suitable equipment, by mounting it away from sources of vibration, or by provision of anti-vibration mountings. A special agreement is recommended between the supplier and the user (see Annex B).

4.5 Transportation and storage

Electrical equipment shall be designed to withstand, or suitable precautions shall be taken to protect against, the effects of transportation and storage temperatures within a range of $-25\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$ and for periods not exceeding 24 h at up to $+70\text{ }^{\circ}\text{C}$. Suitable means shall be provided to prevent damage from humidity, vibration, and shock. A special agreement is recommended between the supplier and the user (see Annex B).

NOTE Electrical equipment susceptible to damage at low temperatures includes PVC-insulated cables.

4.6 Provisions for handling

Heavy and bulky electrical equipment that has to be removed from the hoisting machine for transport, or that is independent of the hoisting machine, shall be provided with suitable means for handling, including where necessary means for handling by cranes or similar equipment (see also 13.4.6).

4.7 Installation

Electrical equipment shall be installed in accordance with:

- the electrical equipment supplier's instructions
- Annexes C and D

5 Incoming supply conductor terminations and devices for disconnecting and switching off

5.1 Incoming supply conductor terminations

It is recommended that, where practicable, the electrical equipment of a hoisting machine should be connected to a single power supply. Where it is necessary to use another supply for certain parts of the equipment (e.g. electronic circuits, electromagnetic clutches), that supply should be derived, as far as is possible, from devices (e.g. transformers, converters) forming part of the electrical equipment of the hoisting machine. For large complex hoisting machines, there may be a need for more than one incoming supply (see 5.3.5.1).

Unless a plug is provided with the hoisting machine for the connection to the supply (see 5.3.2e)), it is recommended that the supply conductors are terminated at the crane-supply-switch. When that is not practicable, separate terminations shall be provided.

Where a neutral conductor is used, it shall be clearly indicated in the technical documentation of the hoisting machine, such as in the installation diagram and in the circuit diagram, and a separate insulated terminal, labelled N, shall be provided for the neutral conductor. The neutral terminal may be provided as part of the supply disconnecting device. (see also Annex B).

There shall be no connection between the neutral conductor and the protective bonding circuit inside the electrical equipment, nor shall a combined PEN terminal be used.

Exception: A connection may be made between the neutral terminal and the PE terminal at the point of supply (see Figure 3) to the hoisting machine for TN-C systems provided they are in accordance with 12.7.2.

All terminals for the incoming supply connection shall be clearly identified in accordance with IEC 60445:2017. For the identification of the external protective conductor terminal, see 5.2.

5.2 Terminal for connection to the external protective earthing system

For each incoming supply, a terminal shall be provided in the vicinity of the associated phase conductor terminals (see 8.2.1) for connection of the hoisting machine to the external protective earthing system or to the external protective conductor, depending upon the supply distribution system and in accordance with the relevant installation standards.

NOTE The earthing system could also include measures against lightning or switching surges see 7.9.

The terminal shall be of such a size as to enable the connection of an external protective copper conductor with a cross-sectional area determined in relation to the size of the associated line conductors in accordance with Table 1.

Table 1 - Minimum cross-sectional area of the external protective copper conductor

Cross-sectional area of phase conductors supplying the equipment S mm ²	Minimum cross-sectional area of the external protective copper conductor S_p mm ²
$S \leq 16$	S
$16 < S \leq 35$	16
$S > 35$	$S/2$

Where an external protective conductor of a material other than copper is used, the terminal size shall be selected accordingly (see also 8.2.2).

At each incoming supply point, the terminal for connection of the external protective earthing system or the external protective conductor shall be marked or labelled with the letters PE (see IEC 60445:2017).

5.3 Supply disconnecting and switching devices

5.3.1 General

The functions of supply disconnection and/or switching are performed by the following devices:

- —crane-supply-switch (see 5.3.5);
- —crane-disconnector (see 5.3.6);
- —crane-switch (see 5.3.7).

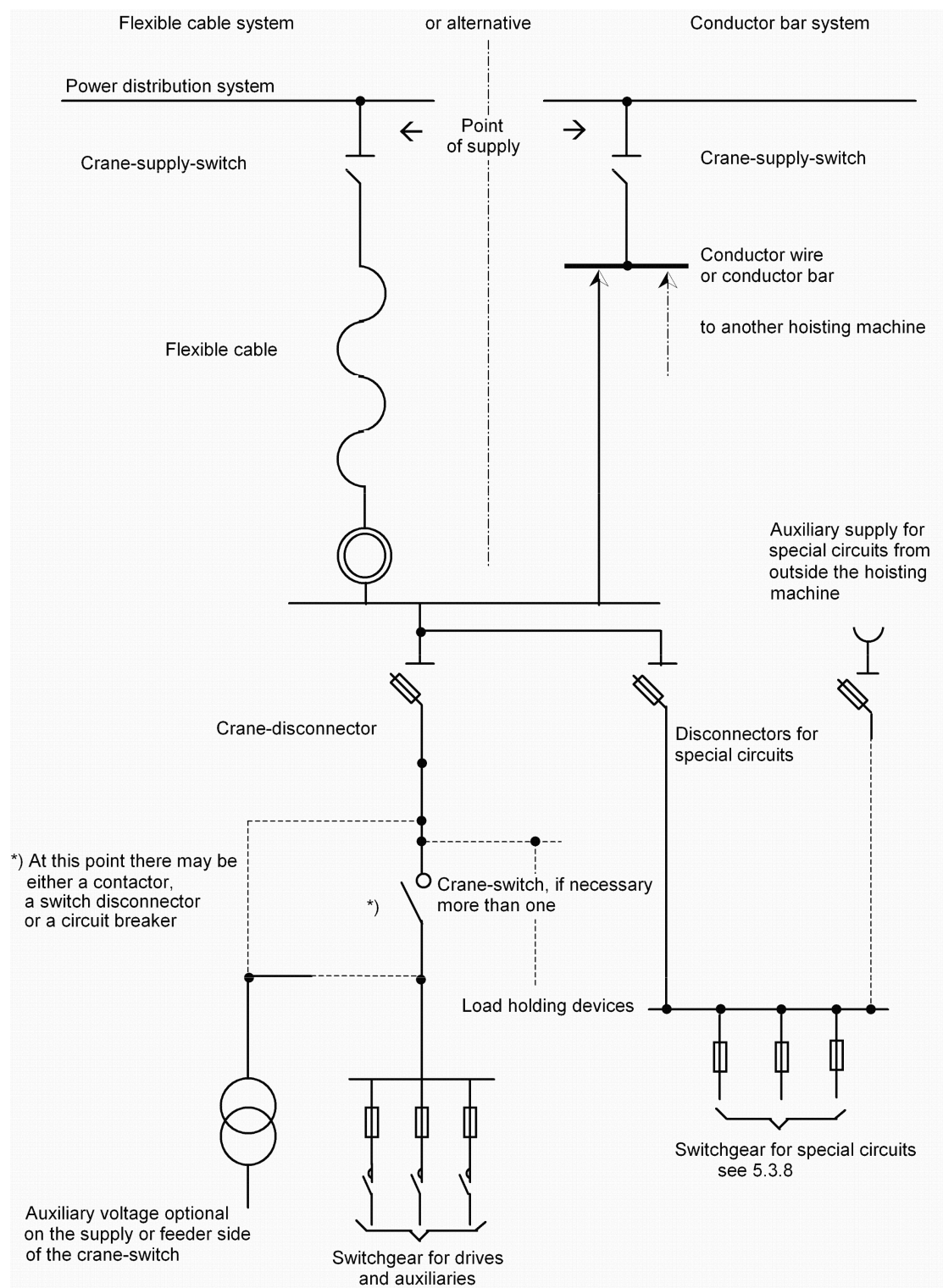
(See also Figure 3.)

5.3.2 Type

The supply disconnecting and switching devices can be one of the following types:

- a) a switch-disconnector, with or without fuses, in accordance with IEC 60947-3:2008, utilization category AC-23B or DC-23B;
- b) a disconnector, with or without fuses, in accordance with IEC 60947-3:2008, that has an auxiliary contact that in all cases causes switching devices to break the load circuit before the opening of the main contacts of the disconnector;
- c) a circuit-breaker suitable for isolation in accordance with IEC 60947-2:2015;

- d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1:2007 as well as a utilization category defined in the product standard as appropriate for on-load switching of motors or other inductive loads;
- e) a plug/socket combination for a flexible cable supply.
- f) control and protective switching device suitable for isolation, in accordance with IEC 60947-6-2:2002



IEC 1 312/98 revised

1164 Figure 3 – Examples of electrical supply systems
1165

5.3.3 Requirements

When the supply disconnecting and switching device is one of the types specified in 5.3.2a) to d) it shall fulfil all of the following requirements.

- Isolate the electrical equipment from the supply and have one OFF (isolated) and one ON position marked with "O" and "I" (symbols IEC 60417-5008 (2002-10) and IEC 60417-5007 (2002-10), see 10.2.2).
- Have a visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating function have been satisfied.
- Have an external operating means (e.g. handle) (exception: power-operated switchgear need not be operable from outside the enclosure where there are other means to open it).
- Be provided with a means permitting it to be locked in the OFF (isolated) position (e.g. by padlocks). When so locked, remote as well as local closing shall be prevented.
- Disconnect all live conductors of its power supply circuit. However, for TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory.
- Have a breaking capacity sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. Where motor(s) are supplied by converter(s) or similar devices, the calculation should take into account the possible effect on the required breaking capacity.

When the supply disconnecting device is a plug/socket combination, it shall fulfil the following requirements.

- Have the breaking capability or be interlocked with a switching device that has a breaking capacity, sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. When the interlocked switching device is electrically operated (e.g. a contactor), it shall have an appropriate utilization category. Where motor(s) are supplied by converter(s) or similar devices, the calculation should take into account the possible effect on the required breaking capacity

- Subclause 13.4.5.

NOTE A suitably rated plug and socket-outlet, cable coupler, or appliance coupler, in accordance with IEC 60309-1:1999 can fulfil these requirements.

Where the supply disconnecting device is a plug/socket combination, a switching device with an appropriate utilization category shall be provided for switching the machine on and off. This can be achieved by the use of the interlocked switching device described above.

5.3.4 Operating means

The operating means (e.g. a handle) of the supply disconnecting and switching device shall be external to the enclosure of the electrical equipment.

Exception: power-operated switchgear need not be provided with a handle outside the enclosure where other means (e.g. pushbuttons) are provided to open the supply disconnecting device from outside the enclosure.

The operating means of the supply disconnecting device and switching device shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level. An upper limit of 1,7 m is recommended.

NOTE The direction of operation is given in IEC 61310-3:2008.

1212 Where the external operating means is not intended for emergency operations:

- 1213 - it is recommended that it be coloured BLACK or GREY (see 10.2)
- 1214 - a supplementary cover or door that can be readily opened without the use of a key or tool may
- 1215 be provided, for example for protection against environmental conditions or mechanical
- 1216 damage. Such a cover/door shall clearly show that it provides access to the operating means.
- 1217 This can be achieved, for example, by use of the relevant symbol IEC 60417-6169-1 (2012-08)
- 1218 (Figure 2) or IEC 60417-6169-2 (2012-08), (Figure 3).



Figure 4 – Disconnector isolator



Figure 5 – Disconnecting circuit breaker

1223 5.3.5 Crane-supply-switch

1224 NOTE This subclause does not apply to hoisting machines having on-board power supplies and without an alternative power
1225 supply from the outside.

1226 5.3.5.1 General

1227 Crane-supply-switches shall be provided

- 1228 – for disconnecting (isolating) the conductor wires or conductor bars or cables to which the hoisting
- 1229 machine(s) is connected from the incoming supply for repair and maintenance works (e.g. on the
- 1230 conductor wires to the hoisting machine(s)); and
- 1231 – where required for emergency stop and/or emergency switching off (see 9.2.5.4).

1232 Where two or more incoming supplies are used, a crane-supply-switch shall be provided for each supply,
1233 together with protective interlocks to ensure their correct operation.

1234 The requirements of 5.6 shall apply as appropriate to crane-supply-switches.

1235 5.3.5.2 Type

1236 The crane-supply-switch shall be one of the types specified in 5.3.2.

1237 In the case of hoisting machines on construction sites, equipment on the site distribution board may be
1238 used to achieve the function of the crane-supply-switch. The requirement of 5.6 shall be fulfilled by
1239 locking regardless of whether or not the disconnecting means is under immediate supervision.

1240 5.3.5.3 Requirements

1241 In the case of a single hoisting machine, the breaking capacity shall be sufficient to switch off the sum
1242 of the current under stalled rotor condition of the largest drive and the normal running currents of the
1243 other drives that can be operating at the same time.

1244 NOTE If there is more than one hoisting machine on one common power supply according to the given service conditions, a
1245 proven simultaneity factor may be used.

1246 If the crane-supply-switch performs the emergency switching off function according to 9.2.5.4.3, it shall
1247 be capable of being opened (remotely or directly) from an easily accessible place(s) close to the hoisting
1248 machine.

1249 The reconnection of a crane-supply-switch that has been remotely operated by an emergency switching
1250 off device shall only be possible after the resetting of the emergency switching off device(s).

1251 Where a conductor wire or conductor bar is fed by several crane-supply-switches connected in parallel,
1252 they shall be provided with protective interlocks to ensure their correct operation.

It is recommended that the crane-supply-switch used to energize an unprotected conductor wire, or conductor bar, or a remote control for the crane-supply-switch be so located that as much as possible of the conductor wire or conductor bar is visible from that place of operation.

The above requirements should also apply in special cases, for example, where

- there are two main supply conductor wires or conductor bars or conductor systems, either of which may be used for supplying the hoisting machine(s); or
- a main supply conductor wire or conductor bar is divided into isolated sections.

In cases where these requirements cannot be fulfilled, the necessary safety shall be provided by other measures.

5.3.6 Crane-disconnector

5.3.6.1 General

A hoisting machine shall be equipped with a single crane-disconnector to enable the electrical equipment to be isolated for maintenance and repair purposes, and to prevent unexpected start-up during mechanical work on the hoisting machine, except under the following circumstances.

- A crane-disconnector is not required if there are no connections and branches in the wiring system between the intended crane-disconnector position and the crane-switch specified in 5.3.7, and the crane-switch performs the functions of the crane-disconnector and conforms to the requirements of 5.6.

- A crane-disconnector is not required for a single hoisting machine which is floor-controlled, and where the crane-supply-switch performs this function.

NOTE A floor-controlled hoisting machine is operated from a suspended pendant control station, a remote fixed control station, or a portable control station.

- A crane-disconnector is not necessary in cases where the voltage can be reduced to, and maintained at, zero by other means (e.g. locking off a diesel generator fuel supply or starter mechanism, etc.).

- On hoisting machines with power supplied at voltages of more than 1 kV AC and having one or more transformers installed on the hoisting machine, supplying a low-voltage system, one or more crane-disconnectors may be required on the secondary side of each transformer to isolate the low-voltage sections (see also 5.5). Circuits associated with each crane-disconnector shall be clearly identifiable, for example, by

- separation, or
- barriers, or
- marking and labelling.

NOTE Preference should be given to the disconnection of a hoisting machine using only one crane-disconnector.

5.3.6.2 Type

Where provisions are made against both inadvertent and unauthorized opening, the crane-disconnector shall, as a minimum, conform to the requirements for disconnectors given in IEC 60947-3:2008. Otherwise, it shall meet the requirements for switch-disconnectors given in IEC 60947-3:2008. The actuator of the crane-disconnector shall conform to the requirements of 5.3.4.

Removable collectors or plug/socket combinations may be used as crane-disconnectors when they perform the same function.

On hoisting machines with an alternative power-supply system, the changeover switch of the supplies may be used as a crane-disconnector if it has a neutral off-position and meets the requirements of 5.3.6.

5.3.6.3 Requirements

The requirements of 5.4, 5.5 and 5.6 shall apply as appropriate.

1298 5.3.7 Crane-switch

1299 5.3.7.1 General

1300 Each hoisting machine shall have one or more crane-switches, operable from the operating control
1301 station, for emergency stop of all motion drives and, where necessary, for interrupting the electrical
1302 power supply to other equipment.

1303 Load holding devices that cannot continue to hold the load when de-energized (e.g. magnets, pneumatic
1304 holding devices) shall be supplied from the supply side of the crane-switch.

1305 Exceptions: Where the emergency stop function is provided by other means, a crane-switch is not
1306 required for the following:

- 1307 – for hoisting machines on which only the hoisting mechanism is power-operated;
- 1308 – on floor-controlled monorail hoists when the trolley travel is powered by hand or by an electric motor
1309 rated at not more than 500 W.

1310 5.3.7.2 Type

1311 The crane-switch shall as a minimum meet the requirements for switches given in IEC 60947-
1312 3:2008. This requirement can be fulfilled by one of the devices specified in 5.3.2a) or c). Contactors
1313 selected in accordance with 4.2.2 and used in combination with disconnecting devices may also be
1314 used.

1315 5.3.7.3 Requirements

1316 The requirements of 5.3.3 and 5.3.4 shall apply as appropriate.

1317 5.3.8 Excepted circuits

1318 Excepted circuits, which need to be operational during repair and maintenance work, shall be supplied
1319 from the supply side of the crane-disconnector specified in 5.3.6 using a dedicated disconnector (see
1320 Figure 3) that conforms to the requirements of 5.6.

1321 Excepted circuits may include but are not limited to the following:

- 1322 – circuits for plug and socket-outlets and lighting circuits;
- 1323 – circuits for lifts, repair and maintenance tools and repair cranes installed in hoisting machines;
- 1324 – circuits for heating, air conditioning and ventilation;
- 1325 – circuits for electrical equipment fulfilling safety measures, for example anti-collision device, aviation
1326 lighting;
- 1327 – circuits for fire alarm systems;
- 1328 – communications circuits, data links or program storage devices;
- 1329 – undervoltage protection circuits that are only provided for automatic tripping in the event of supply
1330 failure;
- 1331 – control circuits for interlocking.

1332 Excepted circuits shall be so designed and installed that their operation during repair and maintenance
1333 work on the hoisting machine does not use unprotected conductor wires, conductor bars or slip-ring
1334 assemblies.

1335 Excepted circuits shall be identifiable by

- 1336 – permanent warning label(s) in accordance with 16.1 placed in proximity to the crane-disconnector;
- 1337 – a corresponding statement included in the maintenance manual; and one or more of the following
1338 shall apply;
 - 1339 - a permanent warning label in accordance with 16.1 is placed in proximity to each special
1340 circuit, or
 - 1341 - the excepted circuit shall be separated from other circuits, or

- the conductors are identified by colour taking into account the recommendation of 13.2.4.

5.4 Devices for removal of power for prevention of unexpected start-up

Devices for removal of power for the prevention of unexpected start-up shall be provided (e.g. where, during maintenance, a start-up of the hoisting machine or part of it can create a hazard). The crane-disconnector (see 5.3.6) fulfils that function for the complete hoisting machine. Where it is necessary to work on individual parts of a hoisting machine, additional devices for switching off shall be provided for each part requiring separate disconnection.

Such devices shall be appropriate and convenient for their intended use, shall be suitably placed and readily identifiable as to their function and purpose.

NOTE 1 This standard does not address all provisions for prevention of unexpected start up. See ISO 14118 (EN 1037).

NOTE 2 Removal of power means removal of the connection to the source of electrical energy but does not imply isolation.

Means shall be provided to prevent inadvertent and/or mistaken closure of these devices either at the controller or from other locations (see also 5.6).

NOTE 3 Further information on the location and actuation of devices such as those used for the prevention of unexpected start-up is provided in ISO 14118 (EN 1037).

The following devices that fulfil the isolation function may be provided for these purposes:

- devices described in 5.3.2;
- disconnectors, withdrawable fuse links and withdrawable links only if located in an enclosed electrical operating area (see 3.27).

Devices that do not fulfil the isolation function (e.g. a contactor switched off by a control circuit, or Power Drive System (PDS) with a Safe Torque Off (STO) function in accordance with IEC 61800-5-2:2017) may only be provided where intended to be used for situations that include

- inspections;
- adjustments;
- work on the electrical equipment where
 - there is no hazard arising from electric shock (see 6) and burn;
 - the switching-off means remains effective throughout the work;
 - the work is of a minor nature (e.g. replacement of plug-in devices without disturbing existing wiring).

The selection of a device should take into account, for example, information derived from the risk assessment, intended use and foreseeable misuse of the device. For example, the use of disconnectors, withdrawable fuse links or withdrawable links located in enclosed electrical operating areas can be inappropriate for use by cleaners (see 17.2b)12)).

5.5 Devices for isolating electrical equipment

Devices shall be provided for isolating (disconnecting) electrical equipment or part(s) of the electrical equipment to enable work to be carried out when it is de-energized and isolated. Such devices shall be

- appropriate and convenient for their intended use;
- suitably placed;
- readily identifiable as to which part(s) or circuit(s) of the equipment is served. Where their function and purpose is not otherwise obvious (e.g. by their location) these devices shall be marked to indicate the extent of the equipment that they isolate.

Means shall be provided to prevent inadvertent and/or mistaken closure of these devices either at the controller or from other locations (see also 5.6).

The crane-disconnector (see 5.3.6) may, in some cases, fulfil that function. However, where it is necessary to work on individual parts of the electrical equipment of a hoisting machine, or on one of a

number of hoisting machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device shall be provided for each part, or for each hoisting machine, requiring separate isolation.

In addition to the crane-disconnector, the following devices that fulfil the isolation function may be provided for this purpose:

- devices described in 5.3.2;
- disconnectors, withdrawable fuse links and withdrawable links only if located in an electrical operating area (see 3.23) and relevant information is provided with the electrical equipment (see 17.2b), 9) and b)12)).

NOTE Where protection against electric shock is provided in accordance with 6.2.2c), withdrawable fuse links or withdrawable links for this purpose are intended for use by skilled or instructed persons.

5.6 Protection against unauthorized, inadvertent and/or mistaken connection

The devices described in 5.4 and 5.5 that are located outside an enclosed electrical operating area shall be equipped with means to secure them in the OFF position (disconnected state), (e.g. by provisions for padlocking, trapped key interlocking). When so secured, remote as well as local reconnection shall be prevented.

Where a non-lockable disconnecting device is used within an enclosed electrical operating area (e.g. withdrawable fuse-links, withdrawable links) other means of protection against reconnection (e.g. warning labels in accordance with 16.1) may be provided.

However, when a plug/socket combination in accordance with 5.3.2e) is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for securing in the disconnected state need not be provided.

6 Protection against electric shock

6.1 General

The electrical equipment shall provide protection of persons against electric shock by

- basic protection (see 6.2 and 6.4);
- fault protection (see 6.3 and 6.4).

The measures for this protection given in 6.2, 6.3, and, for PELV, in 6.4, are a recommended selection from IEC 60364-4-41:2005. Where those recommended measures are not practicable, for example, due to the physical or operational conditions, other measures from IEC 60364-4-41:2005 may be used.

6.2 Basic protection

6.2.1 General

For each circuit or part of the electrical equipment, the measures of either 6.2.2 or 6.2.3 and, where applicable, 6.2.4 shall be applied.

Exception: Where those measures are not appropriate, other measures by basic protection (e.g. by using barriers, by placing out of reach, using obstacles, using construction or installation techniques that prevent access) as defined in IEC 60364-4-41:2005 may be applied (see 6.2.5 and 6.2.6).

When the equipment is located in places open to all persons, which can include children, measures of either 6.2.2 with a minimum degree of by basic protection corresponding to IP4X or IPXXD (see IEC 60529:1989), or 6.2.3 shall be applied.

6.2.2 Protection by enclosures

Live parts shall be located inside enclosures that provide protection against contact with live parts of at least IP2X or IPXXB (see IEC 60529:1989).

Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against contact with live parts provided by the top surfaces shall be IP4X or IPXXD.

Opening an enclosure (i.e. opening doors, lids, covers, and the like) shall be possible only under one of the following conditions.

- a) The use of a key or tool is necessary for access. For enclosed electrical operating areas, see IEC 60364-4-41:2005.

NOTE 1 The use of a key or tool is intended to restrict access to skilled or instructed persons (see 17).

All live parts, (including those on the inside of doors) that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected, shall be protected against direct contact to at least IP2X or IPXXB. Other live parts on the inside of doors shall be protected against direct contact to at least IP1X or IPXXA.

- b) The disconnection of live parts inside the enclosure before the enclosure can be opened.

This may be accomplished by interlocking the door with a disconnecting device (e.g. the crane-disconnector) so that the door can only be opened when the disconnecting device is open and so that the disconnecting device can only be closed when the door is closed.

Exception: A special device or tool as prescribed by the supplier can be used to defeat the interlock provided that

- it is possible at all times while the interlock is defeated to open the disconnecting device and lock the disconnecting device in the OFF (isolated) position or otherwise prevent unauthorized closure of the disconnecting device;

- upon closing the door, the interlock is automatically restored;

- all live parts, (including those on the inside of doors) that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected, are protected against direct contact to at least IP2X or IPXXB and other live parts on the inside of doors are protected against direct contact to at least IP1X or IPXXA;

- relevant information about the procedures for the defeat of the interlock is provided with the instructions for use of electrical equipment (see 17)

- Means are provided to restrict access to live parts behind doors that are not directly interlocked with the disconnecting means to skilled or instructed persons (see 17)

All parts that are still live after switching off the disconnecting device(s) shall be protected against direct contact to at least IP2X or IPXXB (see IEC 60529:1989). Such parts shall be marked with a warning sign in accordance with 16.2.1 (see also 13.2.4 for identification of conductors by colour), except for:

- parts that can be live only because of connection to interlocking circuits and that are distinguished by colour as potentially live in accordance with 13.2.4;

- the supply terminals of the crane-supply-switch and the crane-disconnector when they are mounted alone in a separate enclosure.

- c) Opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against direct contact to at least IP2X or IPXXB (see IEC 60529:1989). Where barriers provide this protection, either they shall require a tool for their removal or all live parts protected by them shall be automatically disconnected when the barrier is removed. Where protection against contact is achieved in accordance with 6.2.2 c), and a hazard can be caused by manual actuation of devices (for example manual closing of contactors or relays), such actuation should be prevented by barriers or obstacles that require a tool for their removal.

6.2.3 Protection by insulation of live parts

Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction. Such insulation shall be capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions.

NOTE Paints, varnishes, lacquers, and similar products alone are generally considered to be inadequate for protection against electric shock under normal operating conditions.

6.2.4 Protection against residual voltages

Live parts having a residual voltage greater than 60 V after the supply has been disconnected shall be discharged to 60 V or less within a time period of 5 s after disconnection of the supply voltage provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 μC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure containing the capacitances.

In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (e.g. pins), the discharge time to 60 V shall not exceed 1 s; otherwise, such conductors shall be protected against direct contact to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (e.g. in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning, for example a warning sign drawing attention to the hazard and stating the delay required shall be provided.

NOTE Frequency converters and DC bus supplies could have typically a longer discharge time than 5 s

6.2.5 Protection by barriers

For protection by barriers, the requirements of IEC 60364-4-41:2005 shall apply

6.2.6 Protection by placing out of reach or protection by obstacles

For protection by placing out of reach, the requirements of IEC 60364-4-41:2005 shall apply. For protection by obstacles, the requirements of IEC 60364-4-41:2005 shall apply.

For conductor wire systems or conductor bar systems with a degree of protection less than IP2X, see 12.7.1.

6.3 Fault protection

6.3.1 General

Fault protection is intended to prevent hazardous situations due to an insulation fault between live parts and exposed conductive parts.

For each circuit or part of the electrical equipment, at least one of the following measures, in accordance with 6.3.2 to 6.3.3, shall be applied:

- measures to prevent the occurrence of a touch voltage (6.3.2); or
- automatic disconnection of the supply before the time of contact with a touch voltage can become hazardous (6.3.3).

NOTE 1 The risk of harmful physiological effects from a touch voltage depends on the value of the touch voltage and the duration of possible exposure.

NOTE 2 For classes of equipment and protective provisions see IEC 61140:2016.

6.3.2 Prevention of the occurrence of a touch voltage

6.3.2.1 General

Measures to prevent the occurrence of a touch voltage include the following:

- provision of class II equipment or by equivalent insulation;
- electrical separation.

6.3.2.2 Protection by provision of class II equipment or by equivalent insulation

This measure is intended to prevent the occurrence of touch voltages on the accessible parts through a fault in the basic insulation.

This protection is provided by one or more of the following:

- 1530 - class II electrical devices or apparatus (double insulation, reinforced insulation or by
1531 equivalent insulation in accordance with IEC 61140:2016);
- 1532 - switchgear and controlgear assemblies having total insulation in accordance
1533 with IEC 61439-1:2011;
- 1534 - supplementary or reinforced insulation in accordance with 412 of IEC 60364-4-41:2005.

1535 6.3.2.3 Protection by electrical separation

1536 Electrical separation of an individual circuit is intended to prevent a touch voltage through contact with
1537 exposed conductive parts that can be energized by a fault in the basic insulation of the live parts of that
1538 circuit.

1539 For this type of protection, the requirements of IEC 60364-4-41:2005 apply.

1540 6.3.3 Protection by automatic disconnection of supply

1541 Automatic disconnection of the supply of any circuit affected by an insulation fault is intended to prevent
1542 a hazardous situation resulting from a touch voltage.

1543 This measure consists of the interruption of one or more of the line conductors by the automatic
1544 operation of a protective device in case of a fault. This interruption shall occur within a sufficiently short
1545 time to limit the duration of a touch voltage to a time within the limits specified in Annex A for TN and TT
1546 systems.

1547 This measure necessitates co-ordination between:

- 1548 - the type of supply systems, the supply source impedance and earthing system;
- 1549 - the impedance values of the different elements of the line and of the associated fault current
1550 paths through the protective bonding circuit;
- 1551 - the characteristics of the protective devices that detect insulation fault(s).

1552 NOTE Details of verification of conditions for protection by automatic disconnection of supply are provided in 18.2.

1553 This protective measure comprises both

- 1554 - protective bonding of exposed conductive parts (see 8.2.3);
- 1555 - and one of following:
- 1556 a) In TN systems, the following protective devices may be used:
- 1557 o overcurrent protective devices;
- 1558 o residual current protective devices (RCDs) and associated overcurrent protective
1559 device(s).

1560 NOTE 2 The preventive maintenance can be enhanced by use of a residual current monitoring device, RCM, complying with
1561 IEC 62020:2018.

1562 b) in TT systems, either:

- 1563 o RCDs and associated overcurrent protective device(s) to initiate the automatic
1564 disconnection of the supply on detection of an insulation fault from a live part to
1565 exposed conductive parts or to earth, or
- 1566 o overcurrent protective devices may be used for fault protection provided a suitably
1567 low value of the fault loop impedance Z_S (see Annex A.2.2.3) is permanently and
1568 reliably assured;

1569 NOTE 3 The preventive maintenance can be enhanced by use of a residual current monitoring device, RCM, complying with
1570 IEC 62020:2018.

- 1571 c) In IT systems the relevant requirements of IEC 60364-4-41:2005 shall be fulfilled.
- 1572 During an insulation fault an acoustic and optical signal shall be sustained. After
1573 annunciation, the acoustic signal may then be manually muted. This can require an
1574 agreement between the supplier and user regarding the provision of insulation
1575 monitoring devices and/or insulation fault location system(s).

1576 NOTE 4 In large machines, the provision of an insulation fault location system (IFLS) in accordance with IEC 61557-9:2017 can
1577 facilitate maintenance.