

Australian Standard[®]

**Safety of machinery—Electrical
equipment of machines**

**Part 11: Requirements for HV
equipment for voltages above 1000 V
a.c. or 1500 V d.c and not exceeding 36
kV (IEC 60204-11, Ed. 1.0 (2000) MOD)**



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 - Victorian WorkCover Authority
-

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Safety of machinery—Electrical equipment of machines

Part 11: Requirements for HV equipment for voltages above 1000 V a.c. or 1500 V d.c and not exceeding 36 kV (IEC 60204-11, Ed. 1.0 (2000) MOD)

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PREFACE

This Standard was prepared by the Standards Australia Committee EL-017, Electrical Equipment of Industrial Machinery.

The objective of this Standard is to provide a framework, and criteria, for assessment of the safety of high voltage electrical equipment of machines.

This Standard is an adoption with national modifications and has been reproduced from IEC 60204-11, Ed. 1.0 (2000), *Safety of machinery—Electrical equipment of machines – Part 11: Requirements for HV equipment for voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV*, and has been varied as indicated to take account of Australian conditions.

The source IEC standard IEC 60204-11, makes numerous references to a European harmonization document HD 637, dealing with high voltage electrical installations. In this Australian standard, the references to HD 637 have been either removed or replaced by reference to the more recent IEC standard IEC 61936-1.

Variations to IEC 60204-11, Ed. 1.0 (2000) are indicated at the appropriate places throughout this standard. Strikethrough (**example**) identifies IEC text, tables and figures which, for the purposes of this Australian Standard, are deleted. Where text, tables or figures are added, each is set in its proper place and identified by shading (**example**). Added figures are not themselves shaded, but are identified by a shaded border.

As this Standard is reproduced from an International Standard, the following applies:

- (a) Its number does not appear on each page of text and its identity is shown only on the cover and title page.
- (b) In the source text 'IEC 60204-11' should read 'AS 60204.11'.
- (c) A full point should be substituted for a comma when referring to a decimal marker.

The terms 'normative' and 'informative' are used to define the application of the annex to which they apply. A normative annex is an integral part of a standard, whereas an informative annex is only for information and guidance.

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INTRODUCTION

This part of IEC 60204 provides requirements and recommendations relating to the high voltage electrical equipment (HV equipment) of machines together with its associated low voltage electrical equipment (LV equipment) so as to promote

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

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

An example of a possible application of these requirements is a machine or group of machines used for the processing of a material where a failure in such machinery can have serious economic consequences.

Figure 1 is a block diagram of a machine and associated equipment showing the various elements of the electrical equipment addressed in this standard. Numbers in parentheses refer to clauses and subclauses in this standard. It is understood that all of the elements taken together including the safeguards, software and the documentation constitute the machine or group of machines working together with usually at least one level of supervisory control.

More guidance on the use of this standard is given in annex F of IEC 60204-1.

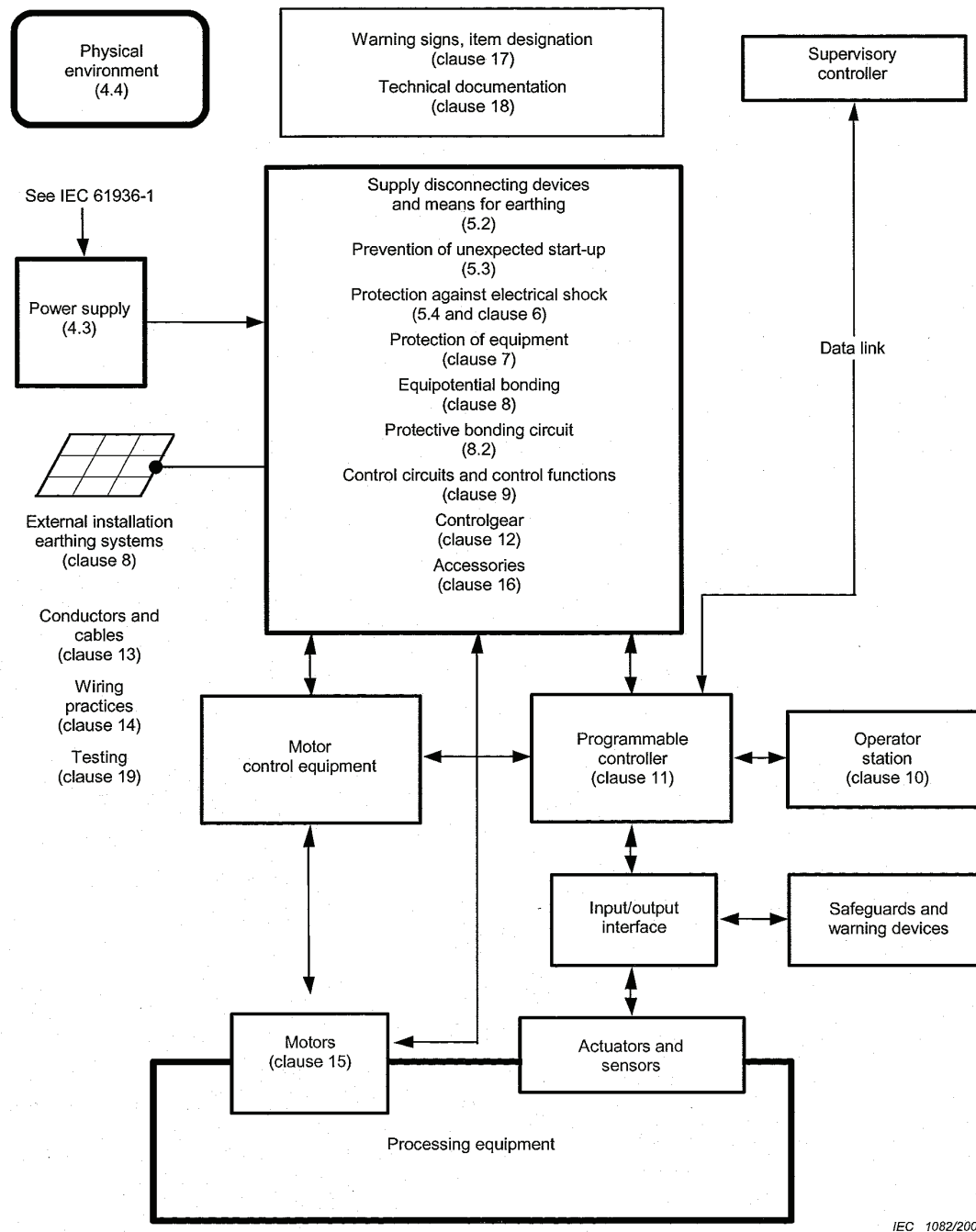


Figure 1 – Block diagram of a machine containing HV equipment

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Safety of machinery—Electrical equipment of machines
Part 11: Requirements for HV equipment for voltages above 1000 V a.c. or 1500 V d.c. and not exceeding 36 kV (IEC 60204-11, Ed. 1.0 (2000) MOD)

Any table, figure or text of the international standard that is struck through is not part of this standard. Any Australian table, figure or text that is added is part of this standard and is identified by shading.

1 Scope

IEC 60204 applies to the electrical and electronic equipment and systems of machines, including a group of machines working together in a coordinated manner, but excluding higher level system aspects (i.e. communications between systems).

This part of IEC 60204 is applicable to equipment, or parts of equipment, which operate with nominal supply voltages above 1 000 V a.c. or 1 500 V d.c. and not exceeding 36 kV a.c. or d.c. with nominal frequencies not exceeding 200 Hz. For higher voltages or frequencies, special requirements may be needed.

In this standard, the term HV equipment also covers the LV equipment forming an integral part of the equipment operating at high voltage. The requirements in this standard primarily cover the parts operating at high voltage except where explicitly stated otherwise. Reference is made to IEC 60204-1 for those requirements which also apply to HV equipment.

NOTE 1 - Other LV equipment not forming part of the HV equipment and defined as operating at voltages not exceeding 1 000 V a.c. or 1 500 V d.c. are covered by IEC 60204-1.

NOTE 2 - In this standard, the term "electrical" includes both electrical and electronic matters (i.e. electrical equipment means both the electrical and the electronic equipment).

The electrical equipment covered by this part of IEC 60204 commences at the point of connection of the supply to the electrical equipment of the machine (see 5.1).

NOTE 3 - For the requirements for power supply installations, see HD-637 IEC 61936-1.

This part of IEC 60204 is an application standard and is not intended to limit or inhibit technological advancement. It does not cover all the requirements (e.g. guarding, interlocking or control) which are needed or required by other standards or regulations in order to safeguard personnel from hazards other than electrical hazards. Each type of machine has unique requirements to be accommodated to provide adequate safety.

NOTE 4 - In the context of this standard, the term "person" refers to any individual; "personnel" are those persons who are assigned and instructed by the user or his agent(s) in the use and care of the machine in question.

This part of IEC 60204 specifically includes, but is not limited to, machines as defined in 3.26 (annex A lists examples of machines whose electrical equipment may be covered by this standard).

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

- are used in the open air (i.e. outside buildings or other protective structures);
- use, process or produce potentially explosive material (e.g. paint or sawdust);
- are used in potentially explosive and/or flammable atmospheres;

- have special risks when producing or using certain materials;
- are used in mines.

Power circuits where electrical energy is directly used as a working tool are excluded from this part of IEC 60204.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60204. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60204 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

References to international standards that are struck through in this clause are replaced by references to Australian or Australian/New Zealand Standards that are listed immediately thereafter and identified by shading. Any Australian or Australian/New Zealand Standard that is identical to the International Standard it replaces is identified as such.

~~IEC 60034-1:1996, *Rotating electrical machines — Part 1: Rating and performance*~~

AS 1359.101, *Rotating electrical machines, Part 101, General requirements—Rating and performance* (identical to IEC 60034-1)

IEC 60050(191):1990, *International Electrotechnical Vocabulary (IEV) — Chapter 191: Dependability and quality of service*

IEC 60050-195:1998, *International Electrotechnical Vocabulary (IEV) — Part 195: Earthing and protection against electric shock*

~~IEC 60050(441):1984, *International Electrotechnical Vocabulary (IEV) — Chapter 441: Switchgear, controlgear and fuses*~~

AS 1852.441, *International electrotechnical vocabulary, Part 441: Switchgear, controlgear and fuses* (identical to IEC 60050(441))

~~IEC 60050(826):1982, *International Electrotechnical Vocabulary (IEV) — Chapter 826: Electrical installations of buildings*~~

AS 1852.826, *International electrotechnical vocabulary, Part 826: Electrical installation of buildings* (identical to IEC 60050(826))

IEC 60050(826):1995, amendment No. 2

~~IEC 60071-1:1993, *Insulation co-ordination — Part 1: Definitions, principles and rules*~~

AS 1824.1, *Insulation co-ordination, Part 1: Definitions, principles and rules*

~~IEC 60071-2:1996, *Insulation co-ordination — Part 2: Application guide*~~

AS 1824.2, *Insulation co-ordination, Part 2: Application guide*

IEC 60076-5:1976, *Power transformers — Part 5: Ability to withstand short-circuit*

IEC 60129:1984, *Alternating current disconnectors and earthing switches*

~~IEC 60204-1:1997, Safety of machinery—Electrical equipment of machines—Part 1: General requirements~~

AS 60204.1, *Safety of machinery—Electrical equipment of machines, Part 1: General requirements*

~~IEC 60298:1990, A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV~~

AS 62271.200, *High-voltage switchgear and controlgear—A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV (IEC 62271-200, Ed.1 (2003) MOD)*

IEC 60364-4-42:1980, *Electrical installations of buildings – Part 4: Protection for safety – Chapter 42: Protection against thermal effects*

IEC 60364-5-54:1980, *Electrical installations of buildings – Part 5: Selection and erection of electrical equipment – Chapter 54: Earthing arrangements and protective conductors*

~~IEC 60417 (all parts), Graphical symbols for use on equipment~~

AS 60417 (all parts), *Graphical symbols for use on equipment (identical to IEC 60417)*

IEC 60420:1990, *High-voltage alternating current switch-fuse combinations*

IEC 60445:1999, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals and of terminations of certain designated conductors, including general rules for an alphanumeric system*

~~IEC 60466:1987, A.C. insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 38 kV~~

AS 2264, *A.C. insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 38 kV*

~~IEC 60529:1989, Degrees of protection provided by enclosures (IP Code)~~

AS 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60621-3:1979, *Electrical installations for outdoor sites under heavy conditions (including open-cast mines and quarries) – Part 3: General requirements for equipment and ancillaries*

IEC 60694:1996, *Common specifications for high-voltage switchgear and controlgear standards*

IEC 60865-1:1993, *Short-circuit currents – Calculation of effects – Part 1: Definitions and calculation methods*

IEC 61230:1993, *Live working – Portable equipment for earthing or earthing and short-circuiting*

IEC 61243-1:1993, *Live working – Voltage detectors – Part 1: Capacitive type to be used for voltages exceeding 1 kV a.c.*

IEC 61310-1:1995, *Safety of machinery – Indication, marking and actuation – Part 1: Requirements for visual, auditory and tactile signals*

IEC 61310-3:1999, *Safety of machinery – Indication, marking and actuation – Part 3: Requirements for the location and operation of actuators*

ISO 3864:1984, *Safety colours and safety signs*

ISO/TR 12100-1:1992, *Safety of machinery – Basic concepts, general principles for design – Part 1: Basic terminology, methodology*

EN 50178:1997, *Electronic equipment for use in power installations*

~~HD 637:1999, *Power installations exceeding 1 kV a.c.*~~

IEC 61936-1, *Power installations exceeding 1 kV a.c – Part 1: Common rules*

AS 2380, *Electrical equipment for explosive atmospheres—Explosion-protection techniques*

AS/NZS 2381, *Electrical equipment for explosive atmospheres—Selection, installation and maintenance*

AS 4024, *Safety of machinery*

AS/NZS 60079, *Electrical equipment for explosive gas atmospheres*

AS/NZS 61241, *Electrical apparatus for use in the presence of combustible dust*

AS 61508, *Functional safety of electrical/electronic/programmable electronic safety-related systems*

3 Definitions

NOTE - The index lists, in alphabetical order, the terms defined in this clause and indicates where they are used in the text of this part of IEC 60204.

For the purpose of this part of IEC 60204, the following definitions apply:

3.1

ambient temperature

temperature of the air or other medium where the equipment is to be used
[IEV 826-01-04]

3.2

barrier

part providing protection against direct contact from any usual direction of access

[IEV 826-03-13]

3.3

cable tray

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

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

[IEV 826-06-07, amendment 2]

3.4

control circuit (of a machine)

circuit used for the operational control of the machine and for protection of the power circuits

3.5 control device

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

3.6 controlgear

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

[IEV 441-11-03]

3.7 direct contact

electric contact of persons or animals with live parts

[IEV 195-06-03]

3.8 duct

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

NOTE - Conduits, cable trunking systems and underfloor channels are types of duct.

3.9 earthing system

locally limited system of conductively connected earth electrodes or metal parts of equal effectiveness (for example tower footings, armourings, metal cable sheaths), of earthing conductors and of bonding conductors

3.10 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

NOTE - **(electrically) instructed person**: A person adequately advised or supervised by an electrically skilled person to enable him or her to perceive risks and to avoid hazards which electricity can create [IEV 826-09-02, modified]

(electrically) skilled person: A person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create [IEV 826-09-01, modified]
[see also IEC 60204-1, 3.28 and 3.52]

3.11 electronic equipment

part of the electrical equipment containing circuitry mainly based on electronic devices and components

3.12 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 a door or the removal of a barrier by the use of a key or tool and which is clearly marked by appropriate warning signs

NOTE - See also NOTE to definition 3.10.

3.13 enclosure

part providing protection of equipment against certain external influences and, in any direction, protection against direct contact [IEV 826-03-12]

NOTE The definition taken from the existing IEC needs the following explanations under the scope of this standard (see IEC 60529, 3.1):

- 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 machine or separate from the machine;
 - a compartment consisting of an enclosed space within the machine structure.

3.14 equipment

general term including material, fittings, devices, appliances, fixtures, apparatus, and the like used as part of, or in connection with, an electrical installation

3.15 equipotential bonding

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

[IEV 195-01-10]

3.16 equipotential bonding conductor

(protective bonding conductor)

protective conductor provided for protective-equipotential-bonding

[IEV 195-02-10]

3.17 exposed-conductive-part

conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails

[IEV 195-06-10]

3.18 extraneous-conductive-part

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

[IEV 195-06-11]

3.19 failure

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

NOTE 1 -After failure the item has a fault.

NOTE 2 -"Failure" is an event, as distinguished from "fault", which is a state.

NOTE 3 -This concept as defined does not apply to items consisting of software only.

[IEV 191-04-01]

NOTE 4 -In practice the terms fault and failure are often used synonymously.

3.20**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 - 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.

3.21**hazard**

source of possible injury or damage to health

[ISO/TR 12100-1, 3.5, modified]

3.22**indirect contact**

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

[IEC 195-06-04]

3.23**interlock (for safeguarding)**

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

3.24**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.

[IEC 195-02-19]

3.25**machine bonding conductor**

conductor connecting the machine equipotential bonding to the earthing system

NOTE - This is an earthing conductor as defined in IEC 826-04-07 and used in HD 637.

3.26**machinery
(machine)**

- a) assembly of linked parts or components, at least one of which moves, with the appropriate machine actuators, control and power circuits, etc., joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material
- b) assembly of machines which, in order to achieve one and the same end, are arranged and controlled so that they function as an integral whole
- c) interchangeable equipment modifying the function of a machine, which is placed on the market (supplied) for the purpose of being assembled with a machine or a series of different machines or with a tractor by the operator himself insofar as this equipment is not a spare part or tool

3.27 marking

signs or inscriptions for the identification of the type of a component or device attached by the manufacturer of the component or device

3.28 neutral conductor

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

[IEV 195-02-06]

3.29 obstacle

part preventing unintentional direct contact, but not preventing direct contact by deliberate action

[IEV 826-03-14]

3.30 overcurrent

current exceeding the rated value. For conductors, the rated value is the current-carrying capacity

[IEV 826-05-06]

3.31 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 - "Overload" should not be used as a synonym for overcurrent.

3.32 plug/socket combination

plug and socket-outlet, cable coupler, or appliance coupler

3.33 power circuit

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

3.34 protective bonding circuit

the whole of the protective conductors and conductive parts used for protection against electric shock in the event of an insulation failure

3.35 protective conductor

conductor required 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

[IEV 826-04-05, modified]

3.36

reference designation

distinctive code which serves to identify an item in a diagram, list or chart, and on the equipment

3.37

risk

combination of the probability and the degree of possible injury or damage to health in a hazardous situation

[ISO/TR 12100-1]

3.38

safe working procedure

method of working that reduces risk

3.39

safeguard

guard or protective device used as a means to protect persons from a present or impending hazard

3.40

safeguarding

safety measures consisting of the use of specific means called safeguards to protect persons from hazards that cannot reasonably be removed or are not sufficiently limited by design

3.41

servicing level

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

3.42

short-circuit current

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

[IEV 441-11-07]

3.43

supplier

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

NOTE - The user may also act in the capacity of a supplier to himself.

3.44

switching device

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

[IEV 441-14-01]

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

3.45 terminal

conductive part of a device provided for electrical connection to external circuits

3.46 user

entity who utilizes the machine and its associated electrical equipment

4 General requirements

4.1 General considerations

This part of IEC 60204 is intended to apply to electrical equipment used with a wide variety of machines and with a group of machines working together in a coordinated manner.

The risks associated with the hazards relevant to the HV equipment shall be assessed as part of the overall requirements for risk assessment of the machine. This will determine the acceptable level of risk, and the necessary protective measures for persons who can be exposed to those hazards, while still maintaining an acceptable level of performance of the machine and its equipment.

Hazards 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 electrical fire;
- failures or faults in control circuits (or components and devices associated with those circuits) resulting in the malfunctioning of the machine;
- disturbances or disruptions in power sources as well as failures or faults in the power circuits resulting in the malfunctioning of the machine;
- loss of continuity of circuits that depend upon sliding or rolling contacts, resulting in a failure of a safety function;
- electrical disturbances (e.g. electromagnetic, electrostatic or radio interference) either from outside the electrical equipment or internally generated;
- release of stored energy (either electrical or mechanical) resulting in, for example, electric shock, or unexpected movement that can cause injury;
- audible noise at levels that cause health problems to persons.

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

Design and development shall be the first consideration in the reduction of risks. Where this is not sufficient, safeguarding and safe working procedures shall be considered. Safeguarding includes the use of safeguards and awareness means.

The use of the inquiry form as shown in annex B of this standard is recommended in order to facilitate an appropriate agreement between the user and the supplier(s) on basic conditions and additional user requirements related to the HV equipment. Those additional requirements are to

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

4.2 Selection of electrical equipment

Electrical components and devices shall be suitable for their intended use and shall conform to relevant Australian and IEC standards where such exist. For example, where factory-built, type-tested HV switchgear is used, it shall be selected from those manufactured and tested in accordance with standards such as IEC 60298, IEC 60466 and IEC 60694.

4.3 Electrical supply

4.3.1 General

The electrical equipment shall be designed to operate correctly with the conditions of the supply

- as specified in 4.3.2, 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.

4.3.2 Supplies

Voltage	Steady-state voltage: 0,9... 1,1 of nominal voltage
Frequency	0,99... 1,01 of nominal frequency continuously; 0,98... 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 % of the total r.m.s. voltage between live conductors for the sum of the 2nd through 5th harmonic. An additional 2 % of the total r.m.s. voltage between live conductors for the sum of the 6th through 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.
Voltage dips	Voltage dips shall not exceed 20 % of the peak voltage of the supply for more than 1 cycle. There shall be more than 1 s between successive dips.

4.3.3 On-board power supply

For special supply systems such as on-board generators, the limits given in 4.3.2 may be exceeded provided that the electrical equipment is designed to operate correctly with those conditions.

4.4 Physical environment and operating conditions

The HV equipment shall be suitable for use in the physical environment and operating conditions specified in 4.4.2 to 4.4.8 of IEC 60204-1. When the physical environment or the operating conditions are outside those specified, an agreement may be needed between the supplier and the user (see annex B).