

INTERNATIONAL STANDARD



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



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Part 32: Requirements for hoisting machines**

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SAFETY OF MACHINERY –
ELECTRICAL EQUIPMENT OF MACHINES –****Part 32: Requirements for hoisting machines****FOREWORD**

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This commented version (CMV) of the official standard IEC 60204-32:2023 edition 3.0 allows the user to identify the changes made to the previous IEC 60204-32:2008 edition 2.0. Furthermore, comments from IEC TC 44 experts are provided to explain the reasons of the most relevant changes, or to clarify any part of the content.

A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text. Experts' comments are identified by a blue-background number. Mouse over a number to display a pop-up note with the comment.

This publication contains the CMV and the official standard. The full list of comments is available at the end of the CMV.

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

This third edition cancels and replaces the second edition published in 2008. This edition 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 sixth 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;
- b) reference for high voltage electrical equipment;
- c) cableless control system requirements;
- d) EMC requirements;
- e) technical documentation requirements;
- f) general updating to current special national conditions, normative standards, and bibliographical references.

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

Draft	Report on voting
44/1000/FDIS	44/1005/RVD

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

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

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

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

- 4.3.1: The voltage characteristics of electricity supplied by public distribution systems in Europe are given in EN 50160:2010.
- 5.1: Exception is not allowed (USA).
- 5.1: TN-C systems are not permitted in low-voltage installations in buildings (Norway).
- 5.2: Terminals for the connection of the protective earthing conductors may be identified by the colour green, the letters “G” or “GR” or “GRD” or “GND”, or the word “ground” or “grounding”, or with the graphical symbol IEC 60417-519:2002-10 or any combination (USA).
- 5.3.1: Isolation of the neutral conductor is mandatory in TN-systems (Norway).

6.3.3 b),

13.4.5 b),

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

6.3.3,

18.2,

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

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

7.2.3: Disconnection of the neutral conductor is mandatory in a TN-S system (France).

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

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

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

9.1.2: Only stranded wires are allowed on machines, except for 0,2 mm² solid conductors within enclosures (USA).

12.2: The smallest power circuit conductor allowed on machines is 0,82 mm² (AWG 18).

Table 5: Cross-sectional area is specified in NFPA 79 using American Wire Gauge (AWG) (USA). See Annex F.

13.2.2: For the protective conductor, the colour identification GREEN (with or without YELLOW stripes) is used as equivalent to the bicolour combination GREEN-AND YELLOW (USA and Canada).

13.2.3: The colour identification WHITE or GREY is used for earthed neutral conductors instead of the colour identification BLUE (USA and Canada).

15.2.2: First paragraph: Maximum value between conductors 150 V (USA).

15.2.2: Second paragraph, fifth bullet: The full load current rating of lighting circuits does not exceed 15 A (USA).

16.4: Nameplate marking requirements (USA).

A.2.2.2: The permissible maximum value of R_A is regulated (e.g. when $U_0 > 300$ V, R_A shall be less than 10 Ω , when $U_0 < 300$ V, R_A shall be less than 100 Ω , U_0 is the nominal AC line to earth voltage in volts (V) (Japan).

A.2.2.2: The maximum permissible value of R_A is 83 Ω (Netherlands).

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

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

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

It is important that high performance is not ~~to be~~ obtained at the expense of the essential factors mentioned above.

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

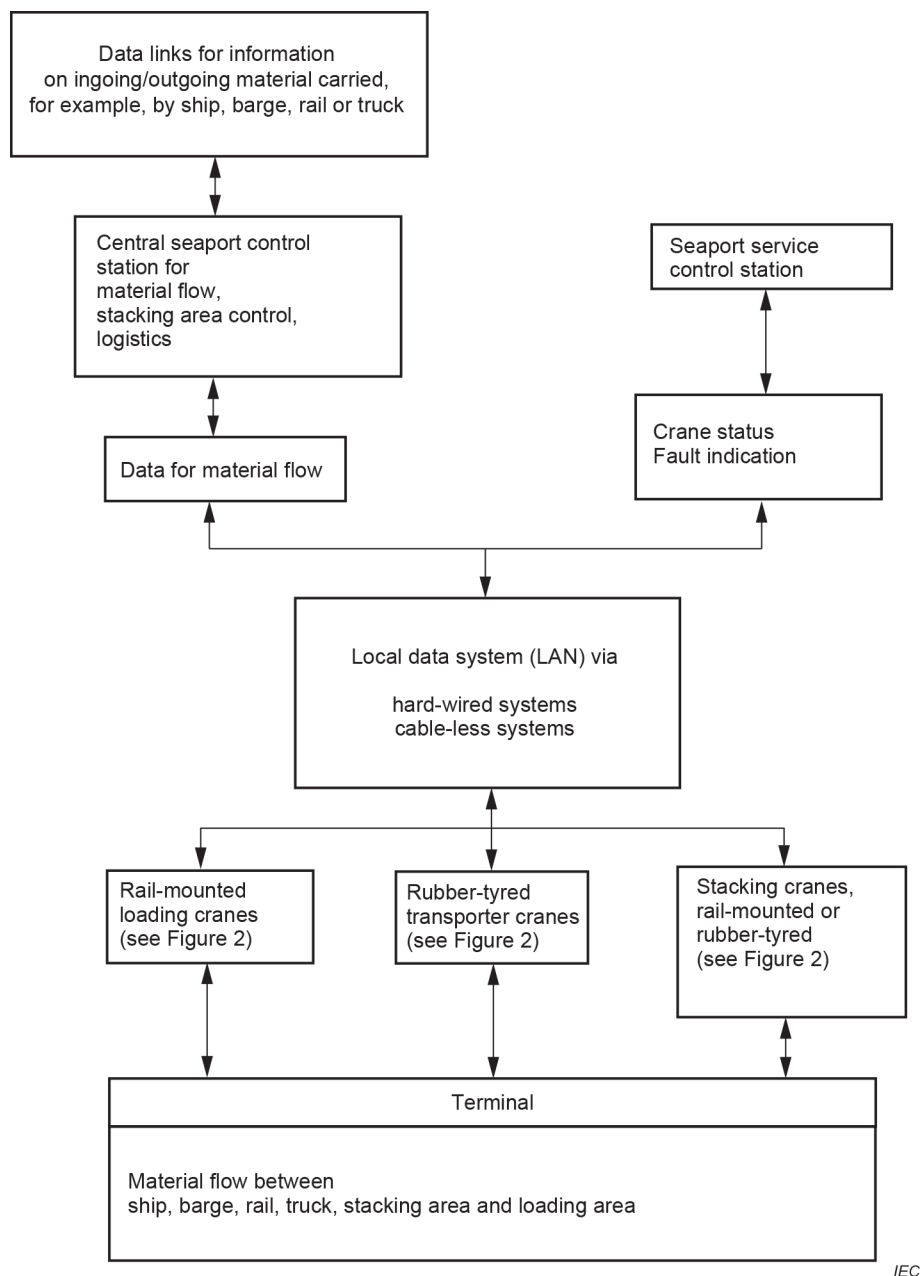
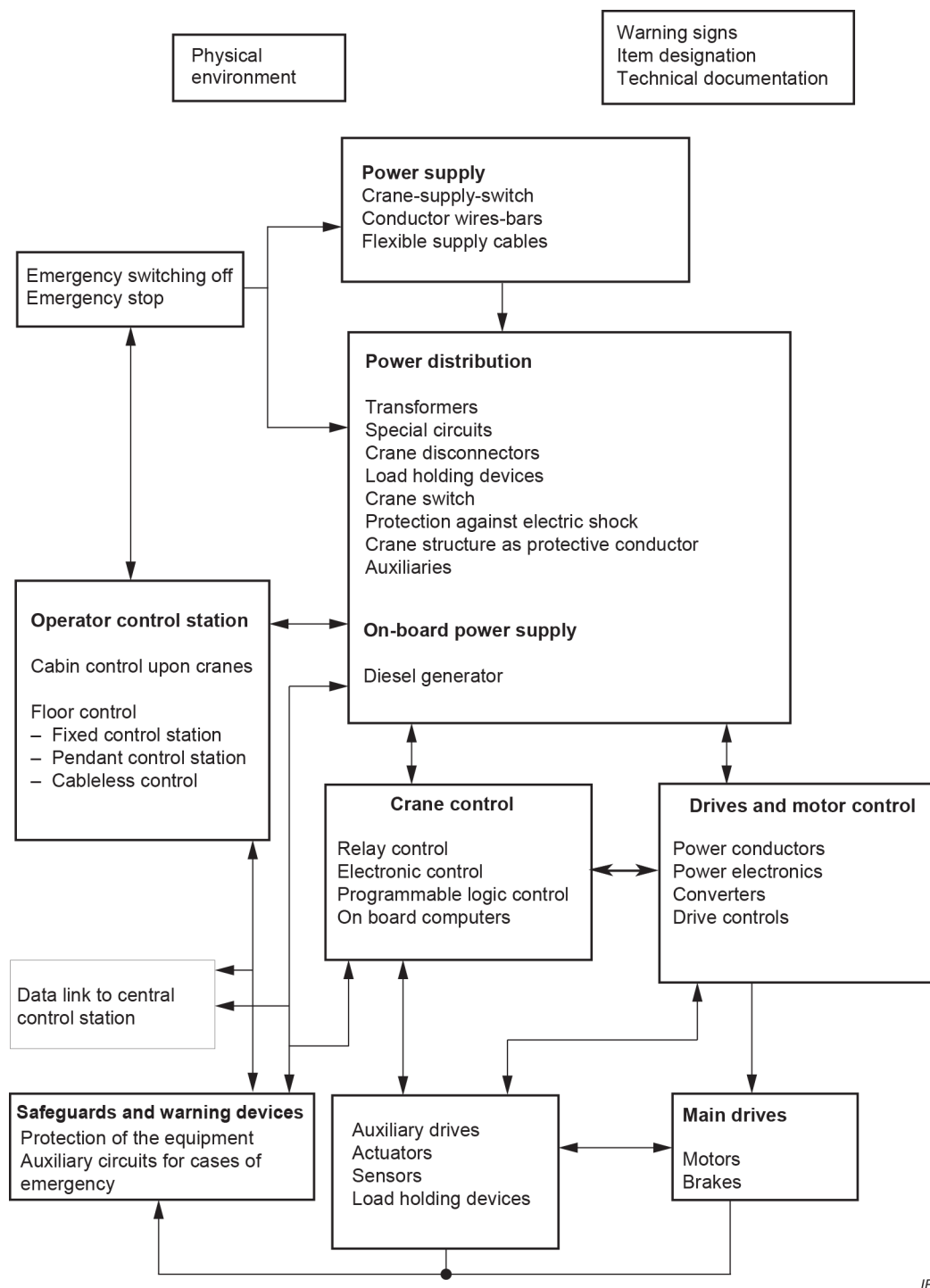


Figure 1 – Block diagram of combined working cranes in a typical material handling system in a seaport



IEC

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 ~~the application of~~ electrical ~~and~~, electronic, programmable **1** electronic equipment and systems to hoisting machines and related equipment, including a group of hoisting machines working together in a co-ordinated manner **2**.

NOTE 1 In this document, 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 document, 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 document 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 ~~For the requirements for the electrical supply installation in buildings, see IEC 60364.~~ The requirements for the electrical supply installation of electrical equipment of a hoisting machine are given in IEC 60364.

This document 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.

NOTE 4 ~~For higher voltages, see IEC 60204-11.~~ Special requirements for electrical equipment of hoisting machines intended to be operated at higher voltages can be found in IEC 60204-11. **3**

This document 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 document does not cover noise risks.

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

~~— are intended for use in open air (i.e., outside buildings or other protective structures);~~

- 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 document, 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;
- cable cranes;
- load holding devices;
- storage and retrieval machines;
- monorail hoists;
- straddle carriers;
- rubber tyred gantry cranes (RTGs).

NOTE 5 A definition of the different crane types can be found in ISO 4306-1.

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

2 Normative references

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

IEC 60034-1:2017, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-5, *Rotating electrical machines – Part 5: Degrees of protection provided by the integral design of rotating electrical machines (IP code) – Classification*

IEC 60034-11, *Rotating electrical machines – Part 11: Thermal protection*

IEC 60068-2-27:1987/2008, ~~Basic Environmental testing procedures~~ – Part 2-27: Tests – Test Ea and guidance: Shock

IEC 60068-2-31:2008, *Environmental testing – Part 2-31: Tests – Test Ec: Rough handling shocks, primarily for equipment-type specimens*

~~IEC 60068-2-32:1975, Basic environmental testing procedures – Part 2-32: Tests – Test Ed: Free fall
Amendment 2 (1990)~~

IEC 60072-1, *Rotating electrical machines – Dimensions and output series – Part 1: Frame numbers 56 to 400 and flange numbers 55 to 1080*

IEC 60072-2, *Dimensions and output series for rotating electrical machines – Part 2: Frame numbers 355 to 1000 and flange numbers 1180 to 2360*

IEC 60072-3, *Dimensions and output series for rotating electrical machines – Part 3: Small built-in motors – Flange numbers BF10 to BF50*

IEC 60073:2002, *Basic and safety principles for man-machine interface, marking and identification – Coding principles for indicators and actuators*

IEC 60309-1, *Plugs, fixed or portable socket-outlets and ~~couplers~~ appliance inlets for industrial purposes – Part 1: General requirements*

~~IEC 60332 (all parts), Tests on electric and optical fibre cables under fire conditions~~

IEC 60364-1:2005, *Low-voltage electrical installations – Part 1: Fundamental principles, assessment of general characteristics, definitions*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*
IEC 60364-4-41:2005/AMD1:2017

~~IEC 60364-4-42:2001, Electrical installations of buildings – Part 4-42: Protection for safety – Protection against thermal effects~~

IEC 60364-4-43:20012008, *Low-voltage electrical installations ~~of buildings~~ – Part 4-43: Protection for safety – Protection against overcurrent*

IEC 60364-5-52:20012009, *Low-voltage electrical installations ~~of buildings~~ – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-53:20022019, *Low-voltage electrical installations ~~of buildings~~ – Part 5-53: Selection and erection of electrical equipment – Devices for protection for safety, isolation, switching, control and monitoring*

IEC 60364-5-54:20022011, *Low-voltage electrical installations ~~of buildings~~ – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements, ~~protective conductors~~ and protective ~~bonding~~ conductors*

IEC 60364-6:20062016, *Low-voltage electrical installations – Part 6: Verification*

IEC 60417, *Graphical symbols for use on equipment* (available at <https://www.graphical-symbols.info/equipment>)

~~IEC 60439-1:1999, Low-voltage switchgear and controlgear assemblies – Part 1: Type tested and partially type tested assemblies⁴. Amendment 1 (2004)~~

IEC 60445:2021, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

~~IEC 60446:1999, Basic and safety principles for man-machine interface, marking and identification – Identification of conductors by colours or alphanumerics~~

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

IEC 60529:2001, *Degrees of protection provided by enclosures (IP Code)*

~~IEC 60617, Graphical symbols for diagrams~~

⁴ ~~There exists a consolidated edition 4.1 (2004) that includes edition 4 and its amendment.~~

IEC 60664-1:~~2007~~, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

IEC 60755:2017, *General safety requirements for residual current operated protective devices*

~~IEC 60898 (all parts), Electrical accessories—Circuit-breakers for overcurrent protection for household and similar installations~~

IEC 60947-1:~~2007~~, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-2:~~2006~~2016, *Low-voltage switchgear and controlgear – Part 2: Circuit-breakers*

IEC 60947-3, *Low-voltage switchgear and controlgear – Part 3: Switches, disconnectors, switch-disconnectors, and fuse-combination units*

IEC 60947-4-1:~~2000~~2018, *Low-voltage switchgear and controlgear – Part 4-1: Contactors and motor-starters – Electromechanical contactors and motor-starters*

~~Amendment 1 (2002)⁴~~

IEC 60947-5-1:~~2003~~2016, *Low-voltage switchgear and controlgear – Part 5-1: Control circuit devices and switching elements – Electromechanical control circuit devices*

IEC 60947-5-5, *Low-voltage switchgear and controlgear – Part 5-5: Control circuit devices and switching elements – Electrical emergency stop device with mechanical latching function*

IEC 60947-6-2, *Low-voltage switchgear and controlgear – Part 6-2: Multiple function equipment – Control and protective switching devices (or equipment) (CPS)*

~~IEC 61082-1:2006, Preparation of documents used in electrotechnology—Part 1: Rules~~

IEC 61140, *Protection against electric shock – Common aspects for installations and equipment*

~~IEC 61180-2:1994, High-voltage techniques for low-voltage equipment—Part 2: Test equipment~~

IEC 61204-7, *Low-voltage switch mode power supplies – Part 7: Safety requirements*

IEC 61310 (all parts), *Safety of machinery – Indication, marking and actuation*

~~IEC 61346 (all parts), Industrial systems, installations and equipment and industrial products—Structuring principles and reference designations~~

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61557-3, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 3: Loop impedance*

IEC 61557-9:2014, *Electrical safety in low voltage distribution systems up to 1 000 V AC and 1 500 V DC – Equipment for testing, measuring or monitoring of protective measures – Part 9: Equipment for insulation fault detection in IT systems*

⁴ ~~There exists a consolidated edition 2.1 (2002) that includes edition 2 and its amendment.~~

IEC 61558-1, Safety of ~~power transformers, power supplies, reactors and similar products~~
transformers, reactors, power supply units and combinations thereof – Part 1: General
requirements and tests

IEC 61558-2-2, Safety of power transformers, power supplies, reactors and combinations
thereof – Part 2-2: Particular requirements and tests for control transformers and power supply
units incorporating control transformers

IEC 61558-2-6, Safety of ~~power transformers, power supply units and similar~~ transformers,
reactors, power supply units and combinations thereof – Part 2-6: Particular requirements and
tests for safety isolating transformers and power supply units incorporating safety isolating
transformers for general-use applications

IEC 61558-2-16, Safety of transformers, reactors, power supply units and combinations
thereof – Part 2-16: Particular requirements and tests for switch mode power supply units and
transformers for switch mode power supply units for general applications

IEC 61800-3, Adjustable speed electrical power drive systems – Part 3: EMC requirements and
specific test methods for PDS and machine tools

IEC 61800-5-1, Adjustable speed electrical power drive systems – Part 5-1: Safety
requirements – Electrical, thermal and energy

IEC 61800-5-2:~~2007~~, Adjustable speed electrical power drive systems – Part 5-2: Safety
requirements – Functional

IEC 61984, Connectors – Safety requirements and tests

IEC 62023, Structuring of technical information and documentation

~~IEC 62027, Preparation of parts lists~~

IEC 62061, Safety of machinery – Functional safety of safety-related ~~electrical, electronic and
programmable electronic~~ control systems

~~IEC 62079, Preparation of instructions – Structuring, content and presentation~~

IEC 62745:2017, Safety of machinery – Requirements for cableless control systems of
machinery

~~ISO 7000:2004, Graphical symbols for use on equipment – Index and synopsis~~

ISO 7010, Graphical symbols – Safety colours and safety signs – Registered safety signs,
available at <https://www.iso.org/obp>

ISO 12100:2010, Safety of machinery – General principles for design – Risk assessment and
risk reduction

~~ISO 12100-1: Safety of machinery – Part 1: Basic terminology, methodology~~

~~ISO 12100-2:2003, Safety of machinery – Basic concepts, General principles for design –
Part 2: Technical principles~~

ISO 13849-1:~~2006~~, Safety of machinery – Safety-related parts of control systems – Part 1:
General principles for design

ISO 13849-2:2003, *Safety of machinery – Safety-related parts of control systems – Part 2: Validation*

ISO 13850:2006/2015, *Safety of machinery – Emergency stop function – Principles for design*

~~ISO 13851:2002, *Safety of machinery – Two hand control devices – Functional aspects and design principles*~~

~~ISO 13852:1996, *Safety of machinery – Safety distances to prevent danger zones being reached by the upper limbs*~~

ISO 13857, *Safety of machinery – Safety distances to prevent hazard zones being reached by upper and lower limbs*

3 Terms, definitions and abbreviated terms 4

3.1 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1.1

actuator

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

Note 1 to entry: The actuator may take the form of a handle, knob, push-button, roller, plunger, etc.

Note 2 to entry: There are some actuating means that do not require an external actuating force but only an action, for example, touchscreens.

~~NOTE 3 – Note the difference between actuator and machine actuator (3.44).~~

Note 3 to entry: See also 3.1.53.

3.1.2

ambient temperature

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

3.1.3

apparatus

finished device or combination thereof made commercially available as a single functional unit, intended for the end user and liable to generate electromagnetic disturbance, or the performance of which is liable to be affected by such disturbance

3.1.4

~~(electrically) protective barrier~~

part providing protection against ~~direct~~ contact by a human being or livestock with hazardous-live parts from any usual direction of access

~~[IEV 826-12-23]~~

[SOURCE: IEC 60050-195:2021, 195-06-15, modified – The term "protective barrier" has been replaced with "barrier".]

3.1.5**basic drive module****BDM**

electronic power converter and related control, connected between an electric supply and a motor

[SOURCE: IEC 61800-2:2021, 3.4]

3.1.6**basic protection**

protection against electric shock under fault-free conditions

Note 1 to entry: Previously referred to as “protection against direct contact”

[SOURCE: IEC 60050-195:1998, 195-06-01, modified – The note to entry has been added.]

3.1.7**cabin-controlled hoisting machine**

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

3.1.8**cable tray**

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

Note 1 to entry: A cable tray ~~may~~ can be perforated or mesh.

[SOURCE: IEC 60050-826:2022, 826-15-08]

3.1.9**cable trunking system**

system of closed enclosures comprising a base with a removable cover intended for the complete surrounding of insulated conductors, cables, cords and/or for the accommodation of other electrical equipment including information technology equipment

[SOURCE: IEC 60050-826:2022, 826-15-04]

3.1.10**concurrent**

~~acting in conjunction; used to describe a situation wherein two or more control devices exist in an actuated condition at the same time (but not necessarily synchronously)~~

<two or more control devices> existing in an actuated condition at the same time, but not necessarily synchronously

3.1.11**conductor wire****conductor bar****conductor rail**

wire, conductive bar or rail of a feeder system having a sliding current collector

3.1.12**conduit**

part of a closed wiring system of generally circular cross-section for insulated conductors and/or cables in electrical or communication installations, allowing them to be drawn in and/or replaced

Note 1 to entry: Conduits should be sufficiently ~~closed~~ close-jointed so that the insulated conductors and/or cables can only be drawn in and not inserted laterally.

[SOURCE: IEC 60050-826:2022, 826-15-03]

3.1.13

control circuit

<of a hoisting machine> circuit used for the control, including monitoring, of a hoisting machine and the electrical equipment

3.1.14

control device

device connected into the control circuit and used for controlling the operation of the hoisting machine (e.g. position sensor, manual control switch, relay, magnetically operated valve, speed sensor)

3.1.15

controlgear

a general term covering switching devices and their combination with associated control, measuring, protective, and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures, and supporting structures, intended in principle for the control of electrical energy consuming equipment

[SOURCE: IEC 60050-441:1984, 441-11-03, ~~modified~~]

3.1.16

control station

operator control station

assembly of one or more control actuators fixed on the same panel or located in the same enclosure

Note 1 to entry: A control station may also contain related equipment, for example, potentiometers, signal lamps, instruments, display devices, etc.

Note 2 to entry: A definition of "actuator" is given in 3.1.1.

3.1.17

controlled stop

stopping of a hoisting machine motion with electrical power to the machine actuators maintained during the stopping process

3.1.18

crane

machine for hoisting/lowering and horizontally relocating suspended loads

3.1.19

crane-disconnector

~~hand-operated~~—disconnecting device installed on a hoisting machine for disconnecting (isolating) a supply circuit (e.g. for repair or maintenance work)

3.1.20

crane-supply-switch

disconnecting (isolating) and switching device used to disconnect the hoisting machine from the incoming supply

3.1.21

crane-switch

switching device designed to break the electrical power supply to the connected drives (e.g. for use in cases of emergency stop)

3.1.22**~~(continuous)~~ current-carrying capacity**

ampacity (US)

maximum value of electric current which can be carried continuously by a conductor, a device or an apparatus, under specified conditions without its steady-state temperature exceeding a specified value

[SOURCE: IEC 60050-826:2022, 826-11-13]

3.1.23**direct contact**

electric contact of ~~persons~~ human beings or ~~animals~~ livestock with live parts

~~[IEV 826-12-03]~~

[SOURCE: IEC 60050-195:2021, 195-06-03.]

3.1.24**direct opening action**

<contact element> achievement of contact separation as the direct result of a specified movement of the switch actuator through non-resilient members (e.g. not dependent upon springs)

[SOURCE: IEC 60947-5-1:2016, K.2.2]

3.1.25**disconnecting device**

device which provides, in the open position, an isolating distance in accordance with specified requirements

3.1.26**duct**

enclosed channel designed expressly for holding and protecting electrical conductors, cables, and busbars

Note 1 to entry: Conduits (3.1.12), cable trunking systems (3.1.9) and underfloor channels are types of duct.

3.1.27**earth****local earth****ground (US)****local ground (US)**

part of the Earth which is in electric contact with an earth electrode and that has an electric potential not necessarily equal to zero

[SOURCE: IEC 60050-195:2021, 195-01-03, modified – The terms "earth" and "ground" have been added.]

3.1.28**electrical operating area**

room or location for electrical equipment to which access is intended to be restricted to skilled or instructed persons, by the opening of a door or the removal of a barrier without the use of a key or tool and which is clearly marked by appropriate warning signs

3.1.29**electronic equipment**

part of the electrical equipment containing circuitry dependent for its operation on electronic devices and components

3.1.30**emergency stop device**

manually actuated control device used to initiate an emergency stop function

[SOURCE: ISO 13850:2015, 3. 3]

~~NOTE—See Annex E.~~

3.1.31**emergency switching-off device**

manually actuated control device used to switch off or to initiate the switching off of the supply of electrical energy to all or a part of an installation where a risk of electric shock or another risk of electrical origin is involved

~~NOTE—See Annex E.~~

3.1.32**enclosed electrical operating area**

room or location for electrical equipment to which access is intended to be restricted to skilled or instructed persons by the ~~opening of use of a key or tool to open~~ a door or ~~the removal of remove~~ a barrier ~~by the use of a key or tool~~, and which is clearly marked by appropriate warning signs

3.1.33**enclosure**

part providing protection of equipment against certain external influences and, in any direction, ~~basic protection as~~ protection against direct contact

Note 1 to entry: The definition taken from the existing IECV needs the following explanations within the scope of this document.

- a) Enclosures provide protection of persons or livestock against access to hazardous parts.
- b) Barriers, shaped openings, or any other means suitable to prevent or limit the penetration of the specified test probes, whether attached to the enclosure or formed by the enclosed equipment, are considered as part of the enclosure, except where they can be removed without the use of a key or tool.
- c) An enclosure may be
 - a cabinet or box, either mounted on the hoisting machine or separate from the hoisting machine;
 - a compartment consisting of an enclosed space within the hoisting machine structure (e.g. box girder).

3.1.34**electrical equipment**

~~material, fittings, devices, components, appliances, fixtures, apparatus, and the like used as part of, or in connection with, the electrical equipment of hoisting machines~~

items used in connection with the utilisation of electricity by machines or parts of machines, for example material, fittings, devices, components, appliances, fixtures, apparatus, and similar

3.1.35**equipotential bonding**

~~provision of electric connections between conductive parts, intended to achieve equipotentiality~~

set of electric connections intended to achieve equipotentiality between conductive parts

[SOURCE: IEC 60050-195:2021, 195-01-10]

3.1.36**exposed conductive part**

conductive part of ~~electrical~~ equipment that can be touched and that is not ~~normally~~ live under normal conditions, but that can become live ~~under fault conditions~~ when basic insulation fails

~~[IEV 826-12-10, modified]~~

[SOURCE: IEC 60050-195:2021, 195-06-10]

3.1.37

extraneous conductive part

conductive part not forming part of the electrical installation and ~~liable~~ that is likely to introduce an electric potential, generally the ~~earth~~ electric potential of a local earth

~~[IEV 826-12-11]~~

[SOURCE: IEC 60050-195:2021, 195-06-11]

3.1.38

failure

termination of the ability of an item to perform a required function

Note 1 to entry: After the failure, the item ~~has a~~ is in fault condition.

Note 2 to entry: A failure is an event, as distinguished from a fault, which is a state.

Note 3 to entry: This concept as defined does not apply to items consisting of software only.

Note 4 to entry: In practice the terms “fault” and “failure” are often used synonymously.

~~[IEV 191-04-01]~~

[SOURCE: IEC 60050-845:2020, 845-27-105, modified – A fourth note to entry has been added.]

3.1.39

fault

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

Note 1 to entry: A fault is often the result of a failure of the item itself, but may exist without prior failure.

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

3.1.40

fault protection

protection against electric shock under single-fault conditions

Note 1 to entry: Previously referred to as “protection against indirect contact”.

[SOURCE: IEC 60050-195:2021, 195-06-02, modified – A note to entry has been added.]

3.1.41

first environment

environment that includes domestic premises, it also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for domestic purposes

Note 1 to entry: Houses, apartments, commercial premises or offices in a residential building are examples of first environment locations.

3.1.42

fixed installation

particular combination of several types of apparatus and, where applicable, other devices, which are assembled, installed and intended to be used permanently at a predefined location

3.1.43**functional bonding**

equipotential bonding necessary for proper functioning of electrical equipment

3.1.44**guard**

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

~~[ISO 12100-1, 3.25, modified]~~

3.1.45**hand-held direct-control device**

manually operated switching device, the enclosure of which is portable by hand during operation, acting direct on a power circuit **without a control circuit**

3.1.46**hazard**

potential source of ~~physical injury or damage to health~~ **harm**

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

Note 2 to entry: The hazard envisaged by this definition either

- is permanently present during the intended use of the machine (e.g. motion of hazardous moving elements, electric arc during a welding phase, unhealthy posture, noise emission, high temperature), or
- can appear unexpectedly (e.g. explosion, crushing hazard as a consequence of an unintended/unexpected start-up, ejection as a consequence of a breakage, fall as a consequence of acceleration/deceleration).

[SOURCE ISO 12100:2010, 3.6, modified – **Note 3 has been deleted.**]

3.1.47**indirect contact**

electric contact of ~~persons~~ **human beings** or ~~animals~~ **livestock** with exposed conductive parts that have become live under fault conditions

~~[IEV 826-12-04]~~

[SOURCE: IEC 60050-195:2021, 195-06-04]

3.1.48**inductive power supply system**

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

Note 1 to entry: The track conductor and the pick-up are analogous to the primary and secondary of a transformer, respectively.

3.1.49**instructed person**

~~(electrically)~~ **instructed person**

person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid hazards that electricity can create

~~[IEV 826-18-02]~~

[SOURCE: IEC 60050-195:2021, 195-04-02]

3.1.50**interlock** ~~(for safeguarding)~~

~~arrangement that interconnects guard(s) or device(s) with the control system and/or all or part of the electrical supply to the hoisting machine~~

arrangement of devices operating together to

- prevent hazardous situations,
- prevent damage to equipment or material,
- prevent specified operations,
- ensure correct operations

3.1.51**limiting device**

device which prevents a hoisting machine or a hoisting machine element from exceeding a designed limit (e.g. space limit, pressure limit, load limit, load moment limit)

~~[ISO 12100-1, 3.26.8]~~

[SOURCE: ISO 12100 3.28.8, modified – In the definition, "machine or hazardous machine condition(s)" has been replaced by "hoisting machine or a hoisting machine element" and "load limit" has been added.]

3.1.52**live part**

~~conductor or conductive part intended to be energized in normal operation, including a neutral conductor, but by convention, not a PEN conductor or PEM conductor or PEL conductor~~

~~NOTE This concept does not necessarily imply a risk of electric shock.~~

~~[IEV 826-12-08]~~

conductive part intended to be energized under normal operating conditions, including the neutral conductor and mid-point conductor, but excluding the PEN conductor, PEM conductor and PEL conductor

[SOURCE: IEC 60050-195:2021, 195-02-19]

3.1.53**machine actuator**

power mechanism used to effect motion of the hoisting machine (for example, motor, solenoid, pneumatic or hydraulic cylinder)

3.1.54**machinery****machine**

assembly of linked parts or components, at least one of which moves, with the appropriate machine actuators, control and power circuits, joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material

Note 1 to entry: The term "machinery" also covers an assembly of machines which, in order to achieve the same ~~end~~ target, are arranged and controlled so that they function as an integral whole

Note 2 to entry: The term "component" is used here in a general sense and does not refer only to electrical components.

~~[ISO 12100-1, 3.1, modified]~~

3.1.55

manually controlled hoisting machine

hoisting machine with continuous ~~direct~~ manual control of the load and with the load continuously visible to the operator

3.1.56

marking

signs or inscriptions primarily for the purpose of identifying equipment, components and/or devices, ~~which can include certain features thereof~~

3.1.57

neutral conductor

N

conductor electrically connected to the neutral point and capable of contributing to the distribution of electrical energy

~~[IEV 826-14-07]~~

[SOURCE: IEC 60050-195:2021, 195-02-06]

3.1.58

obstacle

part preventing unintentional direct contact by a human being or livestock with live parts, but not preventing ~~direct~~ such contact by deliberate action

[SOURCE: IEC 60050-195:2021, 195-06-16, modified – The term "protective obstacle, <electrically>" has been replaced with "obstacle".]

3.1.59

overcurrent

electric current ~~exceeding the rated electric current~~ the values of which exceeds a specific limiting value

~~[IEV 826-11-14]~~

[SOURCE: IEC 60050-151:2001, 151-15-28]

3.1.60

overload ~~(of a circuit)~~

time/current relationship in a circuit which is in excess of the rated full load of the circuit when the circuit is not under a fault condition

Note 1 to entry: "Overload" should not be used as a synonym for "overcurrent".

Note 2 to entry: In hoisting machines the term "overload" is also used for mechanical overload, which may or may not cause an electrical overload.

3.1.61

plug/socket combination

component and suitable mating component, appropriate to terminate conductors, intended for connection or disconnection of two or more conductors

Note 1 to entry: Examples of plug/socket combination include

- connectors which ~~conform to~~ fulfil the requirements of IEC 61984;
- a plug and socket-outlet, a cable coupler, or an appliance coupler in accordance with IEC 60309-1;
- a plug and socket-outlet in accordance with IEC 60884-1 or an appliance coupler in accordance with IEC 60320-1.

3.1.62**power circuit**

circuit that supplies power ~~from the supply network~~ to units of equipment used for productive operation and to transformers supplying control circuits

3.1.63**Power Drive System****PDS**

system consisting of one or more complete drive module(s) (CDM) and a motor or motors

[SOURCE: IEC 61800-2:2021, 3.52]

3.1.64**PDS of category 1**

PDS intended for use in the first environment

3.1.65**PDS of category 2**

PDS, which is neither a plug-in device nor a movable device and, when used in the first environment, is intended to be installed and commissioned only by a professional

Note 1 to entry: A professional is a person or an organization having necessary skills in installing and/or commissioning power drive systems, including their EMC aspects.

3.1.66**PDS of category 3**

PDS intended for use in the second environment and not intended for use in the first environment

3.1.67**PDS of category 4**

PDS of rated voltage equal to or above 1 000 V, or rated current equal to or above 400 A, or intended for use in complex systems in the second environment

3.1.68**protective bonding**

equipotential bonding for protection against electric shock

Note 1 to entry: Measures for protection against electric shock can also reduce the risk of burns or fire.

Note 2 to entry: Protective bonding can be achieved with protective conductors and protective bonding conductors and by conductive joining of conductive parts of the machine and its electrical equipment.

3.1.69**protective bonding circuit**

protective conductors and conductive parts connected together to provide protection against electric shock in the event of insulation failure

3.1.70**protective conductor**

~~conductor required for protective bonding by some measures for protection against electric shock for electrically connecting any of the following parts:~~

- ~~— exposed conductive parts;~~
- ~~— extraneous conductive parts;~~
- ~~— main earthing terminal (PE)~~

~~[IEV 826-13-22, modified]~~

conductor providing a primary fault current path from the exposed conductive parts of the electrical equipment to a protective earthing (PE) terminal

3.1.71

redundancy

application of more than one device or system, or part of a device or system, with the objective of ensuring that in the event of one failing to perform its function, another is available to perform that function

3.1.72

reference designation

distinctive code which serves to identify an ~~item~~ object in the documentation and on the equipment

3.1.73

risk

combination of the probability of occurrence of harm ~~(i.e., physical injury or damage to health)~~ and the severity of that harm

Note 1 to entry: "Harm" refers to physical injury or damage to health.

~~[ISO 12100-1, 3.11, modified]~~

[SOURCE: ISO 12100:2010, 3.12, modified – Note 1 to entry has been added.]

3.1.74

safeguard

guard or protective device provided as a means to protect persons from a hazard

3.1.75

safeguarding

protective measure using safeguards to protect persons from the hazards which cannot reasonably be eliminated or from the risks which cannot be sufficiently reduced by inherently safe design measures

[SOURCE: ~~ISO 12400-1, 3.20~~ ISO 12100:2010, 3.21]

3.1.76

~~**safety-related control function (safety-related control circuit)**~~

~~control function (control circuit) of a hoisting machine that is intended to maintain the safe condition of the machine or prevent an immediate increase of the risk(s)~~

3.1.76

safety function

function of a machine whose failure can result in an immediate increase of the risk(s)

[SOURCE: ISO 12100:2010, 3.30]

3.1.77

second environment

environment that includes all establishments other than those directly connected to a low voltage power supply network which supplies buildings used for domestic purposes

Note 1 to entry: Industrial areas, technical areas of any building fed from a dedicated transformer are examples of second environment locations.

3.1.78

servicing level

level on which persons stand when operating or maintaining the electrical equipment

3.1.79**short-circuit current**

overcurrent resulting from a short circuit due to a fault or an incorrect connection in an electric circuit

[SOURCE: IEC 60050-441:1984, 441-11-07]

3.1.80**short-circuit current rating**

value of prospective short-circuit current that can be withstood by the electrical equipment for the total operating time (clearing time) of the short-circuit protective device (SCPD) under specified conditions

3.1.81**skilled person**~~{electrically}~~ **skilled person**

person with relevant **training**, education and experience to enable him or her to perceive risks and to avoid hazards that electricity can create

~~[IEV 826-18-01]~~

[SOURCE: IEC 60050-195:2021, 195-04-01, modified – Training is an additional and necessary condition.]

3.1.82**supplier**

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

Note 1 to entry: The user organization may also act in the capacity of a supplier to itself.

3.1.83**switching device**

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

~~NOTE – A switching device may perform one or both of these actions.~~

[SOURCE: IEC 60050-441:1984, 441-14-01, modified – In the definition, "and/" has been added.]

3.1.84**terminal**

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

[SOURCE: IEC 60050-442:1998, 442-06-05, modified – In the definition, "or a component" has been added.]

3.1.85**uncontrolled stop**

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

Note 1 to entry: 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 document.

3.1.86**user**

entity who utilizes the hoisting machine and its associated electrical equipment

3.2 Abbreviated terms **5**

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

4 General requirements

4.1 General considerations

This document 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 ~~determine the acceptable level of risk, and the necessary protective measures~~

- identify the need for risk reduction, and
- determine adequate risk reductions, and
- determine the necessary protective measures

for persons who can be exposed to those hazards, while still maintaining an ~~acceptable~~ appropriate level of performance of the hoisting machine and its equipment.

Hazardous situations can result from, but are not limited to, the following causes:

- failures or faults in the electrical equipment resulting in the possibility of electric shock or fire of electrical origin;
- failures or faults in control circuits (or components and devices associated with those circuits) resulting in the malfunctioning of the hoisting machine;
- disturbances or disruptions in power sources as well as failures or faults in the power circuits resulting in the malfunctioning of the hoisting machine;
- loss of continuity of circuits that can result in a failure of a safety function, for example those that depend on sliding or rolling contacts, ~~resulting in a failure of a safety function~~;
- electrical disturbances – for example, electromagnetic, electrostatic – either from outside the electrical equipment or internally generated, resulting in the malfunctioning of the hoisting machine;
- release of stored energy (either electrical or mechanical) resulting in, for example, electric shock, unexpected movement that can cause injury;
- acoustic noise and mechanical vibration at levels that cause health problems to persons;
- surface temperatures that can cause injury.

~~In accordance with the hierarchy of protective measures described in ISO 12100-1 and ISO 12100-2, the required risk reduction is achieved by measures implemented by the supplier at the design stage and further measures implemented by the user.~~

Safety measures are a combination of the measures incorporated at the design stage and those measures required to be implemented by the user.

The design and development process shall identify hazards and the risks arising from them. Where the hazards cannot be removed and/or those risks cannot be sufficiently reduced by inherently safe design measures, protective measures (for example safeguarding) shall be provided to reduce the risk. Additional means (for example awareness means, flashing beacons, warning notices or signs to raise ~~awareness~~ of the risks) shall be provided where further risk reduction is necessary. In addition, working procedures that reduce risk ~~may~~ can be necessary.

~~The use of the inquiry form as shown in Annex B of this standard is recommended to facilitate an agreement~~ It is recommended that, where the user is known, Annex B be used to facilitate an exchange of information between the user and the supplier(s) on basic conditions and additional user specifications related to the electrical equipment. Those additional specifications are to:

- provide additional features that are dependent on the type of hoisting machine (or group of hoisting machines) and the application;
- facilitate maintenance and repair; and
- ~~advance~~ improve the reliability and ease of operation.

NOTE The use of Annex B ~~may~~ can also be useful to determine if a catalogued hoisting machine is suitable for the intended use.

4.2 Selection of equipment

4.2.1 General

Electrical components and devices shall:

- be suitable for their intended use; and
- conform to relevant IEC standards ~~where such exist~~; and
- be applied in accordance with the supplier's instructions.

4.2.2 Selection of power contactors

The contactors with their associated short-circuit protective devices shall have type "2" coordination in accordance with IEC 60947-4-1:2018, 8.2.5.1.

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

~~NOTE Contactors directly controlling motions and demanding a great number of contactor operations should have a mechanical life of at least 3 million operating cycles~~ should have mechanical and electrical lifetime regarding requirements for application in use. **6**

~~4.2.3 Electrical equipment in compliance with the IEC 60439 series~~

~~The electrical equipment of the hoisting machine shall conform to safety requirements identified by the risk assessment of the hoisting machine. Depending upon the hoisting machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the hoisting machine that comply with IEC 60439-1 and, as necessary, other relevant parts of the IEC 60439 series.~~

4.2.3 Switchgear

In addition to the requirements of this document, depending upon the hoisting machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the hoisting machine that conform to relevant parts of the IEC 61439 series.

4.2.4 Selection of PDS

For the PDSs or part of PDS, when it will be incorporated into electrical equipment of hoisting machines, IEC 61800-5-1 shall apply. **7**

4.3 Electrical supply

4.3.1 General requirements

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

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

4.3.2 AC supplies

Voltage Steady-state voltage: 0,9 to 1,1 of nominal voltage

~~NOTE—For certain applications (for example, large container cranes) and by agreement with the user, the voltage range may be reduced to 0,95 ... 1,05 of the nominal voltage at the point of supply (i.e., at the crane supply switch; see Figure 3).~~

Frequency 0,99 to 1,01 of nominal frequency continuously;
0,98 to 1,02 short time.

~~NOTE—The short time value may be specified by the user (see Annex B).~~

Harmonics Harmonic distortion not to exceed ~~10~~ 12 % of the total RMS voltage between live conductors for the sum of the second through to ~~fifth~~ the thirtieth harmonic. ~~An additional 2 % of the total r.m.s. voltage between live conductors for the sum of the sixth to 30th harmonic is permissible.~~

Voltage unbalance Neither the voltage of the negative sequence component nor the voltage of the zero-sequence component in three-phase supplies shall exceed 2 % of the positive sequence component.

Voltage interruption Supply interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle. There shall be more than 1 s between successive interruptions.

~~NOTE—1~~ In some semiconductor converter drives with power feedback, voltage interruptions as short as 3 ms or less can cause conduction-through and fuse blowing.

~~NOTE—2 The crane switch can operate very frequently. All the components (for example, charging circuitries) need to be selected to allow foreseen switching frequency including the use in commissioning phase.~~

Voltage dips Voltage dips shall not exceed 20 % of the ~~peak~~ RMS voltage of the supply for more than one cycle. There shall be more than 1 s between successive dips.

4.3.3 DC supplies

From batteries:

Voltage 0,85 to 1,15 of nominal voltage;
0,7 to 1,2 of nominal voltage in the case of battery-operated vehicles.

Voltage interruption not exceeding 5 ms.

From converting equipment:

Voltage 0,9 to 1,1 of nominal voltage.

Voltage interruption not exceeding 20 ms. There shall be more than 1 s between successive interruptions.

Ripple (peak-to-peak) not exceeding 0,15 of nominal voltage.

NOTE This is a variation to IEC Guide 106 to ensure proper operation of electronic equipment.

4.3.4 ~~On-board power supply~~ Special supply systems 8

For special supply systems (e.g. on-board generators, DC bus, etc.), the limits given in 4.3.2 and 4.3.3 may be exceeded provided that the equipment is designed to operate correctly with those conditions.

~~For a.c. power supply systems, means shall be provided to switch off the power supply automatically when~~

~~— the supply voltage is not within 0,85 ... 1,1 of nominal voltage;~~

~~— the frequency is not within 0,95 ... 1,05 of nominal frequency.~~

4.4 Physical environment and operating conditions

4.4.1 General

The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use. The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of hoisting machines covered by this document. When special conditions apply or the limits specified are exceeded, an ~~agreement~~ exchange of information between user and supplier (see 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 safely in its intended environment.

For electrical equipment of hoisting machines including PDS or part of PDS, IEC 61800-3 shall be applied.

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 or IEC 61000-6-8 give general EMC emission and immunity limits.

NOTE 2 ~~IEC/TR 61000-5-2 gives guidelines for earthing and cabling of electrical and electronic systems aimed at ensuring EMC. If specific product standards exist (for example, IEC 61496-1, IEC 61800-3, IEC 60947-5-2), they take precedence over generic standards.~~

~~Measures to limit the generation of electromagnetic disturbances, i.e., conducted and radiated emissions include~~ 9

- ~~— power supply filtering;~~
- ~~— cable shielding;~~
- ~~— enclosures designed to minimize r.f. radiation;~~
- ~~— r.f. suppression techniques.~~

~~Measures to enhance the immunity of the equipment against conducted and radiated r.f. disturbance include~~

- ~~— design of functional bonding system taking into account the following:~~

~~— connection of sensitive electrical circuits to the chassis. Such terminations should be marked or labelled with the symbol IEC 60417 5020 (2002-10);~~



~~— connection of the chassis to earth (PE) using a conductor with low r.f. impedance and as short as practicable;~~

~~— connection of sensitive electrical equipment or circuits direct to the PE circuit or to a functional earthing conductor (FE) (see Figure 4), to minimize common mode disturbance. This latter terminal should be marked or labelled by the symbol IEC 60417 5018 (2002-10);~~



~~— separation of sensitive circuits from disturbance sources;~~

~~— enclosures designed to minimize r.f. transmission;~~

~~— EMC wiring practices:~~

~~— using twisted conductors to reduce the effect of differential mode disturbances;~~

~~— keeping sufficient distance between conductors emitting disturbances and conductors of sensitive circuits;~~

~~— using cable orientation as close to 90° as possible when cables cross;~~

~~— running the conductors as close as possible to the ground plane;~~

~~— using electrostatic screens and/or electromagnetic shields with a low r.f. impedance termination.~~

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~~ in ambient 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 changes in parameters for example, the reduction of: **10**

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

Other parameters of different components can also alter with altitude. When the characteristic of a component can be altered by the altitude, an appropriate correction factor shall be applied according to the information of its manufacturer.

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 can be necessary 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.

NOTE Annex C and Annex G give additional information.

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 5.3.2 e)), 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. ~~(see also Annex B).~~ The neutral terminal may be provided as part of the supply disconnecting device.

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 60445:2021. For the identification of the external protective conductor terminal, see 5.2.

5.2 Terminal for connection ~~to~~ of the external protective ~~earthing system~~ conductor

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

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 conductors

Cross-sectional area of ~~phase line~~ conductors ~~supplying the equipment~~ S mm ²	Minimum cross-sectional area of the ~~external~~ corresponding 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 and type 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 60445:2021).

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:

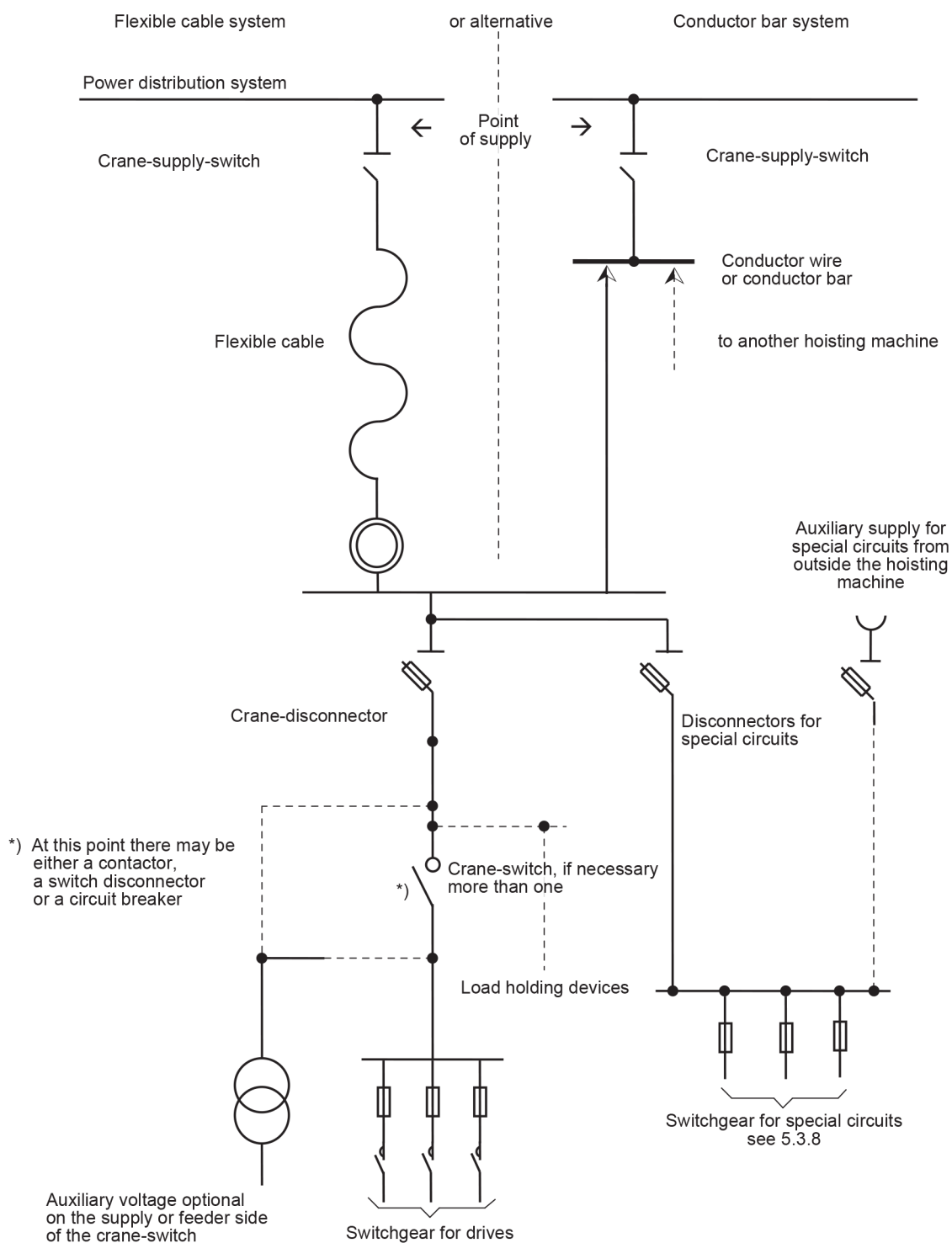
- crane-supply-switch (see 5.3.5);
- crane-disconnector (see 5.3.6);
- crane-switch (see 5.3.7).

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, utilization category AC-23B or DC-23B;
- b) a disconnector, with or without fuses, in accordance with IEC 60947-3, 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 60947-2:2016;
- 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 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.



IEC

Figure 3 – Examples of electrical supply systems

5.3.3 Requirements

When the supply disconnecting and switching device is one of the types specified in 5.3.2 a) 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). ~~Where the external operating means is not intended for emergency operations, it is recommended that it be coloured BLACK or GREY (see 10.7.4 and 10.8.4).~~
- 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 ~~for~~ other loads. The calculated breaking capacity may be reduced by the use of a proven ~~simultaneity~~ 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~~ comply with the following requirements:

- Have the ~~switching~~ 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 ~~for~~ other 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.
- Fulfil the requirements of 13.4.5.

NOTE A suitably rated plug and socket-outlet, cable coupler, or appliance coupler, in accordance with IEC 60309-1 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 of the supply disconnecting device 11

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 ~~(for example, a handle)~~ 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 Further information about direction of operation is available in IEC 61310-3.

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

- it is recommended that it be coloured BLACK or GREY (see 10.2);
- a supplementary cover or door that can be readily opened without the use of a key or tool may be provided, for example for protection against environmental conditions or mechanical damage. Such a cover/door shall clearly show that it provides access to the operating

means. This can be achieved, for example, by use of the relevant symbol IEC 60417-6169-1 (2012-08) (Figure 4) or IEC 60417-6169-2 (2012-08), (Figure 5).

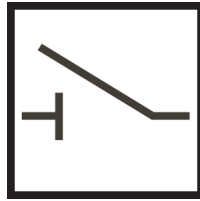


Figure 4 – Disconnecter isolator

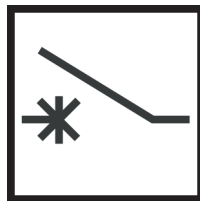


Figure 5 – Disconnecting circuit breaker

5.3.5 Crane-supply-switch

5.3.5.1 General

NOTE The following 5.3.5.1 to 5.3.5.3 do not apply to hoisting machines having on-board power supplies and without an alternative power supply from the outside.

Crane-supply-switches shall be provided

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

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

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

5.3.5.2 Type

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

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

5.3.5.3 Requirements

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

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

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

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

Where a conductor wire or conductor bar is fed by several crane-supply-switches connected in parallel, 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 ~~shall~~ **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. Otherwise, it shall meet the requirements for switch-disconnectors given in IEC 60947-3. 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.

5.3.7 Crane-switch

5.3.7.1 General

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

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

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

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

5.3.7.2 Type

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

5.3.7.3 Requirements

The requirements of 5.3.3 and 5.3.4 shall apply as appropriate. The crane-switch can operate very frequently. All the components (e.g. charging circuitries) shall be selected to allow foreseen switching frequency including the use in commissioning phase.

5.3.8 ~~Special~~ Excepted circuits

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

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

- circuits for plug and socket-outlets and lighting circuits;

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

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

~~Special~~ Excepted circuits shall be identifiable by

- permanent warning label(s) ~~in accordance with 16.1~~ placed in proximity to the crane-disconnector;
- a corresponding statement included in the maintenance manual; and one or more of the following shall apply:
 - ~~a) a permanent warning label in accordance with 16.1 is placed in proximity to each special circuit, or~~
 - ~~b) the special circuit shall be separated from other circuits, or~~
 - the conductors are identified by colour taking into account the recommendation of 13.2.4;
 - excepted circuits are separated from other circuits;
 - excepted circuits are identified by permanent warning label(s).

5.4 Devices for ~~switching off~~ removal of power for prevention of unexpected start-up

Devices for ~~switching off~~ 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 document 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 3.1.32).

Devices that do not fulfil the isolation function **12** (for example 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) may only be ~~provided where intended to be used for situations that include~~ used for prevention of unexpected start-up during tasks such as:

- inspections;
- adjustments;
- work on the electrical equipment where
 - there is no hazard arising from electric shock (see Clause 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).

~~NOTE 3~~ 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 ~~and the persons who operate them. 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 ~~disconnecting~~ isolating **13** electrical equipment

Devices shall be provided for isolating (disconnecting ~~(isolating)~~) the 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~~ the 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 3.1.28) and relevant information is provided with the electrical equipment (see 17.2).

NOTE Where protection against electric shock is provided in accordance with 6.2.2 c), 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.