LVD TEST REPORT

On Behalf of

Product Name:	Sprayer
Trademark:	N/A
Model Number:	Phj, DJphj 1，XJphj2, DJphj 2, XJphj1
Prepared For:	Guangzhou Baiyun district paidun stage lighting instrument factory
Address:	Room 201, Floor 2, No.11 Jiangshi Road, Hebu Village, Jianggao Town, Baiyun District, Guangzhou
Prepared By:	Shenzhen Huaxiang Testing Technology Co , Ltd
Address:	201, Building A10, Fuhai Information Port, Fuhai Street, Bao'an District, Shenzhen City
Report No.:	HUAX230506003KR

TEST REPORT

BS EN 60204-1:2018
Safety of machine- Electrical equipment of machines, Part 1: General requirements

Administrative Data	
Report Reference No. ..... :	HUAX230506003KR
Date of issue..... :	May 10, 2023
Testing laboratory	
Name ..... :	Shenzhen Huaxiang Testing Technology Co , Ltd.
Address……..…… ……..:	201, Building A10, Fuhai Information Port, Fuhai Street, Bao'an District, Shenzhen City
Testing location ..... :	Same as above
Applicant's name ..... :	Guangzhou Baiyun district paidun stage lighting instrument factory
Address ..... :	Room 201, Floor 2, No.11 Jiangshi Road, Hebu Village, Jianggao Town, Baiyun District, Guangzhou
Test specification:	
Directive/ standard ..... :	BS EN 60204-1:2018
Test procedure ..... :	UKCA- LVD
Test item description ..... :	Sprayer
Manufacturer……..:	Guangzhou Baiyun district paidun stage lighting instrument factory
Address ..... :	Room 201, Floor 2, No.11 Jiangshi Road, Hebu Village, Jianggao Town, Baiyun District, Guangzhou
Tradmark..... :	N/A
Model/Type reference ..... :	Phj, DJphj 1，XJphj2, DJphj 2, XJphj1
Rating..... :	AC 110/220V, 50/60Hz, 10/6A

Testing procedure and testing location

Laboratory name……	:	Shenzhen Huaxiang Testing Technology Co , Ltd.
Testing location/address:	:	201, Building A10, Fuhai Information Port, Fuhai Street, Bao'an District, Shenzhen City
Testing lprocedure	:	TL ☒ RMT ☐ SMT ☐ WMT ☐ TMP ☐
Tested By (Test Engineer)	:	Kevin Su
Approved By (Chief Engineer)		Amy Jiang

Test case verdicts	
Test case does not apply to the test object .....:	N(/A)
Test item does meet the requirement ..... :	P(ass)
Test item does not meet the requirement ..... :	F(ail)
Particulars: test item vs. test requirements	
Equipment mobility……	: Changeless
Operating condition……	: Continuous
Tested for IT power systems……	: No
IT testing, phase-phase voltage (V) ……	: N.A.
Class of equipment……	: N.A.
Protection against ingress of water……	: IP20
TESTING:	
Date of receipt of test item .....:	May 04, 2023
Date (s) of performance of tests .....:	May 04, 2023- May 10, 2023

General remarks

This report shall not be reproduced except in full without the written approval of the testing laboratory.

The test results presented in this report relate only to the item(s) tested.

”(see remark #)" refers to a remark appended to the report.

"(see Annex #)" refers to an annex appended to the report.

Throughout this report a comma is used as the decimal separator.

General product information:

- All models Phj are similar except rating power and appearance and all tests are conduct on model Phj .
- This technical report is only used for internal reference of the company, and not for any other legal basis and use.

Copy of marking plate:

Sprayer

Model : Phj

Rating: AC 110/220V, 50/60Hz, 10/6A

Date for manufactured: 2023

Guangzhou Baiyun district paidun stage lighting instrument factory
Room 201, Floor 2, No.11 Jiangshi Road, Hebu Village, Jianggao Town, Baiyun District, Guangzhou

Made in China

Summary of Testing:

1. The product has been tested and found in compliance with BS EN 60204-1 for Safety of machine-Electrical equipment of machines, Part 1: General requirements.
2. The test result complies with the requirements of the relevant standard.

BS EN 60204-1			
Clause	Requirement – Test	Result - Remark	Verdict
BS EN 60204-1:2018 Electrical equipment of machines–Part 1: General requirments			
4	**General requirments**		
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 co-coordinated 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 machine. This will determine the adequate risk reduction 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.		P
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 risk assessment of the machine.	Be suitable for their intended use and conform to relevant IEC/EN standards.	P
4.2.2	**Electrical equipment in compliance with the EN 60439 series**		
	Depending upon the machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the machine that are in compliance with EN 60439-1 and, as necessary, other relevant parts of the EN 60439 series (see also Annex F).		P
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 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.	Comply with clause 4.3.2.	P
4.3.2	**AC supplies**		
	Voltage Steady state voltage: 0,9 to 1,1 of nominal voltage. Frequency: 0,99 to 1,01 of nominal frequency continuously; 0,98 to 1,02 short time. Harmonics: Harmonic distortion not exceeding 10 % of the total r.m.s. voltage between live conductors for the sum of the 2nd through to the 5th harmonic. An additional 2 % of the total r.m.s. voltage between live conductors for the sum of the 6th through to the 30th harmonic is permissible. Voltage unbalance: Neither the voltage of the negative sequence component nor the voltage of the zero sequence components in three-phase supplies exceeding 2 % of the positive sequence component. Voltage interruption: Supply interrupted or at zero voltage for not more than 3 ms at any	AC 110/220V Voltage unbalance<=2% Voltage interruption <=3ms Voltage dips<=20%	P

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	random time in the supply cycle with more than 1 s between successive interruptions. Voltage dips: Voltage dips not exceeding 20 % of the peak voltage of the supply for more than one cycle with 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 with more than 1 s between successive interruptions. Ripple (peak-to-peak): Not exceeding 0,15 of nominal voltage.	Only AC supplies.	N
4.3.4	**Special supply systems**		
	For special supply systems such as on-board generators, 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.		N
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 machines covered by this part of EN 60204. When special conditions apply or the limits specified are exceeded, an agreement between user and supplier (see 4.1) is recommended (see Annex B).		P
4.4.3	**Ambient air temperature**		
	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. The minimum requirement for all electrical equipment is correct operation between air temperatures of +5 °C and +40 °C. For very hot environments (for example hot climates, steel mills, paper mills) and for cold environments, additional measures are recommended (see Annex B).		P
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 humilities are permitted at lower temperatures (for example 90 % at 20 °C). Harmful effects of occasional condensation shall be avoided by design of the equipment or where necessary, by additional measures (for example built-in heaters, air conditioners, drain holes).		P
4.4.5	**Altitude**		
	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.	<2000m.	P
4.4.6	**Contaminants**		

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	Electrical equipment shall be adequately protected against the ingress of solids and liquids. The electrical equipment shall be adequately protected against contaminants (for example 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).	For electrical equipment, IP2X.	P
4.4.7	**Ionizing and non-ionizing radiation**		
	When equipment is subject to radiation (for example 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	No ionizing and non-ionizing radiation outside this equipment.	P
4.4.8	**Vibration, shock, and bump**		
	Undesirable effects of vibration, shock and bump (including those generated by the 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 the machine, or by provision of anti-vibration mountings. A special agreement is recommended between the supplier and the user (see Annex B).	Undesirable effects be avoided by the selection of suitable equipment.	P
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 °C to +55 °C and for short periods not exceeding 24 h at up to +70 °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).	Within the SMPS during approval	P
4.6	**Provisions for handling**		
	Heavy and bulky electrical equipment that has to be removed from the machine for transport or that is independent of the machine, shall be provided with suitable means for handling by cranes or similar equipment.		P
4.7	**Installation**		
	Electrical equipment shall be installed in accordance with the electrical equipment supplier's Instructions.		P
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 machine is connected to a single incoming supply. Where another supply is necessary for certain parts of the equipment (for example, electronic equipment that operates at a different voltage), that supply should be derived, as far as is practicable, from devices (for example, transformers, converters) forming part of the electrical equipment of the machine. For large complex machinery comprising a number of widely-spaced machines working together in a coordinated manner, there can be a need for more than one incoming supply depending upon the site supply arrangements (see 5.3.1) Unless a plug is provided with the machine for the connection to the supply (see 5.3.2 e), it is recommended that the supply conductors are terminated at the	Plugs and couplers are provided. All terminals marked correct labels.	P

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	supply disconnecting device where a neutral conductor is used it shall be clearly indicated in the technical documentation of the machine, such as in the installation diagram and in the circuit diagram, and a separate insulated terminal, labeled N in accordance with 16.1, shall be provided for the neutral conductor (see also Annex B) There shall be no connection between the neutral conductor and the protective bonding circuit inside the electrical equipment nor shall a combined PEN terminal be provided Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the power supply to the machine for TN-C systems. All terminals for the incoming supply connection shall be clearly identified in accordance with IEC 60445 and 16.1. For the identification of the external protective conductor terminal, see 5.2. See 17.8 for the provision of instructions for maintenance of the associated phase conductor terminals for connection of the machine to the external protective earthing system or to the external protective conductor, depending upon the supply distribution system. The terminal shall be of such a size as to enable the connection of an external protective copper conductor with a cross-sectional area in accordance with Table		
5.2	**Terminal for connection to the external protective earthing system**		
	For each incoming supply, a terminal shall be provided in the vicinity	PE label used.	P
5.3	**Supply disconnecting (isolating) device**		
5.3.1	**General**		
	supply disconnecting device shall be provided: —for each incoming source of supply to a machine(s); —for each on-board power supply. The supply disconnecting device shall disconnect (isolate) the electrical equipment of the machine from the supply when required (for example for work on the machine, including the electrical equipment). When two or more supply disconnecting devices are provided, protective interlocks for their correct operation shall also be provided in order to prevent a hazardous situation, including damage to the machine or to the work in progress.		P
5.3.2			
	The supply disconnecting device shall be one of the following types: a) switch-disconnect or, with or without fuses, in accordance with IEC 60947-3, utilization category AC-23B or DC-23B; b) disconnect or, 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; 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	Comply with requirement e). Plugs and couplers used.	P

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Clause	Requirement – Test	Result - Remark	Verdict
	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.		
5.3.3	**Requirements**		
	When the supply disconnecting device is one of the types specified in 5.3.2 a) to d) it shall fulfill 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 (DB:2002-10) and IEC 60417-5007 (DB: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;		P
	—have an external operating means (for example 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 colored 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 (for example by padlocks). When so locked, remote as well as local closing shall be prevented; —disconnect all live conductors of its power supply circuit. However, for TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory; —have a breaking capacity sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. When the supply disconnecting device is a plug/socket combination, it shall fulfill the following requirements: have the switching capability, or be interlocked with a switching device that has a breaking capacity, sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. The calculated breaking capacity may be reduced by the use of a proven diversity factor. When the interlocked switching device is electrically operated (for example a contactor) it —shall have an appropriate utilization category.	The supply disconnecting device is are plugs. See subclause 13.4.5.	
	Where the supply disconnecting device is a plug/socket combination, a switching device with an appropriate utilization category shall be provided for switching the machine on and off. This can be achieved by the use of the interlocked switching device described above.		
5.3.4	**Operating means**		
	The operating means (for example, a handle) of the supply	The supply	P

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	disconnecting 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.	disconnecting device is easily accessible.	
5.3.5	**Excepted circuits**		
	The following circuits need not be disconnected by the supply disconnecting device: —lighting circuits for lighting needed during maintenance or repair; —plug and socket outlets for the exclusive connection of repair or maintenance tools and equipment (for example hand drills, test equipment); —under voltage protection circuits that are only provided for automatic tripping in the event of supply failure; —circuits supplying equipment that should normally rN/Ain energized for correct operation (for example temperature controlled measuring devices, product (work in progress) heaters, program storage devices); —control circuits for interlocking. It is recommended, however, that such circuits be provided with their own disconnecting device. Where such a circuit is not disconnected by the supply disconnecting device: —permanent warning label(s) in accordance with 16.1 shall be appropriately placed in proximity to the supply disconnecting device; —a corresponding statement shall be included in the maintenance manual, and one or more of the following shall apply; —a permanent warning label in accordance with 16.1 is affixed in proximity to each excepted circuit, or —the excepted circuit is separated from other circuits, or —the conductors are identified by colour taking into account the recommendation of 13.2.4.	No such devices.	N
5.4	**Devices for switching off for prevention of unexpected start-up**		
	Devices for switching off for the prevention of unexpected start-up shall be provided (for example where, during maintenance, a start-up of the machine or part of the machine can create a hazard). Such devices shall be appropriate and convenient for the intended use, shall be suitably placed, and readily identifiable as to their function and purpose (for example by a durable marking in accordance with 16.1 where necessary).	No such devices.	N
5.5	**Devices for disconnecting electrical equipment**		
	be carried out when it is de-energized and isolated. Such devices shall be: —appropriate and convenient for the intended use; —suitably placed; —readily identifiable as to which part(s) or circuit(s) of the equipment is served (for example by durable marking in accordance with 16.1 where necessary). 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 supply disconnecting device (see		P

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Clause	Requirement – Test	Result - Remark	Verdict
	5.3) may, in some cases, fulfil that function. However where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of a number of 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 machine, requiring separate isolation. In addition to the supply disconnecting device, 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 3.15) and relevant information is provided with the electrical equipment (see 17.2 b)9) and b)12)).		
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), (for example by provisions for padlocking, trapped key interlocking). When so secured, remote as well as local reconnection shall be prevented.		P
	Where a non-lockable disconnecting device (for example withdrawable fuse-links withdrawable links) other means of protection against reconnection (for example warning labels in accordance with 16.1) may be provided. However, when a plug/socket combination according to 5.3.2 e) is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for securing in the disconnected state need not be provided.	Plug used.	P
6 Protection against electric shock			
6.1	**General**		
	The electrical equipment shall provide protection of persons against electric shock from: —direct contact (see 6.2 and 6.4); —indirect contact (see 6.3 and 6.4). The measures for this protection given in 6.2, 6.3, and, for PELV, in 6.4, are a recommended selection from IEC 60364-4-41. Where those recommended measures are not practicable, for example due to the physical or operational conditions, other measures from IEC 60364-4-41 may be used.	See below.	P
6.2	**Protection against direct contact**		
6.2.1	**General**		
	For each circuit or part of the electrical equipment, the measures of either 6.2.2 or 6.2.3 and where applicable, 6.2.4 shall be applied.	IP2X.	P
	Exception: where those measures are not appropriate, other measures for protection against direct contact (for example by using barriers, by placing out of reach, using obstacles, using construction or installation techniques that prevent access) as defined in IEC 60364-4-41 may be applied (see 6.2.5 and 6.2.6). When the equipment is located in places open to all persons, which can include children measures of either 6.2.2 with a		

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Clause	Requirement – Test	Result - Remark	Verdict
	minimum degree of protection against direct contact corresponding to IP4X or IPXXD (see IEC 60529), or 6.2.3 shall be applied.		
6.2.2	**Protection by enclosures**		
	Live parts shall be located inside enclosures that conform to the relevant requirements of Clauses 4, 11, and 14 and that provide protection against direct contact of at least IP2X or IPXXB (see IEC 60529). Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against direct contact provided by the top surfaces shall be IP4X or IPXXD Opening an enclosure (i.e. opening doors, lids, covers, and the like) shall be possible only under one of the following conditions: a): The use of a key or tool is necessary for access. For enclosed electrical operating areas; b): The disconnection of live parts inside the enclosure before the enclosure can be opened; c): Opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against direct contact to at least IP2X or IPXXB.	IP2X, protected by earthed metal enclosure.	P
6.2.3	**Protection by insulation of live parts**		
	Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction. Such insulation shall be capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions.		P
6.2.4	**Protection against residual voltages**		
	Live parts having a residual voltage greater than 60 V after the supply has been disconnected shall be discharged to 60 V or less within a time period of 5 s after disconnection of the supply voltage provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 µC or less. Where this specified rate of discharge would interfere with the proper functioning of the equipment, a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure containing the capacitances.	IP2X, residual voltage less than 60V after 1s.	P
	In the case of plugs or similar devices, the withdrawal of which results in the exposure of conductors (for example pins), the discharge time shall not exceed 1 s, otherwise such conductors shall be protected against direct contact to at least IP2X or IPXXB. If neither a discharge time of 1 s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires, conductor bars, or slip-ring assemblies, see 12.7.4), additional switching devices or an appropriate warning device (for example a warning notice in accordance with 16.1) shall be applied		
6.2.5	**Protection by barriers**		
	For protection by barriers, 412.2 of IEC 60364-4-41 shall apply.		N

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6.2.6	**Protection by placing out of reach or protection by obstacles**		
	For protection by placing out of reach, 412.4 of IEC 60364-4-41 shall apply. For protection by obstacles, 412.3 of IEC 60364-4-41 shall apply. For conductor wire systems or conductor bar systems with a degree of protection less than IP2X, see 12.7.1.		P
6.3	**Protection against indirect contact**		
6.3.1	**General**		
	Protection against indirect contact (3.29) is intended to prevent hazardous situations due to an insulation fault between live parts and exposed conductive parts. For each circuit or part of the electrical equipment, at least one of the measures in accordance with 6.3.2 to 6.3.3 shall be applied: —measures to prevent the occurrence of a touch voltage (6.3.2); or —automatic disconnection of the supply before the time of contact with a touch voltage can become hazardous (6.3.3).	See below.	P
6.3.2	**Prevention of the occurrence of a touch voltage**		
6.3.2.1	**General**		
	Measures to prevent the occurrence of a touch voltage include the following: —provision of class II equipment or by equivalent insulation; —electrical separation.	Class I equipment.	P
6.3.2.2	**Protection by provision of class II equipment or by equivalent insulation**		
	This measure is intended to prevent the occurrence of touch voltages on the accessible parts through a fault in the basic insulation. This protection is provided by one or more of the following: —class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140); —switchgear and control gear assemblies having total insulation in accordance with IEC 60439-1; —supplementary or reinforced insulation in accordance with 413.2 of IEC 60364-4-41.		N N
6.3.2.3	**Protection by electrical separation**		
	Electrical separation of an individual circuit is intended to prevent a touch voltage through contact with exposed conductive parts that can be energized by a fault in the basic insulation of the live parts of that circuit. For this type of protection, the requirements of 413.5 of IEC 60364-4-41 apply.		P
6.3.3	**Protection by automatic disconnection of supply**		
	This measure consists of the interruption of one or more of the line conductors by th automatic operation of a protective device in case of a fault. This interruption shall occur within a sufficiently short time to limit the duration of a touch voltage to a time within which the touch voltage is not hazardous. Interruption times are given in Annex A.		P
6.4	**Protection by the use of PELV**		
6.4.1	**General requirements**		
	The use of PELV (Protective Extra-Low Voltage) is to protect persons against electric shock from indirect contact and limited		

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	area direct contact (see 8.2.5). PELV circuits shall satisfy all of the conditions:		P
6.4.2	**Sources for PELV**		
	The source for PELV shall be one of the following: —a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6; —a source of current providing a degree of safety equivalent to that of the safety isolating transformer (for example a motor generator with winding providing equivalent isolation); —an electrochemical source (for example a battery) or another source independent of a higher voltage circuit (for example a diesel-driven generator); —an electronic power supply conforming to appropriate standards specifying measures to be –taken to ensure that, even in the case of an internal fault, the voltage at the outgoing terminals cannot exceed the values specified in 6.4.1.		N
7 Protection of equipment			
7.1	**General**		
	This Clause details the measures to be taken to protect equipment against the effects of: —overcurrent arising from a short circuit; —overload and/or loss of cooling of motors; —abnormal temperature; —loss of or reduction in the supply voltage; —overspeed of machines/machine elements; —earth fault/residual current; —incorrect phase sequence; —overvoltage due to lightning and switching surges.		P
7.2	**Overcurrent protection**		
7.2.1	**General**		
	Overcurrent protection shall be provided where the current in a machine circuit can exceed either the rating of any component or the current carrying capacity of the conductors whichever is the lesser value. The ratings or settings to be selected are detailed in 7.2.10.		P
7.2.2	**Supply conductors**		
	Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the overcurrent protective device for the supply conductors to the electrical equipment (see Annex B). The supplier of the electrical equipment shall state on the installation diagram the data necessary for selecting the overcurrent protective device (see 7.2.10 and 17.4).		P
7.2.3	**Power circuits**		
	evices for detection and interruption of overcurrent, selected in accordance with 7.2.10 shall be applied to each live conductor. The following conductors, as applicable, shall not be disconnected without disconnecting all associated live conductors: —the neutral conductor of a.c. power circuits; —the earthed conductor of d.c. power circuits; —d.c. power conductors bonded to exposed conductive parts of mobile machines.	The cross-sectional area of the neutral conductor is equal to the phase conductors.	P

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	Where the cross-sectional area of the neutral conductor is at least equal to or equivalent to that of the phase conductors, it is not necessary to provide over current detection for the neutral conductor nor a disconnecting device for that conductor. For a neutral conductor with a cross-sectional area smaller than that of the associated phase conductors, the measures detailed in 524 of IEC 60364-5-52 shall apply. In IT systems, it is recommended that the neutral conductor is not used. However, where a neutral conductor is used, the measures detailed in 431.2.2 of IEC 60364-4-43 shall apply.		
7.2.4	**Control circuits**		
	Conductors of control circuits directly connected to the supply voltage and of circuits supplying control circuit transformers shall be protected against over current in accordance with 7.2.3. Conductors of control circuits supplied by a control circuit transformer or d.c. supply shall be protected against over current (see also 9.4.3.1): —in control circuits connected to the protective bonding circuit, by inserting an over current protective device into the switched conductor; —in control circuits not connected to the protective bonding circuit; —where the same cross sectional area conductors are used in all control circuits, by inserting an over current protective device into the switched conductor, and; —where different cross sectional areas conductors are used in different sub-circuits, by inserting an overcurrent protective device into both switched and common conductors of each sub-circuit.	Switch and fuse provided.	P
7.2.5	**Socket outlets and their associated conductors**		
	Overcurrent protection shall be provided for the circuits feeding the general purpose socket outlets intended primarily for supplying power to maintenance equipment. Overcurrent protective devices shall be provided in the unearthed live conductors of each circuit feeding such socket outlets.	No such socket outlets.	N
7.2.6	**Lighting circuits**		
	All unearthed conductors of circuits supplying lighting shall be protected against the effects of short circuits by the provision of over current devices separate from those protecting other circuits.	No provided.	N
7.2.7	**Transformers**		
	Transformers shall be protected against over current in accordance with the manufacturer's instructions. Such protection shall (see also 7.2.10): —avoid nuisance tripping due to transformer magnetizing inrush currents; —avoid a winding temperature rise in excess of the permitted value for the insulation class of transformer when it is subjected to the effects of a short circuit at its secondary terminals. The type and setting of the over current protective device should be in accordance with the recommendations of the transformer supplier.	Built-in SMPS and complied with relevant standards.	P
7.2.8	**Location of over current protective devices**		
	An over current protective device shall be located at the point		P

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Clause	Requirement – Test	Result - Remark	Verdict
	where a reduction in the cross-sectional area of the conductors or another change reduces the current-carrying capacity of the conductors, except where all the following conditions are satisfied: —the current carrying capacity of the conductors is at least equal to that of the load; —the part of the conductor between the point of reduction of current-carrying capacity and the position of the over current protective device is no longer than 3 m; —the conductor is installed in such a manner as to reduce the possibility of a short-circuit for example, protected by an enclosure or duct.		
7.2.9	**Overcurrent protective devices**		
	The rated short-circuit breaking capacity shall be at least equal to the prospective fault current at the point of installation. Where the short-circuit current to an over current protective device can include additional currents other than from the supply (for example from motors from power factor correction capacitors), those currents shall be taken into consideration. A lower breaking capacity is permitted where another protective device (for example the over current protective device for the supply conductors (see 7.2.2) having the necessary breaking capacity is installed on the supply side. In that case, the characteristics of the two devices shall be co-coordinated so that the let-through energy ($I2t$) of the two devices in series does not exceed that which can be withstood without damage to the over current protective device on the load side and to the conductors protected by that device (see Annex A of IEC 60947-2). Where fuses are provided as over current protective devices, a type readily available in the country of use shall be selected, or arrangements shall be made for the supply of spare parts.	Using overcurrent protective device, such as fuse.	P
7.2.10	**Rating and setting of overcurrent protective devices**		
	The rated current of fuses or the setting current of other over current protective devices shall be selected as low as possible but adequate for the anticipated over currents (for example during starting of motors or energizing of transformers). When selecting those protective devices, consideration shall be given to the protection of switching devices against damage due to over currents (for example welding of the switching device contacts). The rated current or setting of an over current protective device is determined by the current carrying capacity of the conductors to be protected in accordance with 12.4, D.2 and the maximum allowable interrupting time t in accordance with Clause D.3, taking into account the needs of co-ordination with other electrical devices in the protected circuit.		N
7.3	**Protection of motors against overheating**		
7.3.1	**General**		
	Protection of motors against overheating shall be provided for each motor rated at more than 0,5 kW. Exceptions: In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps), the means of detection shall give a warning signal to which the operator can		N

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Clause	Requirement – Test	Result - Remark	Verdict
	respond. Protection of motors against overheating can be achieved by: —overload protection (7.3.2), —over-temperature protection (7.3.3), or —current-limiting protection (7.3.4). Automatic restarting of any motor after the operation of protection against overheating shall be prevented where this can cause a hazardous situation or damage to the machine or to the work in progress.		
7.3.2	**Overload protection**		
	Where overload protection is provided, detection of overload(s) shall be provided in each live conductor except for the neutral conductor. However, where the motor overload detection is not used for cable overload protection (see also Clause D.2), the number of overload detection devices may be reduced at the request of the user (see also Annex B). For motors having single-phase or d.c. power supplies,detection in only one unearthed live conductor is permitted. Where overload protection is achieved by switching off, the switching device shall switch off all live conductors. The switching of the neutral conductor is not necessary for overload protection. Where motors with special duty ratings are required to start or to brake frequently (for example, motors for rapid traverse, locking, rapid reversal, sensitive drilling) it can be difficult to provide overload protection with a time constant comparable with that of the winding to be protected. Appropriate protective devices designed to accommodate special duty motors or over-temperature protection (see 7.3.3) can be necessary. For motors that cannot be overloaded (for example torque motors, motion drives that either are protected by mechanical overload protection devices or are adequately dimensioned) overload protection is not required.		N
7.3.3	**Over-temperature protection**		
	The provision of motors with over-temperature protection (see IEC 60034-11) is recommended in situations where the cooling can be impaired (for example dusty environments). Depending upon the type of motor, protection under stalled rotor or loss of phase conditions is not always ensured by over-temperature protection, and additional protection should then be provided. Over-temperature protection is also recommended for motors that cannot be overloaded (for example torque motors, motion drives that are either protected by mechanical overload protection devices or are adequately dimensioned), where the possibility of over-temperature exists (for example due to reduced cooling).		N
7.3.4	**Current limiting protection**		
	Where protection against the effects of overheating in three phase motors is achieved by current limitation, the number of current limitation devices may be reduced from 3 to 2 (see 7.3.2). For motors having single phase a.c or d.c. power supplies, current limitation in only one unearthed live conductor is permitted.		N
7.4	**Abnormal temperature protection**		
	Resistance heating or other circuits that are capable of attaining or		N

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Clause	Requirement – Test	Result - Remark	Verdict
	causing abnormal temperatures (for example, due to short-time rating or loss of cooling medium) and therefore can cause a hazardous situation shall be provided with suitable detection to initiate an appropriate control response.		
7.5	**Protection against supply interruption or voltage reduction and subsequent restoration**		
	Where a supply interruption or a voltage reduction can cause a hazardous situation, damage to the machine, or to the work in progress, under voltage protection shall be provided by, for example, switching off the machine at a predetermined voltage level where the operation of the machine can allow for an interruption or a reduction of the voltage for a short time period, delayed under voltage protection may be provided. The operation of the under voltage device shall not impair the operation of any stopping control of the machine. Upon restoration of the voltage or upon switching on the incoming supply, automatic or unexpected restarting of the machine shall be prevented where such a restart can cause a hazardous situation. Where only a part of the machine or of the group of machines working together in a coordinated manner is affected by the voltage reduction or supply interruption, the under voltage protection shall initiate appropriate control responses to ensure co-ordination.		N
7.6	**Motor overspeed protection**		
	Cause a hazardous situation taking into account measures in accordance with 9.3.2. Overspeed protection shall initiate appropriate control responses and shall prevent automatic restarting. The overspeed protection should operate in such a manner that the mechanical speed limit of the motor or its load is not exceeded.		N
7.7	**Earth fault/residual current protection**		
	In addition to providing over current protection for automatic disconnection as described in 6.3, earth fault/residual current protection can be provided to reduce damage to equipment due to earth fault currents less than the detection level of the over current protection. The setting of the devices shall be as low as possible consistent with correct operation of the equipment.	Using copper wires connect to the earth system.	P
7.8	**Phase sequence protection**		
	Where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine, protection shall be provided.		P
7.9	**Protection against over voltages due to lightning and to switching surges**		
	Protective devices can be provided to protect against the effects of overvoltage due to lightning or to switching surges. Where provided: —devices for the suppression of over voltages due to lightning shall be connected to the incoming terminals of the supply		N
	disconnecting device. —devices for the suppression of over voltages due to switching surges shall be connected across the terminals of all equipment requiring such protection.		
8 Equipment potential bonding			

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Clause	Requirement – Test	Result - Remark	Verdict
8.1	**General**		
	This Clause provides requirements for both protective bonding and functional bonding.		P
8.2	**Protective bonding circuit**		
8.2.1	**General**		
	The protective bonding circuit consists of: —PE terminal(s) (see 5.2); —the protective conductors in the equipment of the machine including sliding contacts where they are part of the circuit; —the exposed conductive parts and conductive structural parts of the electrical equipment; —those extraneous conductive parts which form the structure of the machine. All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses that can be caused by earth-fault	Complied.	P
8.2.2	**Protective conductors**		
	Protective conductors shall be identified in accordance with 13.2.2. Copper conductors are preferred. Where a conductor material other than copper is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm2 in cross-sectional area. The cross-sectional area of protective conductors shall be determined in accordance with the requirements of: —543 of IEC 60364-5-54; or —7.4.3.1.7 of IEC 60439-1, as appropriate. This requirement is met in most cases where the relationship between the cross-sectional area of the phase conductors associated with that part of the equipment and the cross-sectional area of the associated protective conductor is in accordance with Table 1 (see 5.2) See also 8.2.8.	Copper conductors comply with relevant clause, and PE label marked.	P
8.2.3	**Continuity of the protective bonding circuit**		
	All exposed conductive parts shall be connected to the protective bonding circuit in accordance with 8.2.1. Exception: see 8.2.5. Where a part is removed for any reason (for example routine maintenance), the protective bonding circuit for the rN/Aining parts shall not be interrupted. Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical, chemical, or electrochemical influences. Where enclosures and conductors of aluminum or aluminum alloys are used, particular consideration should be given to the possibility of electrolytic corrosion. Metal ducts of flexible or rigid construction and metallic cable sheaths shall not be used as protective conductors. Nevertheless, such metal ducts and the metal sheathing of all connecting cables (for example cable armoring, lead sheath) shall be connected to the protective bonding circuit. Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured and a protective conductor (see 8.2.2) is recommended.	See clause 18.2.	P

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Clause	Requirement – Test	Result - Remark	Verdict
	Otherwise fastenings, hinges or sliding contacts designed to have a low resistance shall be used (see 18.2.2, Test 1). The continuity of the protective conductor in cables that are exposed to damage (for example flexible trailing cables) shall be ensured by appropriate measures (for example monitoring). For requirements for the continuity of the protective conductor using conductor wires conductor bars and slip-ring assemblies, see 12.7.2.		
8.2.4	**Exclusion of switching devices from the protective bonding circuit**		
	The protective bonding circuit shall not incorporate a switching device or an over current protective device (for example switch, fuse). No means of interruption of the protective bonding conductor shall be provided. Exception: links for test or measurement purposes that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area. Where the continuity of the protective bonding circuit can be interrupted by means of removable current collectors or plug/socket combinations, the protective bonding circuit shall be interrupted by a first make last break contact. This also applies to removable or withdrawable plug-in units		P
8.2.5	**Parts that need not be connected to the protective bonding circuit**		
	It is not necessary to connect exposed conductive parts to the protective bonding circuit where those parts are mounted so that they do not constitute a hazard because: —they cannot be touched on large surfaces or grasped with the hand and they are small in size (less than approximately 50 mm); or —they are located so that either contact with live parts, or an insulation failure, is unlikely. This applies to small parts such as screws, rivets, and nameplates and to parts inside an enclosure, irrespective of their size (for example electromagnets of contactors or relays and mechanical parts of devices) (see also 410.3.3.5 of IEC 60364-4-41).		P
8.2.6	**Protective conductor connecting points**		
	All protective conductors shall be terminated in accordance with 13.1.1. The protective conductor connecting points shall have no other function and are not intended, for example to attach or connect appliances or parts. Each protective conductor connecting point shall be marked or labelled as such using the symbol IEC 60417-5019 or with the letters PE, the graphical symbol being preferred, or by use of the bicolour combination GREEN-AND-YELLOW, or by any combination of these.	PE circuit not interrupted except for destructing. PE symbol and GREEN-AND-YELLOW conductor used.	P
8.2.7	**Mobile machines**		
	On mobile machines with on-board power supplies, the protective conductors, the conductive structural parts of the electrical equipment, and those extraneous conductive parts which form the structure of the machine shall all be connected to a protective bonding terminal to provide protection against electric shock. Where a mobile machine is also capable of being connected to an		N

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Clause	Requirement – Test	Result - Remark	Verdict
	external incoming power supply, this protective bonding terminal shall be the connection point for the external protective conductor.		
8.2.8	**Additional protective bonding requirements for electrical equipment having earth leakage currents higher than 10 mA a.c. or d.c.**		
	Where electrical equipment has an earth leakage current (for example adjustable speed electrical power drive systems and information technology equipment) that is greater than 10 mA a.c. or d.c. in any incoming supply, one or more of the following conditions for the associated protective bonding circuit shall be satisfied: a) the protective conductor shall have a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al, through its total run; b) where the protective conductor has a cross-sectional area of less than 10 mm^2 Cu or 16 mm^2 Al, a second protective conductor of at least the same cross-sectional area shall be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm^2 Cu or 16 mm^2 Al. c) automatic disconnection of the supply in case of loss of continuity of the protective conductor. To prevent difficulties associated with electromagnetic disturbances, the requirements of 4.4.2 also apply to the installation of duplicate protective conductors. In addition, a warning label shall be provided adjacent to the PE terminal, and where necessary on the nameplate of the electrical equipment. The information provided under 17.2 b)1) shall include information about the leakage current and the minimum cross-sectional area of the external protective conductor.		P
8.3	**Functional bonding**		
	Protection against maloperation as a result of insulation failures can be achieved by connecting to a common conductor in accordance with 9.4.3.1. For recommendations regarding functional bonding to avoid maloperation due to electromagnetic disturbances, see 4.4.2.		P
8.4	**Measures to limit the effects of high leakage current**		
	The effects of high leakage current can be restricted to the equipment having high leakage current by connection of that equipment to a dedicated supply transformer having separate windings. The protective bonding circuit shall be connected to exposed conductive parts of the equipment and, in addition, to the secondary winding of the transformer. The protective conductor(s) between the equipment and the secondary winding of the transformer shall comply with one or more of the arrangements described in 8.2.8.	＜10 mA.	P
9 Control circuits and control functions			
9.1	**Control circuits**		
9.1.1	**Control circuit supply**		
	Where control circuits are supplied from an a.c. source, control transformers shall be used for supplying the control circuits. Such transformers shall have separate windings. Where several transformers are used, it is recommended that the windings of those transformers be connected in such a manner that the secondary voltages are in phase.		P

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Clause	Requirement – Test	Result - Remark	Verdict
	Where d.c. control circuits derived from an a.c. supply are connected to the protective bonding circuit (see 8.2.1), they shall be supplied from a separate winding of the a.c. control circuit transformer or by another control circuit transformer. Transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices (for example interlock device, start/stop control station).		
9.1.2	**Control circuit voltages**		
	The nominal value of the control voltage shall be consistent with the correct operation of the control circuit. The nominal voltage shall not exceed 277 V when supplied from a transformer.	Less than 250V.	P
9.1.3	**Protection**		
	Control circuits shall be provided with over current protection in accordance with 7.2.4 and 7.2.10.		P
9.2	**Control functions**		
9.2.1	**Start functions**		
	Start functions shall operate by energizing the relevant circuit		P
9.2.2	**Stop functions**		
	There are three categories of stop functions as follows: —stop category 0: stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop – see 3.56); —stop category 1: a controlled stop (see 3.11) with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved; —stop category 2: a controlled stop with power left available to the machine actuators.		N
9.2.3	**Operating modes**		
	Each machine can have one or more operating modes determined by the type of machine and its application. When a hazardous situation can result from a mode selection unauthorized and/or inadvertent selection shall be prevented by suitable means (for example key operated switch, access code). Mode selection by itself shall not initiate machine operation. A separate actuation of the start control shall be required. For each specific operating mode, the relevant safety functions and/or protective measures shall be implemented. Indication of the selected operating mode shall be provided (for example the position of a mode selector, the provision of an indicating light, a visual display indication).	Manual mode and auto mode used.	P
9.2.4	**Suspension of safety functions and/or protective measures**		
	Where it is necessary to suspend safety functions and/or protective measures (for example for setting or maintenance purposes), protection shall be ensured by: —disabling all other operating (control) modes —other relevant means.		P
9.2.5	**Operation**		
9.2.5.1	**General**		
	The necessary safety functions and/or protective measures (for example interlocks (see 9.3) shall be provided for safe operation. Measures shall be taken to prevent movement of the machine in an unintended or unexpected manner after any stopping of the machine (for example due to locked-off condition, power supply		P

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Clause	Requirement – Test	Result - Remark	Verdict
	fault, battery replacement, lost signal condition with cableless control). Where a machine has more than one control station, measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.		
9.2.5.2	**Start**		
	The start of an operation shall be possible only when all of the relevant safety functions and/or protective measures are in place and are operational except for conditions as described in 9.2.4. On those machines (for example mobile machines) where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations shall be by hold-to-run controls, together with enabling devices, as appropriate. Suitable interlocks shall be provided to secure correct sequential starting. In the case of machines requiring the use of more than one control station to initiate a start each of these control stations shall have a separate manually actuated start control device. The conditions to initiate a start shall be: —all required conditions for machine operation shall be met, and —all start control devices shall be in the released (off) position, then —all start control devices shall be actuated concurrently (see 3.6).		P
9.2.5.3	**Stop**		
	Stop category 0 and/or stop category 1 and/or stop category 2 stop functions shall be provided as indicated by the risk assessment and the functional requirements of the machine. Stop functions shall override related start functions (see 9.2.5.2). Where required, facilities to connect protective devices and interlocks shall be provided. If such a protective device or interlock causes a stop of the machine, it may be necessary for that condition to be signaled to the logic of the control system. The reset of the stop function shall not initiate any hazardous situation. Where more than one control station is provided, stop commands from any control station shall be effective when required by the risk assessment of the machine.		P
9.2.5.4	**Emergency operations (emergency stop, emergency switching off)**		
9.2.5.4.1	**General**		
	Switching off functions of the emergency operations listed in Annex E, both of which are, in this part of IEC 60204, initiated by a single human action. Once active operation of an emergency stop (see 10.7) or emergency switching off (see 10.8) actuator has ceased following a command, the effect of this command shall be sustained until it is reset. This reset shall be possible only by a manual action at that location		P
9.2.5.4.2	**Emergency stop**		
	Given in ISO 13850. The emergency stop shall function either as a stop category 0 or as a stop category 1 (see 9.2.2). The choice of the stop category of the emergency stop depends on the results of a risk assessment of the machine.		P

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	In addition to the requirements for stop (see 9.2.5.3), the emergency stop function has the following requirements: —it shall override all other functions and operations in all modes; —power to the machine actuators that can cause a hazardous situation(s) shall be either removed immediately (stop category 0) or shall be controlled in such a way to stop the hazardous motion as quickly as possible (stop category 1) without creating other hazards; —reset shall not initiate a restart.		
9.2.5.4.3	**Emergency switching off**		
	The functional aspects of emergency switching off are given in 536.4 of IEC 60364-5-53. Emergency switching off should be provided where: —protection against direct contact (for example with conductor wires, conductor bars, slip ring assemblies, control gear in electrical operating areas) is achieved only by placing out of reach or by obstacles (see 6.2.6); or —there is the possibility of other hazards or damage caused by electricity. Emergency switching off is accomplished by switching off the relevant incoming supply by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply. When a machine cannot tolerate this stop category 0 stop, it may be necessary to provide other measures, for example protection against direct contact so that emergency switching off is not necessary.		P
9.2.5.5	**Monitoring of command actions**		
	Movement or action of a machine or part of a machine that can result in a hazardous situation shall be monitored by providing, for example, over travel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices.		N
9.2.6	**Other control functions**		
9.2.6.1	**Hold-to-run controls**		
	Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation.		P
9.2.6.2	**Two-hand control**		
	Three types of two-hand control are defined in ISO 13851, the selection of which is determined by the risk assessment. These shall have the following features: Type I: this type requires: —the provision of two control devices and their concurrent actuation by both hands; —continuous concurrent actuation during the hazardous situation; —machine operation shall cease upon the release of either one or both of the control devices when hazardous situations are still present. A Type I two-hand control device is not considered to be suitable	No such devices.	N
	for the initiation of hazardous operation. Type II: a type I control requiring the release of both control devices before machine operation can be reinitiated. Type III: a type II control requiring concurrent actuation of the control devices as follows:		

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	—it shall be necessary to actuate the control devices within a certain time limit of each other, not exceeding 0,5 s; —where this time limit is exceeded, both control devices shall be released before machineoperation can be initiated.		
9.2.6.3	**Enabling control**		
	Enabling control (see also 10.9) is a manually activated control function interlock that: a) when activated allows a machine operation to be initiated by a separate start control and b) when de-activated —initiates a stop function in accordance with 9.2.5.3, and —prevents initiation of machine operation. Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It should not be possible to defeat the enabling function by simple means.		P
9.2.6.4	**Combined start and stop controls**		
	Push-buttons and similar control devices that, when operated, alternately initiate and stop motion shall only be provided for functions which cannot result in a hazardous situation.		P
9.2.7	**Cableless control**		
9.2.7.1	**General**		
	This sub clause deals with the functional requirements of control systems employing cableless (for example radio, infra-red) techniques for transmitting commands and signals between a machine control system and operator control station(s). Means shall be provided to readily remove or disconnect the power supply of the operator control station (see also 9.2.7.3). Means (for example key operated switch, access code) shall be provided, as necessary, to prevent unauthorized use of the operator control station. Each operator control station shall carry an unambiguous indication of which machine(s) is (are) intended to be controlled by that operator control station.	No such cableless control.	N
9.2.7.2	**Control limitation**		
	Measures shall be taken to ensure that control commands: —affect only the intended machine; —affect only the intended functions. Measures shall be taken to prevent the machine from responding to signals other than those from the intended operator control station(s). Where necessary, means shall be provided so that the machine can only be controlled from operator control stations in one or more predetermined zones or locations.		N
9.2.7.3	**Stop**		
	Cableless control stations shall include a separate and clearly identifiable means to initiate the stop function of the machine or of all the operations that can cause a hazardous situation. The actuating means to initiate this stop function shall not be marked or labelled as an emergency stop device (see10.7). Enabling control shall be so arranged as to minimize the possibility		N

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	of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It should not be possible to defeat the enabling function by simple means. A machine which is equipped with cableless control shall have a means of automatically initiating the stopping of the machine and of preventing a potentially hazardous operation, in the following situations: —when a stop signal is received; —when a fault is detected in the cableless control system; —when a valid signal (which includes a signal that communication is established and maintained) has not been detected within a specified period of time (see Annex B), except when a machine is executing a pre-programmed task taking it outside the range of the cableless control where no hazardous situation can occur.		
9.2.7.4	**Use of more than one operator control station**		
	Where a machine has more than one operator control station, including one or morecableless control stations, measures shall be provided to ensure that only one of the control stations can be enabled at a given time. An indication of which operator control station is in control of the machine shall be provided at suitable locations as determined by the risk assessment of the machine. Exception: a stop command from any one of the control stations shall be effective when required by the risk assessment of the machine.		N
9.2.7.5	**Battery-powered operator control stations**		
	A variation in the battery voltage shall not cause a hazardous situation. If one or more potentially hazardous motions are controlled using a battery-powered cableless operator control station, a clear warning shall be given to the operator when a variation in battery voltage exceeds specified limits. Under those circumstances, the cableless operator control station shall rN/Ain functional long enough for the operator to put the machine into a nonhazardous situation.		N
9.3	**Protective interlocks**		
9.3.1	**Reclosing or resetting of an interlocking safeguard**		
	The reclosing or resetting of an interlocking safeguard shall not initiate hazardous machine operation		N
9.3.2	**Exceeding operating limits**		
	Where an operating limits (for example speed, pressure, position) can be exceeded leading to a hazardous situation, means shall be provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action.		N
9.3.3	**Operation of auxiliary functions**		
	The correct operation of auxiliary functions shall be checked by appropriate devices (for example pressure sensors). Where the non-operation of a motor or device for an auxiliary function (for example lubrication, supply of coolant, swarf removal) can cause a hazardous situation, or cause damage to the machine or to the work in progress, appropriate interlocking shall be provided.		N
9.3.4	**Interlocks between different operations and for contrary motions**		

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Clause	Requirement – Test	Result - Remark	Verdict
	All contactors, relays, and other control devices that control elements of the machine and that can cause a hazardous situation when actuated at the same time (for example those which initiate contrary motion), shall be interlocked against incorrect operation. Reversing contactors (for example those controlling the direction of rotation of a motor) shall be interlocked in such a way that in normal service no short circuit can occur when switching. Where, for safety or for continuous operation, certain functions on the machine are required to be interrelated, proper co-ordination shall be ensured by suitable interlocks. For a group of machines working together in a co-coordinated manner and having more than one controller provision shall be made to co-ordinate the operations of the controllers as necessary. Where a failure of a mechanical brake actuator can result in the brake being applied when the associated machine actuator is energized and a hazardous situation can result, interlocks shall be provided to switch off the machine actuator.		N
9.3.5	**Reverse current braking**		
	Where braking of a motor is accomplished by current reversal, measures shall be provided to prevent the motor starting in the opposite direction at the end of braking where that reversal can cause a hazardous situation or damage to the machine or to the work in progress. For this purpose, a device operating exclusively as a function of time is not permitted. Control circuits shall be so arranged that rotation of a motor shaft, for example manually shall not result in a hazardous situation.		N
9.4	**Control functions in the event of failure**		
9.4.1	**General requirements**		
	Where failures or disturbances in the electrical equipment can cause a hazardous situation or damage to the machine or to the work in progress, appropriate measures shall be taken to minimize the probability of the occurrence of such failures or disturbances. The required measures and the extent to which they are implemented, either individually or in combination depend on the level of risk associated with the respective application (see 4.1).		P
9.4.2	**Measures to minimize risk in the event of failure**		
9.4.2.1	**Use of proven circuit techniques and components**		
	These measures include but are not limited to: —bonding of control circuits to the protective bonding circuit for functional purposes (see 9.4.3.1 and Figure 2); —connection of control devices in accordance with 9.4.3.1; —stopping by de-energizing (see 9.2.2); —the switching of all control circuit conductors to the device being controlled (see 9.4.3.1); —switching devices having direct opening action (see IEC 60947-5-1); —circuit design to reduce the possibility of failures causing undesirable operations.	(See appended table)	P
9.4.2.2	**Provisions of partial or complete redundancy**		
	By providing partial or complete redundancy, it is possible to minimize the probability that one single failure in the electrical circuit can result in a hazardous situation. Redundancy can be		N

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	effective in normal operation (on-line redundancy) or designed as special circuits that take over the protective function (off-line redundancy) only where the operating function fails. Where off-line redundancy which is not active during normal operation is provided, suitable measures shall be taken to ensure that those control circuits are available when required.		
9.4.2.3	**Provision of diversity**		
	The use of control circuits having different principles of operation, or using different types of components or devices can reduce the probability of hazards resulting from faults and/or failures. Examples include: —the combination of normally open and normally closed contacts operated by interlocking guards; —the use of different types of control circuit components in the circuit; —the combination of electromechanical and electronic equipment in redundant configurations. The combination of electrical and non-electrical systems (for example mechanical, hydraulic, pneumatic) may perform the redundant function and provide the diversity.		N
9.4.2.4	**Provision for functional tests**		
	Functional tests may be carried out automatically by the control system, or manually by inspection or tests at start-up and at predetermined intervals or a combination as appropriate (see also 17.2 and 18.6).		P
9.4.3	**Protection against maloperation due to earth faults, voltage interruptions and loss of circuit continuity**		
9.4.3.1	**Earth faults**		
	Earth faults on any control circuit shall not cause unintentional starting, potentially hazardous motions, or prevent stopping of the machine.Methods to meet these requirements include but are not limited to the following: Method a): Control circuits, fed by control transformers; Method b): Control circuits fed from a control transformer with a centre-tapped winding, this centre tap connected to the protective bonding circuit; Method c): Where the control circuit is not fed from a control transformer and is either: 1) directly connected between the phase conductors of an earthed supply, or; 2) directly connected between the phase conductors or between a phase conductor and a neutral conductor of a supply that is not earthed or is earthed through a high impedance.	Method a).	P
9.4.3.2	**Voltage interruptions**		
	The requirements detailed in 7.5 shall apply. Where the control system uses a memory device(s), proper	No such risk.	P
	functioning in the event of power failure shall be ensured (for example by using a non-volatile memory) to prevent any loss of memory that can result in a hazardous situation.		
9.4.3.3	**Loss of circuit continuity**		
	Where the loss of continuity of safety-related control circuits depending upon sliding contacts can result in a hazardous		P

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	situation, appropriate measures shall be taken (for example by duplication of the sliding contacts).		
10 Operator interface and machine-mounted control devices			
10.1	**General**		
10.1.1	**General device requirements**		
	This Clause contains requirements for devices mounted outside or partially outside control enclosures. As far as is practicable, those devices shall be selected, mounted, and identified or coded in accordance with relevant parts of IEC 61310. The possibility of inadvertent operation shall be minimized by, for example, positioning of devices, suitable design, and provision of additional protective measures. Particular consideration shall be given to the selection, arrangement, programming and use of operator input devices such as touch screens, keypads and keyboards, for the control of hazardous machine operations. See IEC 60447.		P
10.1.2	**Location and mounting**		
	As far as is practicable, machine-mounted control devices shall be: —readily accessible for service and maintenance; —mounted in such a manner as to minimize the possibility of damage from activities such as material handling. The actuators of hand-operated control devices shall be selected and installed so that: —they are not less than 0,6 m above the servicing level and are within easy reach of the normal working position of the operator; —the operator is not placed in a hazardous situation when operating them. The actuators of foot-operated control devices shall be selected and installed so that: —they are within easy reach of the normal working position of the operator; —the operator is not placed in a hazardous situation when operating them.	Easily reach and control.	P
10.1.3	**Protection**		
	The degree of protection (see IEC 60529) together with other appropriate measures shall afford protection against: —the effects of aggressive liquids, vapours, or gases found in the physical environment or used on the machine; —the ingress of contaminants (for example swarf, dust, particulate matter). In addition, the operator interface control devices shall have a minimum degree of protection against direct contact of IPXXD (see IEC 60529).		P
10.1.4	**Position sensors**		
	Position sensors (for example position switches, proximity switches) shall be so arranged that they will not be damaged in the event of over travel. Position sensors in circuits with safety-related control functions shall have direct opening action (see IEC 60947-5-1) or shall provide similar reliability (see 9.4.2).		P

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10.1.5	**Portable and pendant control stations**		
	Portable and pendant operator control stations and their control devices shall be so selected and arranged as to minimize the possibility of inadvertent machine operations caused by shocks and vibrations (for example if the operator control station is dropped or strikes an obstruction) (see also 4.4.8).		N
10.2	**Push-buttons**		
10.2.1	**Colors**		
	Push-button actuators shall be color-coded in accordance with Table 2 (see also 9.2 and Annex B). The colors for START/ON actuators should be WHITE, GREY, BLACK or GREEN with a preference for WHITE. RED shall not be used. The color RED shall be used for emergency stop and emergency switching off actuators.The colors for STOP/OFF actuators should be BLACK, GREY, or WHITE with a preference for BLACK. GREEN shall not be used. RED is permitted, but it is recommended that RED is not used near an emergency operation device. WHITE, GREY, or BLACK are the preferred colors for push-button actuators that alternately act as START/ON and STOP/OFF push-buttons. The colors RED, YELLOW, or GREEN shall not be used (see also 9.2.6). WHITE, GREY, or BLACK is the preferred colors for push-button actuators that cause operation while they are actuated and cease the operation when they are released (for example hold-to-run). The colors RED, YELLOW, or GREEN shall not be used. Reset push-buttons shall be BLUE, WHITE, GREY, or BLACK. Where they also act as a STOP/OFF button, the colors WHITE, GREY, or BLACK are preferred with the main preference being for BLACK. GREEN shall not be used. Where the same color WHITE, GREY, or BLACK is used for various functions (for example WHITE for START/ON and for STOP/OFF actuators) a supplementary means of coding (for example shape, position, symbol) shall be used for the identification of push-button actuators.	Complied.	P
10.2.2	**Markings**		
	In addition to the functional identification as described in 16.3, it is recommended that pushbuttons be marked, near to or preferably directly on the actuators, with the symbols given in Table 3.		P
10.3	**Indicator lights and displays**		
10.3.1	**General**		
	Indicator lights and displays serve to give the following types of information: —Indication: to attract the operator's attention or to indicate that a certain task should be performed. The colors RED, YELLOW, BLUE, and GREEN are normally used in this mode; for flashing indicator lights and displays, see 10.3.3. —confirmation: to confirm a command, or a condition, or to confirm the termination of a change or transition period. The colors BLUE and WHITE are normally used in this mode and GREEN may be used in some cases.		P

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	Indicator lights and displays shall be selected and installed in such a manner as to be visible from the normal position of the operator. Indicator light circuits used for warning lights shall be fitted with facilities to check the operability of these lights.		
10.3.2	**Colors**		
	Unless otherwise agreed between the supplier and the user。 Indicator lights shall be color-coded with respect to the condition (status) of the machine in accordance with Table 4. Indicating towers on machines should have the applicable colors in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.		P
10.3.3	**Flashing lights and displays**		
	For further distinction or information and especially to give additional emphasis, flashing lights and displays can be provided for the following purposes: —to attract attention; —to request immediate action; —to indicate a discrepancy between the command and actual state; —to indicate a change in process (flashing during transition). It is recommended that higher frequency flashing lights or display be used for higher priority information (see IEC 60073 for recommended flashing rates and pulse/pause ratios). Where flashing lights or displays are used to provide higher priority information, audible warning devices should also be provided		P
10.4	**Illuminated push-buttons**		
	Illuminated push-button actuators shall be color-coded in accordance with Tables 2 and 4. Where there is difficulty in assigning an appropriate color, WHITE shall be used. The color RED for the emergency stop actuator shall not depend on the illumination of its light.		P
10.5	**Rotary control devices**		
	Devices having a rotational member, such as potentiometers and selector switches, shall have means of prevention of rotation of the stationary member. Friction alone shall not be considered sufficient.		P
10.6	**Start devices**		
	Actuators used to initiate a start function or the movement of machine elements (for example slides, spindles, carriers) shall be constructed and mounted so as to minimize inadvertent operation. However, mushroom-type actuators may be used for two-hand control (see also ISO 13851).		P
10.7	**Emergency stop devices**		
10.7.1	**Location of emergency stop devices**		
	Devices for emergency stop shall be readily accessible. Emergency stop devices shall be located at each operator control station and at other locations where the initiation of an emergency stop can be required (exception: see 9.2.7.3). There can be circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station. In such cases means (for example,		N

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Clause	Requirement – Test	Result - Remark	Verdict
	information for use) shall be provided to minimize confusion		
10.7.2	**Types of emergency stop device**		
	The types of device for emergency stop include: —a push-button operated switch with a palm or mushroom head type; —a pull-cord operated switch; —a pedal-operated switch without a mechanical guard. The devices shall have direct opening operation (see IEC 60947-5-1, Annex K).		N
10.7.3	**Color of actuators**		
	Actuators of emergency stop devices shall be colored RED. If a background exists immediately around the actuator, then this background shall be colored YELLOW. See also ISO 13850.		N
10.7.4	**Local operation of the supply disconnecting device to effect emergency stop**		
	The supply disconnecting device may be locally operated to serve the function of emergency stop when: —it is readily accessible to the operator; and —it is of the type described in 5.3.2 a), b), c), or d). When also intended for such use, the supply disconnecting device shall meet the colour requirements of 10.7.3.		N
10.8	**Emergency switching off devices**		
10.8.1	**Location of emergency switching off devices**		
	Emergency switching off devices shall be located as necessary for the given application. Normally, those devices will be located separate from operator control stations. Where it is necessary to provide a control station with an emergency stop device and an emergency switching off device, means shall be provided to avoid confusion between these devices.		N
10.8.2	**Types of emergency switching off device**		
	The types of device for emergency switching off include: —a push-button operated switch with a palm or mushroom head type of actuator; —a pull-cord operated switch. The devices shall have direct opening action (see IEC 60947-5-1, Annex K).The push-button operated switch may be in a break-glass enclosure.		N
10.8.3	**Color of actuators**		
	Actuators of emergency switching off devices shall be colored RED. If a background exists immediately around the actuator, then this background shall be colored YELLOW. Where confusion can occur between emergency stop and emergency switching off devices means shall be provided to minimize confusion.		N
10.8.4	**Local operation of the supply disconnecting device to effect emergency switching off**		
	Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and should meet the color requirements of 10.8.3.		N
10.9	**Enabling control device**		
	When an enabling control device is provided as a part of a system,	Obvious to	P

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	it shall signal the enabling control to allow operation when actuated in one position only. In any other position, operation shall be stopped or prevented. Enabling control devices shall be selected and arranged so as to minimize the possibility of defeating. Enabling control devices shall be selected that have the following features: —designed in accordance with ergonomic principles; —for a two-position type: —position 1: off-function of the switch (actuator is not operated); —position 2: enabling function (actuator is operated). —for a three-position type: —position 1: off-function of the switch (actuator is not operated); —position 2: enabling function (actuator is operated in its mid position); —position 3: off-function (actuator is operated past its mid position); —when returning from position 3 to position 2, the enabling function is not activated.	operator.	
11 Control gear: location, mounting, and enclosures			
11.1	**General requirements**		
	All control gear shall be located and mounted so as to facilitate: —its accessibility and maintenance; —its protection against the external influences or conditions under which it is intended to operate; —operation and maintenance of the machine and its associated equipment.		P
11.2	**Location and mounting**		
11.2.1	**Accessibility and maintenance**		
	All items of control gear shall be placed and oriented so that they can be identified without moving them or the wiring. For items that require checking for correct operation or that are liable to need replacement, those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers, barriers or obstacles). Terminals not part of control gear components or devices shall also conform to these requirements. All control gear shall be mounted so as to facilitate its operation and maintenance from the front. Where a special tool is necessary to adjust, maintain, or remove a device, such a tool shall be supplied. Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0,4 m and 2,0 m above the servicing level. It is recommended that terminals be at least 0,2 m above the servicing level and be so placed that conductors and cables can be easily connected to them. No devices except devices for operating, indicating, measuring, and cooling shall be mounted on doors or on normally removable access covers of enclosures. Where control devices are connected through plug-in arrangements, their association shall be made clear by type (shape), marking or reference designation, singly or in combination (see 13.4.5).		P

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	Plug-in devices that are handled during normal operation shall be provided with no interchangeable features where the lack of such a facility can result in malfunctioning. Plug/socket combinations that are handled during normal operation shall be located and mounted so as to provide unobstructed access. Test points for connection of test equipment, where provided, shall be: —mounted so as to provide unobstructed access; —clearly identified to correspond with the documentation (see 17.3); —adequately insulated; —Sufficiently spaced.		
11.2.2	**Physical separation or grouping**		
	Non-electrical parts and devices, not directly associated with the electrical equipment, shall not be located within enclosures containing control gear. Devices such as solenoid valves should be separated from the other electrical equipment (for example in a separate compartment). Control devices mounted in the same location and connected to the supply voltage, or to both supply and control voltages, shall be grouped separately from those connected only to the control voltages. Terminals shall be separated into groups for: —power circuits; —associated control circuits; —other control circuits, fed from external sources (for example for interlocking). The groups may be mounted adjacently, provided that each group can be readily identified (for example by markings, by use of different sizes, by use of barriers or by colors). When arranging the location of devices (including interconnections), the clearances and creep age distances specified for them by the supplier shall be maintained, taking into account the external influences or conditions of the physical environment.		P
11.2.3	**Heating effects**		
	Heat generating components (for example heat sinks, power resistors) shall be so located that the temperature of each component in the vicinity rN/Ains within the permitted limit.		N
11.3	**Degrees of protection**		
	The protection of control gear against ingress of solid foreign objects and of liquids shall be adequate taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental conditions) and shall be sufficient against dust, coolants, and swarf. Enclosures of control gear shall provide a degree of protection of at least IP22 (see IEC 60529). Exceptions: a) Where an electrical operating area is used as a protective enclosure for an appropriate degree of protection against the ingress of solid bodies and liquids. b) Where removable collectors on conductor wire or conductor bar	Degrees of protection: IP2X.	P

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Clause	Requirement – Test	Result - Remark	Verdict
	systems are used and IP22 is not achieved, but the measures of 6.2.5 are applied.		
11.4	**Enclosures, doors and openings**		P
12 Conductors and cables			
12.1	**General requirements**		
	Conductors and cables shall be selected so as to be suitable for the operating conditions (for example voltage, current, protection against electric shock, grouping of cables) and external influences (for example ambient temperature, presence of water or corrosive substances mechanical stresses (including stresses during installation), fire hazards) that can exist.	Reinforce/double insulation PVC cables provided.	P
12.2	**Conductors**		
	In general, conductors shall be of copper. Where aluminum conductors are used, the cross-sectional area shall be at least 16 mm^2. To ensure adequate mechanical strength, the cross-sectional area of conductors should not be less than as shown in Table 5. However, conductors with smaller cross-sectional areas or other constructions than shown in Table 5 may be used in equipment provided adequate mechanical strength is achieved by other means and proper functioning is not impaired.	Copper used, conform to relevant IEC/EN standards.	P
12.3	**Insulation**		
	The types of insulation include (but are not limited to): —polyvinyl chloride (PVC); —rubber, natural and synthetic; —silicone rubber (SiR); —mineral; —cross-linked polyethylene (XLPE); —ethylene propylene compound (EPR). Where the insulation of conductors and cables (for example PVC) can constitute hazards due to the propagation of a fire or the emission of toxic or corrosive fumes, guidance from the cable supplier should be sought. It is important to give special attention to the integrity of a circuit having a safety-related function. The insulation of cables and conductors used, shall be suitable for a test voltage: —not less than 2 000 V a.c. for a duration of 5 min for operation at voltages higher than 50 V a.c. or 120 V d.c., or – not less than 500 V a.c. for a duration of 5 min for PELV circuits (see IEC 60364-4-41 class III equipment). The mechanical strength and thickness of the insulation shall be such that the insulation cannot be damaged in operation or during laying, especially for cables pulled into ducts.	Protection degree of electrical operation box: 2000Vac for 5min.	P
12.4	**Current-carrying capacity in normal service**		
	The current-carrying capacity depends on several factors, for example insulation material number of conductors in a cable, design (sheath), methods of installation, grouping and ambient temperature. One typical example of the current-carrying capacities for PVC insulated wiring between enclosures and individual items of equipment under steady-state conditions is given in Table 6.		P
12.5	**Conductor and cable voltage drop**		

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	The voltage drop from the point of supply to the load shall not exceed 5 % of the nominal voltage under normal operating conditions. In order to conform to this requirement, it can be necessary to use conductors having a larger cross-sectional area than that derived from Table 6.		P
12.6	**Flexible cables**		
12.6.1	**General**		
	Flexible cables shall have Class 5 or Class 6 conductors.	Class 5.	
12.6.2	**Mechanical rating**		
	The cable handling system of the machine shall be so designed to keep the tensile stress of the conductors as low as is practicable during machine operations. Where copper conductors are used, the tensile stress applied to the conductors shall not exceed 15 N/mm2 of the copper cross-sectional area. Where the dN/Ands of the application exceed the tensile stress limit of 15 N/mm2, cables with special construction features should be used and the allowed maximal tensile stress should be agreed with the cable manufacturer. The maximum stress applied to the conductors of flexible cables with material other than copper shall be within the cable manufacturer's specification.	Flexible cables: VDE or UL certificate provided.	P
12.6.3	**Current-carrying capacity of cables wound on drums**		
	Cables to be wound on drums shall be selected with conductors having a cross-sectional area such that, when fully wound on the drum and carrying the normal service load, the maximum allowable conductor temperature is not exceeded. For cables of circular cross-sectional area installed on drums, the maximum current-carrying capacity in free air should be derated in accordance with Table 7 (see also Clause 44 of IEC 60621-3).		P
12.7	**Conductor wires, conductor bars and slip-ring assemblies**		
12.7.1	**Protection against direct contact**		
	Conductor wires, conductor bars and slip-ring assemblies shall be installed or enclosed in such a way that, during normal access to the machine, protection against direct contact is achieved by the application of one of the following protective measures: —protection by partial insulation of live parts, or where this is notpracticable; —protection by enclosures or barriers of at least IP2X (see 412.2 of IEC 60364-4-41). Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X (see 412.2.2 of IEC 60364-4-41). Where the required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching off in accordance with 9.2.5.4.3 shall be applied. Conductor wires and conductor bars shall be so placed and/or protected as to: —prevent contact, especially for unprotected conductor wires and conductor bars, with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains; —prevent damage from a swinging load.		P

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12.7.2	**Protective conductor circuit**		
	Where conductor wires, conductor bars and slip-ring assemblies are installed as part of the protective bonding circuit, they shall not carry current in normal operation. Therefore, the protective conductor (PE) and the neutral conductor (N) shall each use a separate conductor wire, conductor bar or slip-ring. The continuity of the protective conductor circuit using sliding contacts shall be ensured by taking appropriate measures (for example, duplication of the current collector continuity monitoring).		P
12.7.3	**Protective conductor current collectors**		
	Protective conductor current collectors shall have a shape or construction so that they are not interchangeable with the other current collectors. Such current collectors shall be of the sliding contact type.		N
12.7.4	**Removable current collectors with a disconnector function**		
	Removable current collectors having a disconnector function shall be so designed that the protective conductor circuit is interrupted only after the live conductors have been disconnected, and the continuity of the protective conductor circuit is re-established before any live conductor is reconnected (see also 8.2.4).		N
12.7.5	**Clearances in air**		
	Clearances between the respective conductors and between adjacent systems, of conductor wires, conductor bars, slip-ring assemblies and their current collectors shall be suitable for at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1.		P
12.7.6	**Creepage distances**		
	Creepage distances between the respective conductors, between adjacent systems of conductor wires, conductor bars and slip-ring assemblies, and their current collectors shall be suitable for operation in the intended environment, for example open air (IEC 60664-1), inside buildings, protected by enclosures. In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply: —unprotected conductor wires, conductor bars, and slip-ring assemblies shall be equipped with insulators with a minimum creepage distance of 60 mm; —enclosed conductor wires, insulated multipole conductor bars and insulated individual conductor bars shall have a minimum creepage distance of 30 mm. The manufacturer's recommendations shall be followed regarding special measures to prevent a gradual reduction in the insulation values due to unfavorable ambient conditions (for example deposits of conductive dust, chemical attack).	>60 mm.	P
12.7.7	**Conductor system sectioning**		
	Where conductor wires or conductor bars are arranged so that they can be divided into isolated sections, suitable design measures shall be employed to prevent the energization of adjacent sections by the current collectors themselves.		P
12.7.8	**Construction and installation of conductor wire, conductor bar systems and slip-ring assemblies**		
	Conductor wires, conductor bars and slip-ring assemblies in power		P

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Clause	Requirement – Test	Result - Remark	Verdict
	circuits shall be grouped separately from those in control circuits. Conductor wires, conductor bars and slip-ring assemblies shall be capable of withstanding without damage, the mechanical forces and thermal effects of short-circuit currents. Removable covers for conductor wire and conductor bar systems laid underground or under floor shall be so designed that they cannot be opened by one person without the aid of a tool. Where conductor bars are installed in a common metal enclosure, the individual sections of the enclosure shall be bonded together and connected to a protective bonding conductor at several points depending upon their length. Metal covers of conductor bars laid underground or under floor shall also be bonded together and connected to a protective bonding conductor. The protective bonding circuit shall include the covers or cover plates of metal enclosures or under floor ducts. Where metal hinges form a part of the bonding circuit, their continuity shall be verified (see Clause 18). Underground and under floor conductor bar ducts shall have drainage facilities.		
13 Wiring practices			
13.1	**Connections and routing**		
13.1.1	**General requirements**		
	All connections, especially those of the protective bonding circuit, shall be secured against accidental loosening.	Terminal and bonding used for fixing.	P
13.1.2	**Conductor and cable runs**		
	Conductors and cables shall be run from terminal to terminal without splices or joints. Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be joints for the purpose of this Sub clause. Exception: Where it is impracticable to provide terminals in a junction box (for example on mobile machines, on machines having long flexible cables; cable connections exceeding a length which is not practical to be supplied by the cable manufacturer on one cable drum; repair of cable due to mechanical stresses during installation and operation), splices or joints may be used. Where it is necessary to connect and disconnect cables and cable assemblies, a sufficient extra length shall be provided for that purpose. The terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors. Wherever practicable, the protective conductor shall be placed close to the associated live conductors in order to decrease the impedance of the loop.		P
13.1.3	**Conductors of different circuits**		
	Conductors of different circuits may be laid side by side, may occupy the same duct (for example conduit, cable trunking system), or may be in the same multiconductor cable provided that the arrangement does not impair the proper functioning of the respective circuits. Where those circuits operate at different voltages, the conductors shall be separated by suitable barriers or	Conductors for different circuits lie side by side or occupy the same duct.	P

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	shall be insulated for the highest voltage to which any conductor within the same duct can be subjected, for example line to line voltage for unearthed systems and phase to earth voltage for earthed systems.		
13.1.4	**Connection between pick-up and pick-up converter of an inductive power supply system**		
	The cable between the pick-up and the pick-up converter as specified by the manufacturer of the inductive power supply shall be: —as short as practicable; —adequately protected against mechanical damage.	Adequately protected against mechanical damage.	P
13.2	**Identification of conductors**		
13.2.1	**General requirements**		
	Each conductor shall be identifiable at each termination in accordance with the technical documentation (see Clause 17).It is recommended (for example to facilitate maintenance) that conductors be identified by number, alphanumeric, color (either solid or with one or more stripes), or a combination of color and numbers or alphanumeric. When numbers are used, they shall be Arabic; lettersbvshall be Roman (either upper or lower case).	Identification at each termination.	P
13.2.2	**Identification of the protective conductor**		
	The protective conductor shall be readily distinguishable by shape, location, marking, or color. When identification is by color alone, the bicolor combination GREEN-ANDYELLOW shall be used throughout the length of the conductor. This colour identification is strictly reserved for the protective conductor. For insulated conductors, the bicolor combination GREEN-AND-YELLOW shall be such that on any 15 mm length, one of the colors covers at least 30 % and not more than 70 % of the surface of the conductor, the other color covering the rN/Ainder of the surface. Where the protective conductor can be easily identified by its shape, position, or construction (for example a braided conductor, uninsulated stranded conductor), or where the insulated conductor is not readily accessible, color coding throughout its length is not necessary but the ends or accessible locations shall be clearly identified by the graphical symbol IEC 60417-5019 (DB: 2002-10) or by the bicolor combination GREEN-AND-YELLOW.	GREEN-ANDYELLOW conductor used.	P
13.2.3	**Identification of the neutral conductor**		
	Where a circuit includes a neutral conductor that is identified by color alone, the color used for this conductor shall be BLUE. In order to avoid confusion with other colors, it is recommended that an unsaturated blue be used, called here “light blue” (see 3.2.2 of IEC 60446). Where the selected color is the sole identification of the neutral conductor, that color shall not be used for identifying any other conductor where confusion is possible. Where identification by color is used, bare conductors used as neutral conductors shall be either colored by a stripe, 15 mm to 100 mm wide in each compartment or unit and at each accessible location, or colored throughout their length.		P
13.2.4	**Identification by color**		
	Where color-coding is used for identification of conductors (other		P

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Clause	Requirement – Test	Result - Remark	Verdict
	than the protective conductor (see 13.2.2) and the neutral conductor (see 13.2.3)), the following colors may be used: BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE.		
13.3	**Wiring inside enclosures**		
	Conductors inside enclosures shall be supported where necessary to keep them in place. Non-metallic ducts shall be permitted only when they are made with a flame-retardant insulating material (see the IEC 60332 series). It is recommended that electrical equipment mounted inside enclosures be designed and constructed in such a way as to permit modification of the wiring from the front of the enclosure (see also 11.2.1). Where that is not practicable and control devices are connected from the rear of the enclosure, access doors or swing out panels shall be provided.	Keep in place and modify from front panel ,and against flame.	P
13.4	**Wiring outside enclosures**		
13.4.1	**General requirements**		
	The means of introduction of cables or ducts with their individual glands, bushings, etc., into an enclosure shall ensure that the degree of protection is not reduced (see 11.3).		P
13.4.2	**External ducts**		
	Conductors and their connections external to the electrical equipment enclosure(s) shall be enclosed in suitable ducts (i.e. conduit or cable trunking systems) as described in 13.5except for suitably protected cables that may be installed without ducts and with or without the use of open cable trays or cable support means. Where devices such as position switches or proximity switches are supplied with a dedicated cable, their cable need not be enclosed in a duct when the cable is suitable for the purpose, sufficiently short, and so located or protected, that the risk of damage is minimized. Fittings used with ducts or multiconductor cable shall be suitable for the physical environment.		P
13.4.3	**Connection to moving elements of the machine**		
	Connections to frequently moving parts shall be made using conductors in accordance with 12.2 and 12.6. Flexible cable and flexible conduit shall be so installed as to avoid excessive flexing and straining, particularly at the fittings.		P
13.4.4	**Interconnection of devices on the machine**		
	Where several machine-mounted switching devices (for example position sensors, pushbuttons) are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points. Such terminals shall be conveniently placed, adequately protected, and shown on the relevant diagrams.		P
13.4.5	**Plug/socket combinations**		
	Where plug/socket combinations are provided, they shall fulfill one or more of the following requirements as applicable: Exception: The following requirements do not apply to components or devices inside an enclosure, terminated by fixed	Comply with a)~f) and i).	P

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Clause	Requirement – Test	Result - Remark	Verdict
	plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination. a)/b)/c)/d)/e)/f)/g)/ h)/i)/j)/k) Exception: The requirements of item k) do not apply to control functions using high frequency signals on the power supply.		
13.4.6	**Dismantling for shipment**		
	Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points. Such terminals shall be suitably enclosed and plug/socket combinations shall be protected from the physical environment during transportation and storage.		P
13.4.7	**Additional conductors**		
	Consideration should be given to providing additional conductors for maintenance or repair. When spare conductors are provided, they shall be connected to spare terminals or isolated in such a manner as to prevent contact with live parts.		P
13.5	**Ducts, connection boxes and other boxes**		
13.5.1	**General requirements**		
	Ducts shall provide a degree of protection suitable for the application (see IEC 60529). All sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come in contact shall be removed from ducts and fittings. Where necessary additional protection consisting of a flame-retardant, oil-resistant insulating material shall be provided to protect conductor insulation. Drain holes of 6 mm diameter are permitted in cable trunking systems, connection boxes, and other boxes used for wiring purposes that can be subject to accumulations of oil or moisture.	No sharp edges, flash, burrs, rough surfaces or threads.	P
13.5.2	**Percentage fill of ducts**		
	Consideration of the percentage fill of ducts should be based on the straightness and length of the duct and the flexibility of the conductors. It is recommended that the dimensions and arrangement of the ducts be such as to facilitate the insertion of the conductors and cables.		P
13.5.3	**Rigid metal conduit and fittings**		
	Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material suitable for the conditions. The use of dissimilar metals in contact that can cause galvanic action should be avoided. Conduits shall be securely held in place and supported at each end, Fittings shall be compatible with the conduit and appropriate for the application. Fittings shall be threaded unless structural difficulties prevent assembly. Where threadless fittings are used, the conduit shall be securely fastened to the equipment. Conduit bends shall be made in such a manner that the conduit shall not be damaged and the internal diameter of the conduit		N
	shall not be effectively reduced.		
13.5.4	**Flexible metal conduit and fittings**		
	A flexible metal conduit shall consist of a flexible metal tubing or woven wire amour. It shall be suitable for the expected physical environment.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	Fittings shall be compatible with the conduit and appropriate for the application.		
13.5.5	**Flexible non-metallic conduit and fittings**		
	Flexible non-metallic conduit shall be resistant to kinking and shall have physical characteristics similar to those of the sheath of multiconductor cables. The conduit shall be suitable for use in the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.	Comply with relevant requirements.	P
13.5.6	**Cable trunking systems**		
	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving or contaminating portions of the machine. Covers shall be shaped to overlap the sides; gaskets shall be permitted. Covers shall be attached to cable trunking systems by suitable means. On horizontal cable trunking systems, the cover shall not be on the bottom unless specifically designed for such installation. Where the cable trunking system is furnished in sections, the joints between sections shall fit tightly but need not be gasketed. The only openings permitted shall be those required for wiring or for drainage. Cable trunking systems shall not have opened but unused knockouts.		P
13.5.7	**Machine compartments and cable trunking systems**		
	The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided the compartments or cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed. Conductors run in enclosed compartments and cable trunking systems shall be so secured and arranged that they are not subject to damage.		P
13.5.8	**Connection boxes and other boxes**		
	Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance. Those boxes shall provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate (see 11.3). Those boxes shall not have opened but unused knockouts nor any other openings and shall be so constructed as to exclude materials such as dust, flying, oil, and coolant.		P
13.5.9	**Motor connection boxes**		
	Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (for example brakes, temperature sensors plugging switches, tachometer generators).		N
14 Electric motors and associated equipment			
14.1	**General requirements**		
	Electric motors should conform to the relevant parts of IEC 60034 series. The protection requirements for motors and associated equipment are given in 7.2 for over current protection, in 7.3 for overload protection, and in 7.6 for overspeed protection.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	As many controllers do not switch off the supply to a motor when it is at rest, care shall be taken to ensure compliance with the requirements of 5.3, 5.4, 5.5, 7.5, 7.6 and 9.4. Motor control equipment shall be located and mounted in accordance with Clause 11.		
14.2	**Motor enclosures**		
	It is recommended that motor enclosures be chosen from those included in IEC 60034-5. The degree of protection shall be at least IP23 (see IEC 60529) for all motors. More stringent requirements can be needed depending on the application and the physical environment (see 4.4). Motors incorporated as an integral part of the machine shall be so mounted that they are adequately protected from mechanical damage.		N
14.3	**Motor dimensions**		
	As far as is practicable, the dimensions of motors shall conform to those given in the IEC 60072 series.		N
14.4	**Motor mounting and compartments**		
	Each motor and its associated couplings, belts, pulleys, or chains, shall be so mounted that they are adequately protected and are easily accessible for inspection, maintenance, adjustment and alignment, lubrication, and replacement. The motor mounting arrangement shall be such that all motor hold-down means can be removed and all terminal boxes are accessible. Motors shall be so mounted that proper cooling is ensured and the temperature rise rN/Ains within the limits of the insulation class (see IEC 60034-1). Where practicable, motor compartments should be clean and dry, and when required, shall be ventilated directly to the exterior of the machine. The vents shall be such that ingress of swarf, dust, or water spray is at an acceptable level. There shall be no opening between the motor compartment and any other compartment that does not meet the motor compartment requirements. Where a conduit or pipe is run into the motor compartment from another compartment not meeting the motor compartment requirements, any clearance around the conduit or pipe shall be sealed.		N
14.5	**Criteria for motor selection**		
	The characteristics of motors and associated equipment shall be selected in accordance with the anticipated service and physical environmental conditions (see 4.4). In this respect, the points that shall be considered include: —type of motor; —type of duty cycle (see IEC 60034-1); —fixed speed or variable speed operation, (and the consequent variable influence of the ventilation); —mechanical vibration; —type of motor control; —influence of the harmonic spectrum of the voltage and/or current feeding the motor (particularly when it is supplied from a static convertor) on the temperature rise; —method of starting and the possible influence of the inrush current on the operation of other users of the same power		N

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Clause	Requirement – Test	Result - Remark	Verdict
	supply, taking also into account possible special considerations stipulated by the supply authority; —variation of counter-torque load with time and speed; —influence of loads with large inertia; —influence of constant torque or constant power operation; —possible need of inductive reactors between motor and converter.		
14.6	**Protective devices for mechanical brakes**		
	Operation of the overload and over current protective devices for mechanical brake actuators shall initiate the simultaneous de-energization (release) of the associated machine actuators.		N
15 Accessories and lighting			
15.1	**Accessories**		
	Where the machine or its associated equipment is provided with socket-outlets that are intended to be used for accessory equipment (for example hand-held power tools, test equipment), the following apply: —the socket-outlets should conform to IEC 60309-1. Where that is not practicable, they should be clearly marked with the voltage and current ratings; —the continuity of the protective bonding circuit to the socket-outlet shall be ensured except where protection is provided by PELV; —all unearthed conductors connected to the socket-outlet shall be protected against over current and, when required, against overload in accordance with 7.2 and 7.3 separately from the protection of other circuits; —where the power supply to the socket-outlet is not disconnected by the supply disconnecting device for the machine or the section of the machine, the requirements of 5.3.5 apply.		N
15.2	**Local lighting of the machine and equipment**		
15.2.1	**General Connections to the protective**		
	The ON/OFF switch shall not be incorporated in the lampholder or in the flexible connecting cords. Stroboscopic effects from lights shall be avoided by the selection of appropriate luminaries. Where fixed lighting is provided in an enclosure, electromagnetic compatibility should be taken into account using the principles outlined in 4.4.2.	No lamp used.	N
15.2.2	**Supply**		
	The nominal voltage of the local lighting circuit shall not exceed 250 V between conductors. A voltage not exceeding 50 V between conductors is recommended.		N
15.2.3	**Protection**		
	Local lighting circuits shall be protected in accordance with 7.2.6.		N
15.2.4	**Fittings**		
	Adjustable lighting fittings shall be suitable for the physical environment. The lamp holders shall be: —in accordance with the relevant IEC standard; —constructed with an insulating material protecting the lamp cap so as to prevent unintentional contact.		N

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Clause	Requirement – Test	Result - Remark	Verdict
	Reflectors shall be supported by a bracket and not by the lamp holder. Exception: where fixed lighting is out of reach of operators during normal operation, the provisions of this Sub clause do not apply.		
16 Marking, warning signs and reference designations			
16.1	**General**		
	Warning signs, nameplates, markings, and identification plates shall be of sufficient durability to withstand the physical environment involved.		P
16.2	**Warning signs**		
16.2.1	**Electric shock hazard**		
	Enclosures that do not otherwise clearly show that they contain electrical equipment that can give rise to a risk of electric shock shall be marked with the graphical symbol IEC 60417-5036(DB:2002-10). The warning sign shall be plainly visible on the enclosure door or cover. The warning sign may be omitted (see also 6.2.2 b)) for: —an enclosure equipped with a supply disconnecting device; —an operator-machine interface or control station; —a single device with its own enclosure (for example position sensor).		P
16.2.2	**Hot surfaces hazard**		
	Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures of the electrical equipment, the graphical symbol IEC 60417-5041 (DB: 2002-10) shall be used.		N
16.3	**Functional identification**		
	Control devices, visual indicators, and displays (particularly those related to safety) shall be clearly and durably marked with regard to their functions either on or adjacent to the item. Such markings may be as agreed between the user and the supplier of the equipment (see Annex B). Preference should be given to the use of standard symbols given in IEC 60417- DB: 2002 and ISO 7000.		P
16.4	**Marking of equipment**		
	Equipment (for example control gear assemblies) shall be legibly and durably marked in a way that is plainly visible after the equipment is installed. A nameplate giving the following information shall be attached to the enclosure adjacent to each incoming supply: —name or trade mark of supplier; —certification mark, when required; —serial number, where applicable; —rated voltage, number of phases and frequency (if a.c.), and full-load current for each supply; —short-circuit rating of the equipment; —main document number (see IEC 62023). The full-load current shown on the nameplate shall be not less than the running currents for all motors and other equipment that can be in operation at the same time under normal conditions. Where only a single motor controller is used, that information may instead be		P

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Clause	Requirement – Test	Result - Remark	Verdict
	provided on the machine nameplate where it is plainly visible.		
16.5	**Reference designations**		
	All enclosures, assemblies, control devices, and components shall be plainly identified with the same reference designation as shown in the technical documentation.		P
17	**Technical documentation**		
17.1	**General**		
	The information necessary for installation, operation, and maintenance of the electrical equipment of a machine shall be supplied in the appropriate forms, for example, drawings, diagrams, charts, tables, instructions. The information shall be in an agreed language (see also Annex B). The information provided may vary with the complexity of the electrical equipment. For very simple equipment, the relevant information may be contained in one document, provided that the document shows all the devices of the electrical equipment and enables the connections to the supply network to be made.		P
17.2	**Information to be provided**		
	The information provided with the electrical equipment shall include: a) A main document (parts list or list of documents); b) Complementary documents		P
17.3	**Requirements applicable to all documentation**		
	Unless otherwise agreed between manufacturer and user: —the documentation shall be in accordance with relevant parts of IEC 61082; —reference designations shall be in accordance with relevant parts of IEC 61346; —Instructions/manuals shall be in accordance with IEC 62079. —Parts lists where provided shall be in accordance with IEC 62027, class B. NOTE See item 13 of Annex B. For referencing of the different documents, the supplier shall select one of the following methods: —where the documentation consists of a small number of documents (for example less than 5) each of the documents shall carry as a cross-reference the document numbers of all other documents belonging to the electrical equipment; or —for single level main documents only (see IEC 62023), all documents shall be listed with document numbers and titles in a drawing or document list; or —all documents of a certain level (see IEC 62023) of the document structure shall be listed, with document numbers and titles, in a parts list belonging to the same level.		P
17.4	**Installation documents**		
	The installation documents shall give all information necessary for the preliminary work of setting up the machine (including commissioning). In complex cases, it may be necessary to refer to the assembly drawings for details.		P
17.5	**Overview diagrams and function diagrams**		
	Where it is necessary to facilitate the understanding of the		P

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Clause	Requirement – Test	Result - Remark	Verdict
	principles of operation, an overview diagram shall be provided. An overview diagram symbolically represents the electrical equipment together with its functional interrelationships without necessarily showing all of the interconnections. NOTE 1 Examples of overview diagrams can be found in IEC 61082 series. Function diagrams may be provided as either part of, or in addition to, the overview diagram.		
17.6	**Circuit diagrams**		
	A circuit diagram(s) shall be provided. This diagram(s) shall show the electrical circuits on the machine and its associated electrical equipment. Any graphical symbol not shown in IEC 60617-DB:2001 shall be separately shown and described on the diagrams or supporting documents. The symbols and identification of components and devices shall be consistent throughout all documents and on the machine. Where appropriate, a diagram showing the terminals for interface connections shall be provided. That diagram may be used in conjunction with the circuit diagram(s) for simplification. The diagram should contain a reference to the detailed circuit diagram of each unit shown. Switch symbols shall be shown on the electromechanical diagrams with all supplies turned off (for example electricity, air, water, lubricant) and with the machine and its electrical equipment ready for a normal start. Conductors shall be identified in accordance with 13.2. Circuits shall be shown in such a way as to facilitate the understanding of their function as well as maintenance and fault location. Characteristics relating to the function of the control devices and components which are not evident from their symbolic representation shall be included on the diagrams adjacent to the symbol or referenced to a footnote.		P
17.7	**Operating manual**		
	The technical documentation shall contain an operating manual detailing proper procedure for set-up and use of the electrical equipment. Particular attention should be given to the safety measures provided. Where the operation of the equipment can be programmed, detailed information on methods of programming, equipment required, program verification, and additional safety procedures(where required) shall be provided.	Detailing proper procedure for set-up and use of the electrical equipment.	P
17.8	**Maintenance manual**		
	The technical documentation shall contain a maintenance manual detailing proper procedures for adjustment, servicing and preventive inspection, and repair. Recommendations on Maintenance/service intervals and records should be part of that manual. Where methods for the verification of proper operation are provided (for example software testing programs), the use of		P

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Clause	Requirement – Test	Result - Remark	Verdict
	those methods shall be detailed.		
17.9	**Parts list**		
	The parts list, where provided, shall comprise, as a minimum, information necessary for ordering spare or replacement parts (for example components, devices, software, test equipment, technical documentation) required for preventive or corrective maintenance including those that are recommended to be carried in stock by the user of the equipment.		P
18	**Verification**		
18.2	**TABLE: Earth bonding**		P
	Test Current (A)..... :	10A	
	Ambient (°C)..... :	25	
Test locations (most unfavorable case)		Conductor diameter (mm^2)	Measure resistance (mΩ)
	PE – enclosure outside	0.75	73.6
18.3	**TABLE: Insulation resistance test**		P
	Test Voltage (V)..... :	500Va.c.	
	Ambient (°C)..... :	25	
Test locations (most unfavorable case)		Insulation resistance (MΩ)	
	PE - L	>100	
	PE - N	>100	
18.4	**TABLE: Dielectric test**		P
	Test Voltage (V)..... :	1000Va.c.	
	Test Duration (s)..... :	1 min.	
Test locations (most unfavorable case)		Observation	
	PE - L	Puncture Flash-over	
	PE - N	Puncture Flash-over	
18.5	**Protection against residual voltages**		
	Where appropriate, tests shall be performed to ensure compliance with 6.2.4.	See clause 6.2.4.	P
18.6	**Functional tests**		
	The functions of electrical equipment shall be tested. The function of circuits for electrical safety (for example earth fault detection) shall be tested.		P

ATTACHMENTS: REAL PHOTOS DOCUMENTATION OF EUT

Figure-1

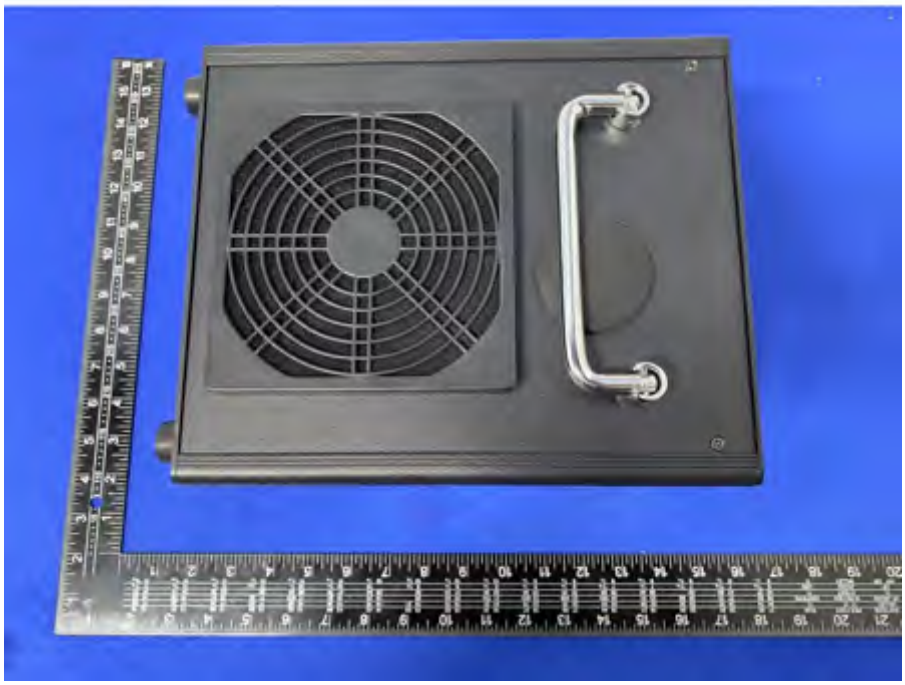

Figure-2

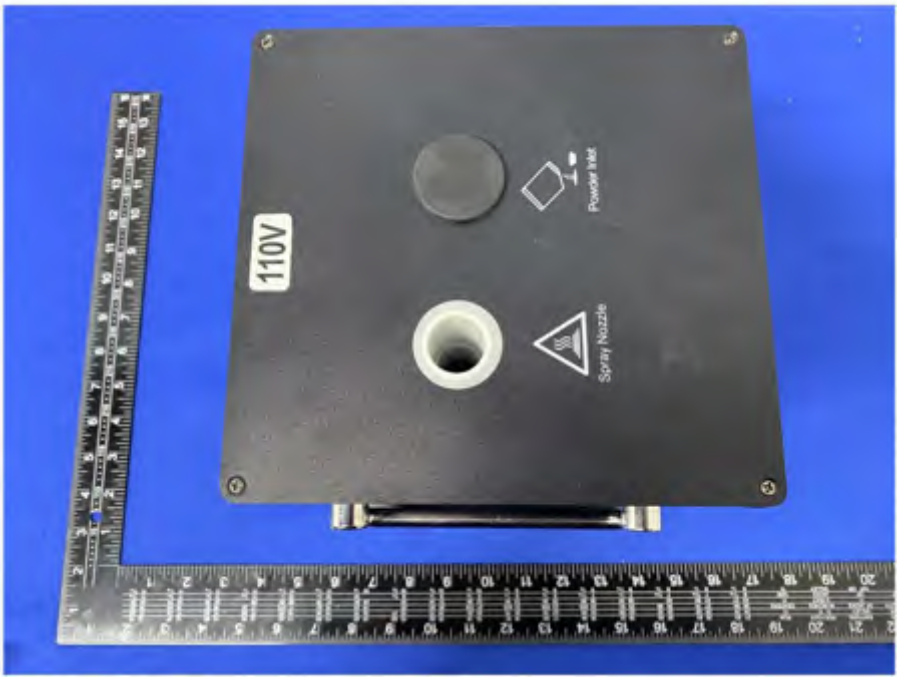

Figure-3

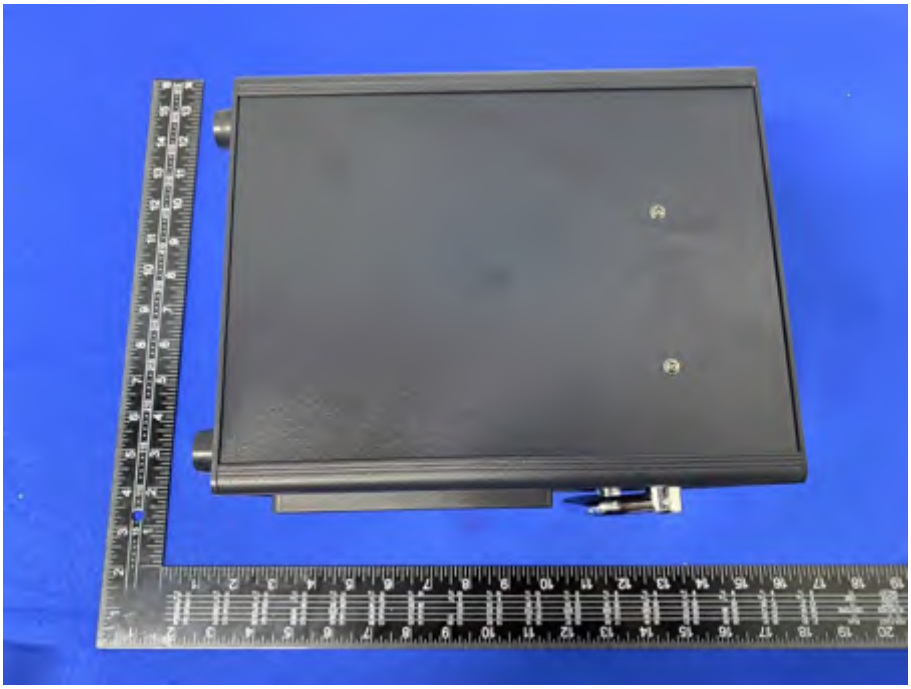

Figure-4

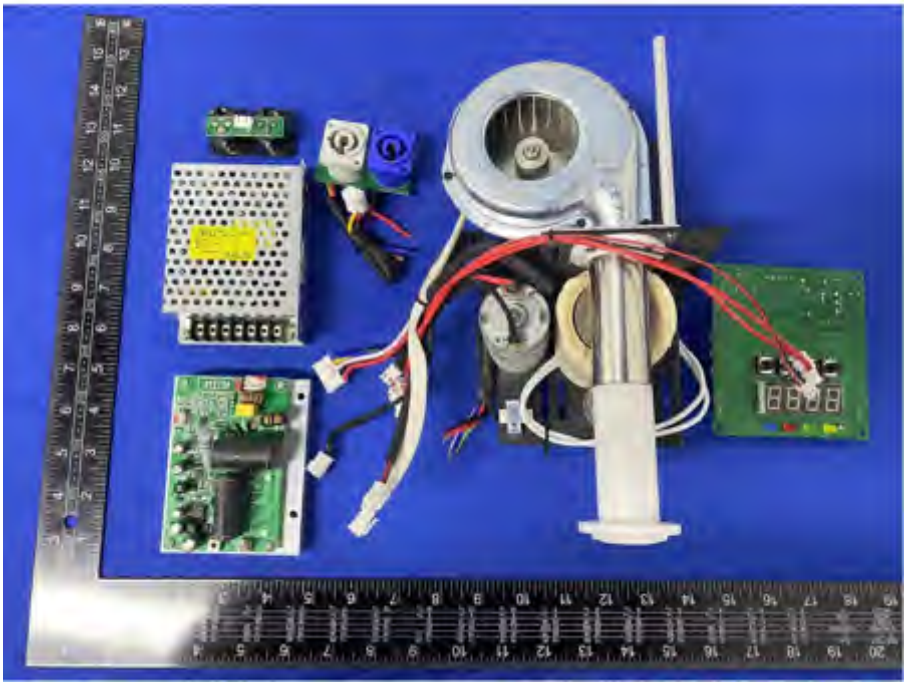

Figure-5

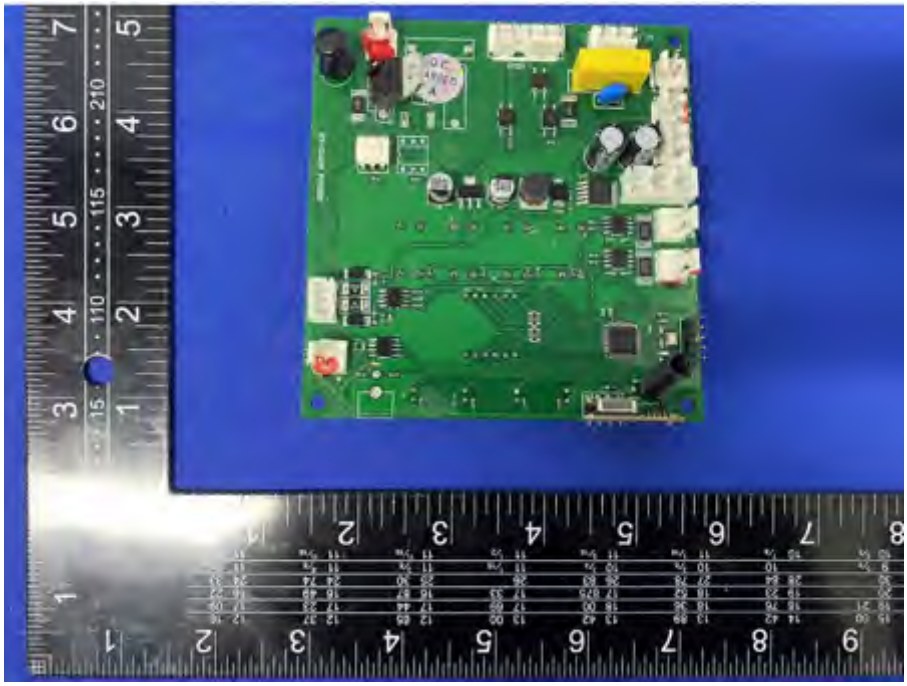

Figure-6

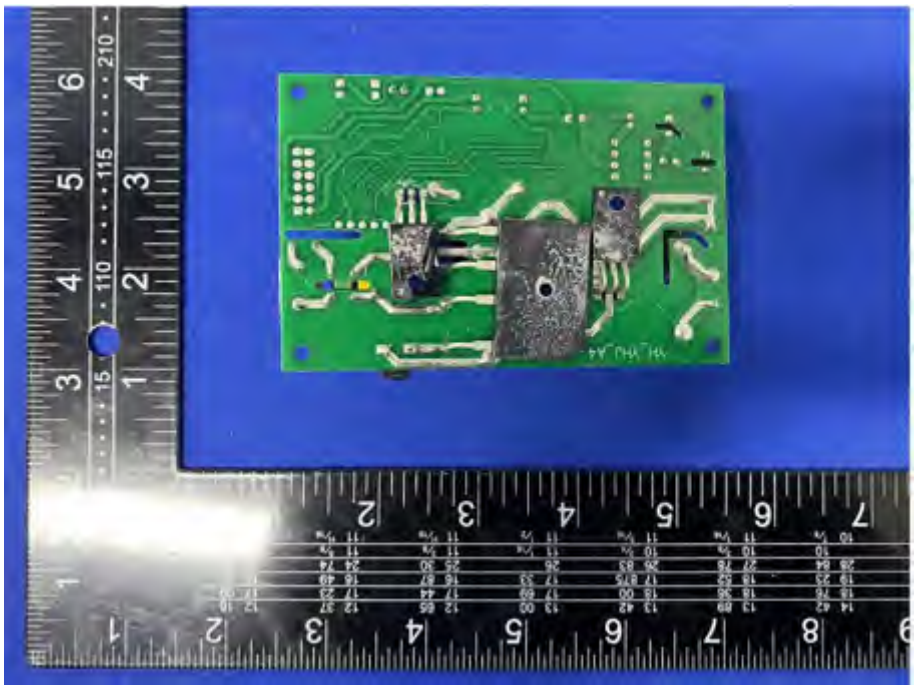

Figure-7

Figure-8

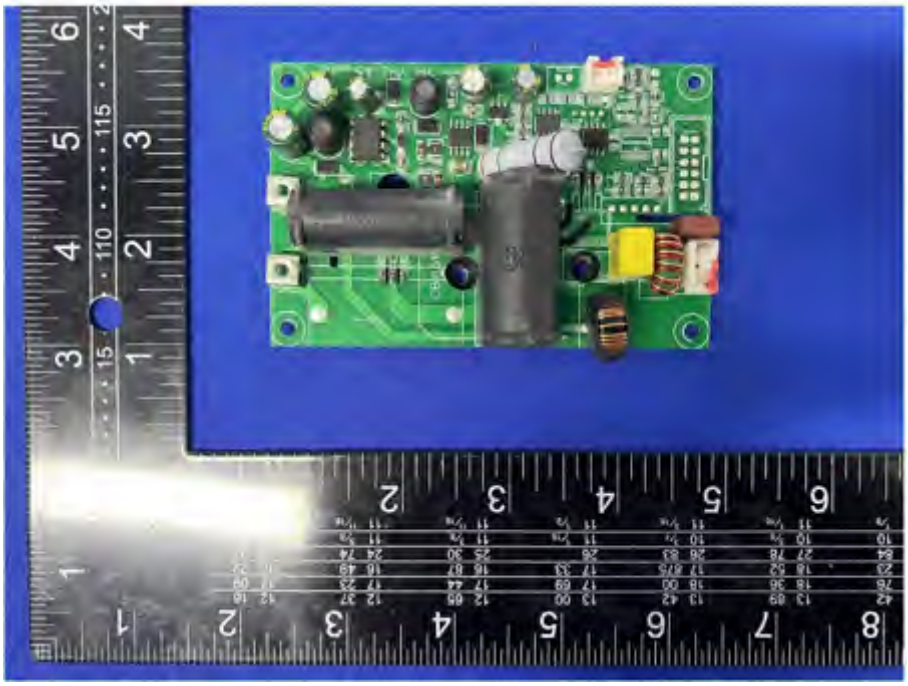

Figure-9

****** THE END ******