



TEST REPORT

For

Shenzhen Reeman Intelligent Equipment Co.,Ltd

UVC Sterilizing Robot

Model: HBOT11U, HBOT12U, WBOT11U

Test Report Number: WD20072007MS



Dongguan Wode Testing Co.,Ltd

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TEST REPORT EN 60204-1:2018 Safety of machine- Electrical equipment of machines, Part 1: General requirements	
Report Reference No:	WD20072007MS
Tested by (+ signature):	Dylan (Engineer) <i>Dylan</i>
Approved by (name + signature):	Alex (Manager) <i>Alex</i>
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Applicant	
Name:	Shenzhen Reeman Intelligent Equipment Co.,Ltd
Address:	No.401 Building No.15, Incubator, Robot Zhizao Industries Park, COFCO(Fu'an) Dayang Road, Fuyong Sub-district, Bao'an District, Shenzhen City, Guangdong Province, China
Test specification:	
Directive:	2006/42/EC
Standard:	EN 60204-1:2018
Test procedure	CE-MD
Test item	
Description:	UVC Sterilizing Robot
Model and/or type reference:	HBOT11U, HBOT12U, WBOT11U
Trademark:	
Manufacturer:	Shenzhen Reeman Intelligent Equipment Co.,Ltd
Address:	No.401 Building No.15, Incubator, Robot Zhizao Industries Park, COFCO(Fu'an) Dayang Road, Fuyong Sub-district, Bao'an District, Shenzhen City, Guangdong Province, China
Rating(s):	37V ₋₋₋

Copy of marking plate:

紫外线消毒机器人 UVC Sterilizing Robot

产品型号/Model: **HBOT11U** 额定电池电压/ Rated battery voltage : **37V**
 短路电流/Short circuit current : **20A** 额定功率/Rated power : **225W**
 充电电压/充电电流/Charge voltage/Charge current : **42V/3A/5A**
 序列号/ Serial number :
 出厂日期/ Date of production :
 制造商名称: **深圳市锐曼智能装备有限公司**Shenzhen Reeman Intelligent Equipment Co.,Ltd
 制造商地址: **深圳市宝安区福永街道大洋路中粮 (福安) 机器人智造产业园孵化器第15栋401号**NO.401, Building NO.15, Incubator,Robot Intelligent Manufacturing Industrial Park, COFCO (Fu'an) Dayang Road, Fuyong Sub-district, Bao'an District, Shenzhen
 注意事项: **非专业请勿拆开机器, 严禁拍打, 撞机以免触电或损坏机器, 机器正常行驶坡度≤10度。** Precautions:Do not disassemble the machine for non-professionals,it is strictly forbidden to beat,hit the machine to avoid electric shock or damage the machine,the normal driving gradient of the machine is less than or equal to 10 degree.



紫外线消毒机器人 UVC Sterilizing Robot

产品型号/Model: **HBOT12U** 额定电池电压/ Rated battery voltage : **37V**
 短路电流/Short circuit current : **20A** 额定功率/Rated power : **333W**
 充电电压/充电电流/Charge voltage/Charge current : **42V/3A/5A**
 序列号/ Serial number :
 出厂日期/ Date of production :
 制造商名称: **深圳市锐曼智能装备有限公司**Shenzhen Reeman Intelligent Equipment Co.,Ltd
 制造商地址: **深圳市宝安区福永街道大洋路中粮 (福安) 机器人智造产业园孵化器第15栋401号**NO.401, Building NO.15, Incubator,Robot Intelligent Manufacturing Industrial Park, COFCO (Fu'an) Dayang Road, Fuyong Sub-district, Bao'an District, Shenzhen
 注意事项: **非专业请勿拆开机器, 严禁拍打, 撞机以免触电或损坏机器, 机器正常行驶坡度≤10度。** Precautions:Do not disassemble the machine for non-professionals,it is strictly forbidden to beat,hit the machine to avoid electric shock or damage the machine,the normal driving gradient of the machine is less than or equal to 10 degree.



紫外线消毒机器人 UVC Sterilizing Robot

产品型号/Model: **WBOT11U** 额定电池电压/ Rated battery voltage : **37V**
 短路电流/Short circuit current : **20A** 额定功率/Rated power : **225W**
 充电电压/充电电流/Charge voltage/Charge current : **42V/3A/5A**
 序列号/ Serial number :
 出厂日期/ Date of production :
 制造商名称: **深圳市锐曼智能装备有限公司**Shenzhen Reeman Intelligent Equipment Co.,Ltd
 制造商地址: **深圳市宝安区福永街道大洋路中粮 (福安) 机器人智造产业园孵化器第15栋401号**NO.401, Building NO.15, Incubator,Robot Intelligent Manufacturing Industrial Park, COFCO (Fu'an) Dayang Road, Fuyong Sub-district, Bao'an District, Shenzhen
 注意事项: **非专业请勿拆开机器, 严禁拍打, 撞机以免触电或损坏机器, 机器正常行驶坡度≤10度。** Precautions:Do not disassemble the machine for non-professionals,it is strictly forbidden to beat,hit the machine to avoid electric shock or damage the machine,the normal driving gradient of the machine is less than or equal to 10 degree.



Remarks:

The Importer's name and address shall be marked on the label before shipment.
 Other informations may be included if no misuse or misunderstanding.

Summary of testing:

The submitted samples were found to be in compliance with EN 60204-1:2018.

Test case verdicts

Test case does not apply to the test object :	N(N/A)
Test item does meet the requirement :	P(Pass)
Test item does not meet the requirement :	F(Fail)

Testing

Date of receipt of test item :	July.02, 2020
Date(s) of performance of test :	July. 03, 2020 to Sept. 04, 2020

Testing location:

No.401 Building No.15, Incubator, Robot Zhizao Industries Park, COFCO(Fu'an) Dayang Road, Fuyong Sub-district, Bao'an District, Shenzhen City, Guangdong Province, China

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:

UV Sterilizing Robot has a beautiful beige-white appearance, centimeter-level precision navigation, the world's original remote deployment technology, multi-machine coordination capabilities, automatic obstacle avoidance and other functions, can automatically navigate to a specified location indoor.

Mode	Supply Voltage/Capacity	Differences
HBOT11U	Nominal voltage : 37V The nominal capacity is 20.8AH	This machine is square chassis, length of UVC lamp tube: 90CM, power of lamp tube: 30W, electrical parameters are the same as HBOT12U and WBOT11U
HBOT12U	Nominal voltage : 37V The nominal capacity is 20.8AH	This machine is square chassis, length of UVC lamp tube: 120CM lamp tube power 36W. The electrical parameters of HBOT11U and WBOT11U are the same
WBOT11U	Nominal voltage : 37V The nominal capacity is 20.8AH	This machine is a round chassis, length of UVC lamp tube: 90CM, power of lamp tube: 30W, and HBOT11U, HBOT12U. The electrical parameters are the same.

EN 60204-1:2018			
Clause	Requirement - Test	Result - Remark	Verdict
4	GENERAL REQUIREMENTS		—
4.1	General		P
	Hazards relevant to the electrical equipment are assessed as part of the overall risk assessment of the machine as described	Risk assessments as well as the evaluation on corresponding measures are carried out. And the result of which is found to be suitable.	P
4.2	Selection of equipment		P
4.2.1	Electrical components and devices shall be: <ul style="list-style-type: none"> - suitable for their intended use - conform to IEC standards where such exist - be applied in accordance with supplier's instructions 	Suitable for their intended use	P
4.2.2	Where appropriate electrical equipment in compliance with IEC 61439 series	Comply with requirement	P
4.3	Electrical supply		P
4.3.1	Electrical equipment to be designed for correct operation within the conditions of mains power supply		P
4.3.2	AC supplies		N
	Supply Voltage: Steady state voltage: 0.9 ... 1.1 of nominal voltage		N
	Frequency: 0.99 ... 1.01 of nominal frequency continuously; 0.98 ... 1.02 short time.		N
	Harmonics: not exceeding 12 % of the total r.m.s. etc.		N
	Voltage unbalance: not exceeding 2% deviation		N
	Voltage interruption: interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1 s between successive interruptions		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Voltage dips not exceeding 20 % of the rms voltage of the supply for more than one cycle with more than 1 s between successive dips		N
4.3.3	DC supplies		P
	Supply voltage: - batteries: 0.85 – 1.15 of nominal voltage - battery-operated vehicles: 0.7 – 1.2 of nom. volt. - from converting equipment: 0.9 – 1.1 of nom. volt.	37V DC	P
	Voltage interruption: - batteries: not exceeding 5 ms - converting equipment: not exceeding 20 ms		P
	Ripple (peak-to-peak): not exceed. 0.15 of nom. volt.		P
4.3.4	Special supply systems (e.g. on-board generators, DC bus) limits acc. 4.3.2 / .3 may be exceeded, provided equipment is designed accordingly		N
4.4	Physical environment and operating conditions		P
4.4.1	Electrical equipment suitable for the physical environment and operating conditions of its intended use.	Manufacturer is responsible for selecting suitable electric equipment acc. to IEC or EN standards.	P
4.4.2	Immunity and/or emission tests required unless		N
	- incorporated devices and components comply with the relevant product standard and		N
	- installation and wiring according supplier instructions or Annex H:		N
4.4.3	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. (Minimum requirement: air temperatures of +5 °C and +40 °C)		P
4.4.4	Electrical equipment shall be capable of operating correctly when the relative humidity is up to 50 % at a maximum temperature of +40 °C		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Harmful effects of condensation shall be avoided		P
4.4.5	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level		P
	For equipment to be used at higher altitudes the reduction of dielectric strength, switching capability and cooling effects shall be taken into account		P
4.4.6	Electrical equipment shall be adequately protected against the ingress of solids and liquids (see 11.3)		P
4.4.7	When equipment is subjected to radiation, additional measures shall be taken		N
4.4.8	Undesirable effects of vibration, shock and bump avoided by suitable means		N
4.5	Electrical equipment designed to withstand the effects of transportation and storage within a temperature range of - 25 to + 55 °C	The shipping and storage environment are described in the instructions	P
4.6	Heavy or bulky electrical equipment of the machine provided with suitable means for handling		P
5	INCOMING SUPPLY CONDUCTOR TERMINATIONS AND DEVICES FOR DISCONNECTING AND SWITCHING OFF		—
5.1	Incoming supply conductor terminations		P
	Recommendation that electrical equipment of a machine is connected to a single supply (For large complex machinery, there can be a need for more than one incoming supply)	Single source power (battery power)	P
	Unless a plug is provided, supply conductors should be terminated at the supply disconnecting device		P
	Neutral conductor clearly indicated in technical documentation with "N" (see cl. 16.1)		N
	A separate terminal, labelled N provided (it may be part of the supply disconnecting device)		N

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Clause	Requirement - Test	Result - Remark	Verdict
	No connection between neutral conductor and protective bonding circuit		N
	Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the electrical equipment to a TN-C supply system.		N
	For machines supplied from parallel sources the requirements of IEC 60364-1 apply		N
	All terminals of incoming supply clearly marked in ac. with IEC 60445)	Marked with "+" and "-"	P
5.2	Terminal for connection of external protective conductor (PE)		—
	For each incoming supply, a terminal shall be provided in the same compartment as the line conductor terminals for connection to the external protective conductor		N
	Terminal size according to table 1 in relation to the line conductors		N
	Where an external protective conductor other than copper is used, the terminal size and type shall be selected accordingly		N
	At each incoming point this terminal shall be marked or labelled with the letters PE		N
5.3	Supply disconnecting device		—
5.3.1	A supply disconnecting device shall be provided: – for each incoming supply to a machine – for each on-board power supply		P
	Where two or more such devices exist, interlocks shall be provided to prevent hazardous situations		N
5.3.2	The supply disconnecting device shall be one of the following:		—
	a) a switch-disconnector, acc. to IEC 60947-3 for at least appliance category AC-23 B or DC-23 B	key switch	P
	b) a control and protective switching device suitable for insulation acc. to IEC 60947-6-2		N

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Clause	Requirement - Test	Result - Remark	Verdict
	c) a circuit-breaker suitable for isolation (acc. to IEC 60947-2)		N
	d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements and the appropriate utilization category and/or specified endurance requirements		N
	e) a plug/socket combination for a flexible cable supply		N
5.3.3	A disconnection device acc. to 5.3.2 a) to d) has to fulfil all of the following requirements		—
	- isolate the electrical equipment from the supply and have one OFF (isolated) and one ON position marked with "O" and "I"		P
	- 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		N
	- have an operating means (see 5.3.4)		N
	- coloured black or grey recommended (If used as an emergency stop, red/yellow combination selected)		N
	- be provided with a means permitting it to be locked in the OFF position (padlocks). When so locked, remote as well as local closing shall be prevented		N
	- disconnect all live conductors of its power supply circuit 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		N
	- have a braking capacity to interrupt the system, when the largest motor is stalled		N

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Clause	Requirement - Test	Result - Remark	Verdict
	A plug/socket combination used as a disconnection device shall: - comply with 13.4.5 - have a braking capacity to interrupt the system, when the largest motor is stalled		N
5.3.4	Operating means of supply disconnecting devices (e.g. a handle) shall be external to the enclosure		P
	Exception: for power-operated switchgear this can be some other means (e.g. pushbutton) instead of a handle		N
	The operating means shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level (upper limit of 1,7 m is recommended)		N
	Where intended for emergency operation, see 10.7.3 or 10.8.3		P
	Where not intended for emergency operation - the colours black or grey are recommended - a supplementary cover or door that can be readily opened without a key or tool may be provided. It shall clearly show its function, e.g. by relevant symbols		P
5.3.5	The following circuits need not be disconnected by the supply disconnecting device: - lighting circuits for lighting needed during maintenance or repair; - socket outlets for the exclusive connection of repair or maintenance tools and equipment; - undervoltage protection circuits that are only provided for automatic tripping in the event of supply failure; - circuits supplying equipment that should normally remain energized for correct operation Such circuits should be provided with their own disconnecting device.		N
	Where expected circuits are not disconnected by the supply disconnecting device:		—

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Clause	Requirement - Test	Result - Remark	Verdict
	<ul style="list-style-type: none"> - permanent warning labels shall be placed close to the operating means 		N
	<ul style="list-style-type: none"> - a statement shall be included in the maintenance manual and 		N
	<ul style="list-style-type: none"> - the conductors are identified by colour, taking into account the recommendation of Cl.13.2.4, or - expected circuits are separated from other circuits, or - expected circuits are identified by permanent warning labels 		N
5.4	Devices for removal of power for prevention of unexpected start-up		—
	Devices for removal of power for the prevention of unexpected start-up shall be provided where this can create a hazard	Adopt power off switch	P
	They shall be appropriate and convenient for the intended use, suitably placed, and readily identifiable as to their function and purpose		P
	Where not obvious, they shall be marked to indicate the extent of removal of power		P
	Devices in accordance with 5.3.2 may be used for this purpose		P
	Disconnectors, withdrawable fuse links and withdrawable links only used, if located in enclosed electrical operator area (see 3.1.23)		N
	Devices that do not fulfil the isolation function (e.g. a contactor switched off by a control circuit etc.) only used for tasks such as: <ul style="list-style-type: none"> - inspections; - adjustments; - work on the electrical equipment where there are <p style="text-align: center;">only minor risks (as described)</p>		N
5.5	Devices for isolating electrical equipment		—

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Clause	Requirement - Test	Result - Remark	Verdict
	Devices shall be provided for isolating electrical equipment or parts of it to enable work	Adopt power off switch	P
	Such devices shall be: - appropriate and convenient for the intended use; - suitably placed; - readily identifiable as to which part or circuit of the equipment is served. They shall be marked unless their function and purpose is obvious		P
	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 is provided for each part, or for each machine, requiring separate isolation		N
	In addition, 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 used, if located in enclosed electrical operator area (see 3.1.23) and information provided (see cl 17)		N
5.6	Protection against unauthorized, inadvertent and/or mistaken connection		—
	Where devices acc. to cl. 5.4 and 5. are located outside an enclosed electrical operator area, locking means in OFF position shall be provided When so secured, local and remote reconnection shall be prevented	The key switch can be locked in the off position	P
	Where these devices are located inside an enclosed electrical operator area, other means of protection against unintended reconnection can be sufficient		N
	Where a plug/socket combinations 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 are not needed		N

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Clause	Requirement - Test	Result - Remark	Verdict
6	PROTECTION AGAINST ELECTRIC SHOCK		—
6.1	The electrical equipment shall provide protection against electric shock by basic protection and fault protection	Meet requirements	P
	Where the measures for protection as in 6.2, 6.3 and 6.4 are not practicable, other measures from IEC 60364-4-41 may be used (e.g. SELV)		P
6.2	Basic protection		—
6.2.1	For each circuit the measures of 6.2.2, 6.2.3 and, where applicable, 6.2.4 shall apply		N
	Where not appropriate, other measures as defined in IEC 60364-4-41 may be applied (see also 6.2.5 and 6.2.6)		N
	For equipment in places open to all persons including children, 6.2.2 with a minimum protection of IP4X or IPXXD, or 6.2.3 shall be applied		N
6.2.2	Live parts shall be located inside enclosures that provide protection against contact with live parts of at least IP2X or IPXXB.		P
	Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against contact with live parts provided by the top surfaces shall be IP4X or IPXXD.		P
	Opening an enclosure (i.e. opening doors, lids, covers, etc) shall be possible only under one of the following conditions:		—

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>a) The use of a key or tool is necessary for access</p> <p>All live parts (including those on the inside of doors) likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected, are protected against contact to at least IP2X or IPXXB</p> <p>Other live parts on the inside of doors are protected against unintentional direct contact to at least IP1X or IPXXA.</p>		P
	<p>b) The disconnection of live parts inside the enclosure before it can be opened (see explanation)</p> <p>Exception: a key or tool as prescribed by the supplier can be used to defeat the interlock, provided that the following conditions are met:</p> <ul style="list-style-type: none"> - it is possible at all times while the interlock is defeated to open the disconnecting device and lock the disconnecting device in the OFF position or otherwise prevent unauthorised closure of the disconnecting device; - upon closing the door, the interlock is automatically restored - all live parts (), likely to be touched ... are protected against unintentional contact to at least IP2X or IPXXB and other live parts on the inside of doors shall be protected against unintentional contact to at least IP1X or IPXXA - relevant information about the procedure for the defeat of the interlock is provided with the instructions for use of the electrical equipment - means are provided to restrict access to live parts behind doors that are not directly interlocked with the disconnecting means to skilled or instructed persons <p>All parts still alive after switching off the</p>		P

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>disconnecting device shall be protected against direct contact to at least IP 2X or IP XXB and be marked with a warning sign in accordance with 16.2.1 except for:</p> <ul style="list-style-type: none"> - parts that can be live only because of connection to interlocking circuits and that are distinguished by colour as potentially live in accordance with 13.2.4 - the supply terminals of the supply disconnecting device when the latter is mounted alone in a separate enclosure 		
	<p>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 contact to at least IP2X or IPXXB.</p> <p>Where barriers provide this protection, either they shall require a tool for their removal or all live parts protected by them shall be automatically disconnected when the barrier is removed.</p> <p>Where a hazard can be caused by manual action of devices () , such action shall be prevented by barriers or obstacles that require a tool for their removal</p>		P
6.2.3	<p>Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction and that is capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions</p>		N
	<p>Note: Paint, varnish lacquer etc. alone are generally considered inadequate</p>		N
6.2.4	<p>Live parts having a residual voltage greater than 60 V when disconnected, shall be discharged to 60 V or less within 5 s, if this does not interfere with the proper functioning of the equipment</p>		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Exempted are components having stored charges of 60 μ C or less		N
	Where not possible, an appropriate warning shall be placed according to the details given		N
	In case of pins of plugs etc. the discharge time shall not exceed 1s. Otherwise such conductors shall be protected to at least IP2X or IPXXB.		N
	If above requirements cannot be achieved, additional disconnecting devices or appropriate warning devices shall be provided		N
	When equipment is accessible to all persons incl. children, warnings are not sufficient and a protection of IP4X or IPXXD is required		N
6.2.5	For protection by barriers, the requirements of IEC 60364-4-41 shall apply (412.2)		N
6.2.6	For protection by placing out of reach or protection by obstacles, the requirements of IEC 60364-4-41 shall apply (412.4 and 412.3)		N
	For conductor wire or bar systems with less than IP2X or IPXXB, see 12.7.1		N
6.3	Fault protection		—
6.3.1	For each circuit or part of el. equipment at least one of the measures of 6.3.2 to 6.3.3 shall be applied:		—
	-Prevention of the occurrence of a touch voltage		P
	-Protection by automatic disconnection of supply		N
6.3.2	Prevention of the occurrence of a touch voltage		--
6.3.2.2	Protection by provision of 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) or	Class III devices	N

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Clause	Requirement - Test	Result - Remark	Verdict
	- switchgear and control gear assemblies having total insulation in accordance with IEC 61439-1or		N
	- supplementary or reinforced insulation in accordance with IEC 60364-4-41(413.2)		N
6.3.2.3	For protection by electrical separation the requirements of IEC 60364-4-41 apply (413.5)		N
6.3.3	Protection by automatic disconnection of supply		N
	This measure consists of the interruption of one or more line conductors in a time within the limits specified in Annex A for TN and TT systems		N
	This requires co-ordination between: <ul style="list-style-type: none"> - the type of supply, the source impedance and the earthing system - several impedance values - characteristics of protective devices - (For details see 18.2) 		N
	This protective measure comprises both:		—
	- protective bonding of exposed parts (8.2.3)		N
	- one of the following:		—
	a) In TN systems, the following protective devices may be used:		N
	• overcurrent protective device or		N
	• residual current protective devices (RCDs) and associated overcurrent protective devices		N
	b) In TT systems either:		N
	• RCDs and associated overcurrent protective devices or		N
	• overcurrent protective devices provided a low fault loop impedance is assured		N
	c) In IT-Systems the requirements of IEC 60364-4-41 shall be fulfilled		N

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Clause	Requirement - Test	Result - Remark	Verdict
	During an insulation fault an acoustic and an optical signal shall be sustained. The acoustic signal may manually be muted		N
	Where automatic disconnection is provided under a) and disconnection acc. to A.1.1 cannot be assured, supplementary protective bonding shall be provided to fulfil A.1.3		N
	Where protection of a PDS (power drive system) is not provided by the converter, the necessary protection shall be acc. to the converter manufacturer's instructions		N
6.4	Protection by the use of PELV		—
6.4.1	PELV circuits shall satisfy all of the following conditions:		—
	a) the nominal voltage does not exceed: -25 V AC r.m.s. or 60 V ripple-free AC when the equipment is normally used in dry locations and when large area contact of live parts with the human body is not expected; or -6 V AC r.m.s. or 15 V ripple-free DC in all other cases;		N
	b) one side of the circuit or one point of the source of the supply of that circuit is connected to the protective bonding circuit;		N
	c) live parts of PELV circuits shall be electrically separated from other live circuits (see IEC 61558)		N
	d) conductors of each PELV circuit shall be physically separated from those of any other circuit. If this requirement is impracticable, the insulation provisions of 13.1.3 shall apply		N
	e) plugs and socket-outlets for a PELV circuit shall conform to the following: -plugs shall not to enter socket-outlets of other voltage systems -socket-outlets shall not admit plugs of other voltage systems		N

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Clause	Requirement - Test	Result - Remark	Verdict
6.4.2	The sources for PELV shall be one of the following:		—
	- a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6 or		N
	- a source of current with a degree of safety equi-valent to that of the safety isolating transformer or		N
	- a source independent of circuit with higher voltage (e.g. battery or diesel –driven) or	battery	P
	- electronic power supply conforming to appropriate standards		N
7.	PROTECTION OF EQUIPMENT		—
7.2	Overcurrent protection		—
7.2.1	Overcurrent protection shall be provided where the current in any circuit can exceed the rating of a component or the capacity of a conductor	Overcurrent protection is provided	P
7.2.2	Supply conductors		—
	Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the supply conductors or the overcurrent protective device for it		N
	In the installation documents, the data necessary for conductor dimensioning and selecting the overcurrent protective device are stated (see 7.2.10 and 17.4)		N
7.2.3	Power circuits		—
	Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10, are applied to each live conductor including supplies to control circuit transformers.	Fuse body is used as overcurrent protection	P

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Clause	Requirement - Test	Result - Remark	Verdict
	The following conductors shall not be disconnected without disconnecting all associated live conductors: –the neutral conductor of AC power circuits; –the earthed conductor of DC power circuits; –DC power conductors bonded to exposed conductive parts of mobile machines.		N
	Where the cross-section area of the neutral conductor is at least equal to the line conductor, no overcurrent detection nor disconnecting device is required for that conductor		N
	Otherwise the measures detailed in 524 of IEC 60364-5-52:2009 shall apply		N
	In IT-Systems, it is recommended that no neutral conductor is used. Where a neutral conductor is used, the measures detailed in 431.2.2 of IEC 60364-4-43:2008 shall apply.		N
7.2.4	Control circuits		—
	Conductors of control circuits directly connected to the supply shall be protected against overcurrent in accordance with 7.2.3.	Fuse body is used as overcurrent protection	P
	Conductors of control circuits supplied by a transformer or DC supply shall be protected against overcurrent (see also 9.4.3.1.1):		—
	–In control circuits, connected to the protective bonding circuit, by an overcurrent protective device in the switched conductor.		N
	–In circuits, not connected to the protective bonding circuit: <ul style="list-style-type: none"> • Where all control circuits have the same current carrying capacity, by an overcurrent protective device in the switched conductor • Otherwise, by an overcurrent protective device in both, switched and common conductors of each control circuit 		N


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Clause	Requirement - Test	Result - Remark	Verdict
	Exception: Where a supply unit provides current limiting below the capacity of the conductors and the connected components, no overcurrent protective device is required		N
7.2.5	Overcurrent protection shall be provided for circuits feeding general purpose socket outlets	No socket	N
7.2.6	Unearthed conductors of lighting circuits shall be protected separately from other circuits.	No lighting circuits	N
7.2.7	Transformers shall be protected in accordance with the manufacturer's instructions and includes: <ul style="list-style-type: none"> - avoiding tripping due to transformer magnetizing inrush currents - avoiding a winding temperature rise in excess of the permitted value for the insulation class when there is a short circuit at the secondary terminals 	DC-DC	P
7.2.8	Location of overcurrent protective devices		—
	It shall be located at the point where a reduction in the cross sectional area of the conductors or another change reduces the current-carrying capacity of the conductors except:		P
	<ul style="list-style-type: none"> - current carrying capacity of the conductors is at least equal to that of the load and - conductors between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is ≤ 3 m and - the conductor is protected e.g. by an enclosure or duct. 		P
7.2.9	Overcurrent protective devices		—
	The rated short-circuit breaking capacity I_{cn} shall be at least equal to the prospective fault current at the point of installation. Additional currents other than from the supply (e.g. from motors, from power factor correction capacitors) shall be taken into consideration.		P


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Clause	Requirement - Test	Result - Remark	Verdict
	Where fuses are provided as overcurrent 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.		P
7.2.10	Rating and setting of overcurrent protective devices:		—
	Rated current of fuses or overcurrent setting of other protective devices selected as low as possible, but adequate for anticipated overcurrents.		P
	The rated current of overcurrent protective device for conductors is determined by the current carrying capacity of the conductors to be protected in accordance with Cl. 12.4, D.2 and the maximum allowable interrupting time t in accordance with Clause D.3.		P
7.3	Protection of motors against overheating		—
7.3.1	Protection shall be provided for each motor rated at more than 0.5 kW.	400W	N
	Exception: 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 respond.		N
	Automatic restarting prevented where this can cause a hazard		N
7.3.2	Protection achieved by overload protection device: <ul style="list-style-type: none"> - detection in each live conductor - switching off of all live conductors (not necessary to switch of neutral conductor) 		P
	For special duty motors, appropriate protective devices are recommended		N
	For motors that cannot be overloaded, overload protection is not required.		N

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Clause	Requirement - Test	Result - Remark	Verdict
7.3.3	Protection achieved by over-temperature protection device: Is recommended in situations where the cooling can be impaired (for example dusty environments)		P
7.4	Equipment shall be protected against abnormal temperatures that can result in a hazardous situation.		P
7.5	Protection against the effects of 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, undervoltage protection is provided.		N
	Upon restoration of supply voltage, automatic or unexpected restarting of machine prevented.		N
	Undervoltage protection does initiate appropriate control responses to ensure necessary coordination of groups of machines working together		N
7.6	Motor overspeed protection shall be provided where overspeeding can occur and could possibly cause a hazardous situation.	The driver provides speed feedback monitoring	P
7.7	Additional earth fault/residual current protection In addition to providing overcurrent 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 overcurrent protection		N
7.8	Phase sequence protection shall be provided, where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine.		N
7.9	Surge protective devices (SPDs) can be provided to protect against the effects of overvoltages due to lightning or to switching surges.		N

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Clause	Requirement - Test	Result - Remark	Verdict
7.10	The short-circuit current rating of the electrical equipment shall be determined by the application of design rules or by calculation or by test.	10A	P
8	EQUIPOTENTIAL BONDING		—
8.2	Protective bonding circuit		—
8.2.1	All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses		N
	Protective conductors which does not form part of a cable shall not be less than:		—
	- 2.5 mm ² Cu or 16 mm ² Al if protection against mechanical damage is provided		N
	- 4 mm ² Cu or 16 mm ² Al if protection against mechanical damage is not provided		N
	Exposed conductive parts of equipment in accordance with 6.3.2.3 (Protection by electrical separation) shall not be connected to the protective bonding circuit.		N
	Small parts and other conductive parts that do not constitute a hazard need not to be earthed		N
8.2.2	Protective conductors		—
	Protective conductors shall be identified in accordance with 13.2.2.		N
	Copper conductors are preferred.		N
	Where other material 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 mm ² in cross-sectional area.		N

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>Metal enclosures or frames or mounting plates may be used as protective conductors if they satisfy the following three requirements:</p> <ul style="list-style-type: none"> - protection against mechanical, chemical or electrochemical deterioration - compliant with 543.1 of IEC 60364-5-54: - permit the connection of other protective conductors where foreseen 		N
	<p>The cross-section of protective conductors shall be calculated according to 543.1.2 of IEC 60364-5-54, or selected in accordance with Table 1.</p>		N
	<p>Each protective conductor shall:</p> <ul style="list-style-type: none"> - be part of a multicore cable, or; - be in a common enclosure with the line conductor, or; - have a cross-sectional area of at least; <ul style="list-style-type: none"> • 2.5 mm² Cu or 16 mm² Al with protection against mechanical damage • 4 mm² Cu or 16 mm² Al without protection against mechanical damage 		N
	<p>A protective conductor not forming part of a cable is considered to be mechanically protected if it is installed in a conduit, trunking or protected in a similar way.</p>		N
	<p>The following parts shall be connected to the protective bonding circuit but shall not be used as protective conductors:</p> <ul style="list-style-type: none"> - conductive structural parts of the machine; - metal ducts of flexible or rigid construction; - metallic cable sheaths or armouring; - metallic pipes containing flammable materials such as gases, liquids, powder. - flexible or pliable metal conduits; - constructional parts subject to mechanical stress in normal service; - • flexible metal parts; support wires; cable trays and cable ladders. 		N

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Clause	Requirement - Test	Result - Remark	Verdict
8.2.3	Continuity of the protective bonding circuit		—
	Where a part is removed the protective bonding circuit for the remaining parts isn't interrupted.		N
	Current-carrying capacity of connection and bonding points not impaired by mechanical, chemical, or electrochemical influences (e.g. electrolytic corrosion on aluminium parts)		N
	Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured. The use of a protective conductor (see 8.2.2) is recommended.		N
	For cables that are exposed to damage (for example flexible trailing cables) the continuity of the protective conductors are ensured by appropriate measures (for example monitoring).		N
	Where the continuity can be interrupted, a first make last break contact is required.		N
8.2.4	Protective conductor connecting points are not intended to attach appliances or parts.		N
	Each connecting point shall be marked or labelled as such using the symbol IEC 60417-5019 or the letters PE or by use of bicolour GREEN / YELLOW		N
8.2.5	Mobile machines with on-board power supplies: The protective bonding system is connected to a single protective bonding terminal. This protective bonding terminal is the connection point for a possible additional external incoming power supply		N
8.2.6	Additional requirements for electrical equipment having earth leakage currents higher than 10 mA		—
	Where electrical equipment has an earth leakage current greater than 10 mAAC or DC the associated protective bonding circuit shall satisfy one of the following:		—

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Clause	Requirement - Test	Result - Remark	Verdict
	a) the protective conductor is completely enclosed or otherwise protected		N
	b) the protective conductor has a cross-sectional area of at least 10 mm ² Cu or 16 mm ² Al		N
	c) a second protective conductor of at least the same cross-sectional area is provided		N
	d) the supply is automatically disconnected in case of loss of continuity of the protective conductor		N
	e) where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series is provided		N
	A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.		N
8.3	Measures to restrict the effects of high leakage current can be taken as described		N
8.4	If functional bonding is used, the connecting points should be marked with symbol IEC 60417-5020		N
9	CONTROL CIRCUITS AND CONTROL FUNCTIONS		—
9.1.	Control circuit		—
9.1.1	Where control circuits are supplied from an AC source, transformers having separate windings shall be used to separate the power supply from the control supply.		N
	Examples include: control transformers acc. to IEC 61558-2-2, SMPS acc. to IEC 61558-2-16 power supplies acc. to IEC 61204-7		N
	Where several transformers are used, it is recommended that the secondary voltages are in phase.		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Exception: Transformers or switch mode power supply units fitted with transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices		N
	Where DC control circuits derived from an AC supply are connected to the protective bonding, they shall be supplied from a separate winding		N
9.1.2	The nominal voltage of control circuits should preferably not exceed <ul style="list-style-type: none"> - 230 V @ 50 Hz - 277 V @ 60 Hz - 220 V @ DC 	3.3V DC	P
9.1.3	Control circuits are provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		P
9.2.	Control functions		—
9.2.2	Categories of stop functions are stop category 0, 1, 2		—
9.2.3	Operation		—
9.2.3.1	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.	one control station	N
9.2.3.2	Start functions shall operate by energizing the relevant circuit.		P
	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.		P
	Where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations are by hold-to-run controls, together with enabling devices, as appropriate.		N

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>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.</p> <p>The conditions to initiate a start are:</p> <ul style="list-style-type: none"> - 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 have to be actuated concurrently (see 3.1.7). 	one control station	N
9.2.3.3	<p>Stop category 0 and/or stop category 1 and/or stop category 2 stop functions are provided as indicated by the risk assessment and the functional requirements of the machine (see 4.1).</p>	Stop category 0, stop category 1	P
	Stop functions shall override related start functions		P
	Where more than one control station is provided, stop commands from any control station is effective when required by the risk assessment of the machine.	one control station	N
9.2.3.4	Emergency operations (emergency stop, emergency switching off)		—
9.2.3.4.1	Emergency stop or emergency switching off commands shall be sustained until it is reset.	meet requirements	P
	This reset shall be possible only by a manual action at that location where the command has been initiated.	meet requirements	P
	The reset of the command shall not restart the machinery but only permit restarting.		P
	It shall not be possible to restart the machinery until all emergency stop commands are reset.	meet requirements	P
	It shall not be possible to reenergize the machinery until all emergency switching off commands are reset.		P
9.2.3.4.2	The emergency stop does function either as a stop category 0 or as a stop category 1.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	<ul style="list-style-type: none"> - it shall override all other functions and operations in all modes - it shall stop the hazardous motion as quickly as practicable without creating other hazards - a reset shall not initiate a restart 	meet requirements	P
9.2.3.4.3	<p>Emergency switching off should be provided where:</p> <ul style="list-style-type: none"> - Protection against direct contact 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 	Use the circuit breaker	P
	Emergency switching off is accomplished by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply		N
9.2.3.5	Operating modes		—
	Where machinery uses several control or operating modes requiring different protective measures and having a different impact on safety, it shall be fitted with a mode selector which can be locked in each position	Automatic Mode, Wireless control manual mode	P
	Another selection method can be used (for example an access code)	Access code	P
	Mode selection by itself does not initiate machine operation. A separate actuation of the start control has to be stated by the operator.		P
	Indication of the selected operating mode shall be provided (e.g. the position of a mode selector, the provision of an indicating light, a visual display indication)	Visual display indication	P
9.2.3.6	Movement or action that can result in a hazardous situation shall be monitored by providing, for example, overtravel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices	Motor overspeed detection	P

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Clause	Requirement - Test	Result - Remark	Verdict
9.2.3.7	Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation		N
9.2.3.8	Two-hand controls shall be one of the following types and have the following features		N
	Type I: this type requires: <ul style="list-style-type: none"> - 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 		N
	Type II: a Type I control requiring the release of both control devices before machine operation can be reinitiated		N
	Type III: a Type II control requiring concurrent actuation of the control devices as follows: <ul style="list-style-type: none"> - 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 machine operation can be initiated 		N
9.2.3.9	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		N
9.2.3.10	Combined start and stop controls: Push-buttons etc. that alternately initiate and stop motion shall only be provided for functions, which cannot result in a hazardous situation.		N
9.2.4	Cableless control system		—

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Clause	Requirement - Test	Result - Remark	Verdict
9.2.4.1	The CCS shall have functionality and a response time suitable for the application based on the risk assessment.		P
9.2.4.2	The ability of a CCS to control a machine shall be automatically monitored, either continuously or at suitable intervals.		P
	If the communication signal has degraded (e.g., reduced signal level, low battery power) a warning shall be given		P
	When the ability to control a machine has been lost, an automatic stop of the machine shall be initiated.		P
	Its restoration shall not restart the machine.		P
9.2.4.3	Measures shall be taken to prevent the machine from responding to signals other than those from the intended operator control station(s).		P
	Cableless operator control station(s) shall only control the intended machine(s) and shall affect only the intended machine functions.		P
9.2.4.4	When more than one cableless operator control station is used, then:		—
	- only one control station shall be enabled at a time except as necessary for the operation	only one control station	N
	- transfer of control shall require a deliberate manual action at the station having control		N
	- transfer shall only be possible if both stations are in the same mode		N
	- a transfer shall not change the mode of operation or function		N
	- on the station that has control, a visual indication shall indicate this		N
9.2.4.5	Portable cableless operator control stations shall be provided with means to prevent unauthorized use	Access code	P

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Clause	Requirement - Test	Result - Remark	Verdict
	Each machine should have an indication when it is under cableless control	Visual display indication	P
	When possible to be connected to several machines, means shall be provided on the portable device to select		N
	Selecting a machine shall not initiate control commands.		N
9.2.4.6	A deliberate disabling shall meet the requirements of 9.2.4.2.		P
	Where disabling without interrupting machine operation is necessary, appropriate means shall be provided to transfer control		P
9.2.4.7	Emergency stop devices on portable cableless operator control stations shall not be the sole means of initiating an emergency stop		P
	Confusion between active and inactive emergency stop devices shall be avoided		P
9.2.4.8	Restarting of a cableless control shall not result in a reset of an emergency stop condition		P
	The instructions shall state that a reset shall only be performed when it can be seen that the reason has been cleared		N
9.3	Protective interlocks		—
9.3.1	The reclosing or resetting of an interlocking safeguard does not initiate hazardous machine operation		N
9.3.2	Where an operating limit (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	The correct operation of auxiliary functions shall be checked by appropriate devices		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Where the non-operation of a device can cause a hazard, appropriate interlocking shall be provided		N
9.3.4	Interlocks between different operations and for contrary motions shall be provided, if these operations can lead to hazardous situations		P
9.3.5	Where braking of a motor is accomplished by current reversal, measures shall 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		N
	For this purpose, a device operating exclusively as a function of time is not permitted		N
	Control circuits shall be so arranged that rotation of a motor shaft, for example manually, does not result in a hazardous situation		N
9.3.6	Where it is necessary to suspend safety functions and/or protective measures, the control or operating mode selector shall simultaneously:		—
	- disable all other operating (control) modes		N
	- permit operation only by the use of a hold-to-run device or by a similar control device positioned so as to permit sight of the hazardous elements		N
	- prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors		N
	If these four conditions cannot be fulfilled, the mode selector shall activate other protective measures to ensure a safe intervention zone. In addition, the operator shall be able to control operation of the parts he is working on from the adjustment point.		N
9.4	Control functions in the event of failure		—

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Clause	Requirement - Test	Result - Remark	Verdict
9.4.1	The electrical control system(s) shall have an appropriate performance that has been determined from the risk assessment of the machine		P
	The requirements for safety-related control functions of IEC 62061 and/or ISO 13849-1,ISO 13849-2 shall apply		P
	Where memory retention is achieved for example, by battery power, measures shall be taken to prevent hazardous situations arising from failure, undervoltage or removal of the battery		N
	Means shall be provided to prevent unauthorized or inadvertent memory alteration by, for example, requiring the use of a key, access code or tool		N
9.4.2	Measures to minimize risk in the event of failure		—
9.4.2.2	Use of proven circuit techniques and components (see examples)		P
9.4.2.3	Provisions of partial or complete redundancy		P
9.4.2.4	Provision of diversity (see examples)		N
9.4.2.5	Provision for functional tests		P
9.4.3	Protection against malfunction of control circuits		—
9.4.3.1.1	Measures shall be provided to reduce the probability that insulation faults on any control circuit can cause malfunction		P
9.4.3.1.2	Method a) – Earthed control circuits fed by transformers		N
	The common conductor shall be connected to the protective bonding circuit at the point of supply.		N
	All control elements are to be inserted on the other side of the components		N
9.4.3.1.3	Method b) – Non-earthed control circuits fed by transformers shall either		N

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Clause	Requirement - Test	Result - Remark	Verdict
	1) have 2-pole control switches that operate on both conductors; or		N
	2) be provided with a device that interrupts the circuit automatically in the event of an earth fault; or		N
	3) where 2) above would increase the risk, it can be sufficient to provide an insulation monitoring device that will initiate an acoustic and optical signal		N
9.4.3.1.4	Method c) – Control circuits fed by transformer with an earthed centre-tap winding shall have overcurrent protective devices that break both the conductors		N
	The control switches shall be 2-pole types that operate on both conductors		N
9.4.3.1.5	Method d) – Control circuits not fed by a transformer are only allowed for machines with a maximum of one motor starter and/or maximum of two control devices, in accordance with 9.1.1		N
	Possible cases are:		—
	1) directly connected to an earthed supply system (TN- or TT-system)		N
	If powered between two lines, multi-pole control switches are required		N
	2) directly connected to a supply system that is not earthed or is earthed through a high impedance (IT-system)		N
	A device shall be provided that interrupts the circuit automatically in the event of an earth fault		N
9.4.3.2	Where the loss of memory due to a power failure can result in a hazardous situation, appropriate measures shall be taken		N
9.4.3.3	Where the loss of continuity of control circuits depending upon sliding contacts can result in a hazard, appropriate measures shall be taken		N

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Clause	Requirement - Test	Result - Remark	Verdict
10	OPERATOR INTERFACE AND MACHINE-MOUNTED CONTROL DEVICES		—
10.1.1	Control devices for operator interface shall, as far as is practicable, be selected, mounted, and identified or coded in accordance with IEC 61310 series		P
10.1.2	As far as is practicable, machine-mounted control devices shall be:		—
	- readily accessible for service and maintenance		P
	- mounted in such a manner as to minimize the possibility of damage from activities such as material handling		P
	The actuators of hand-operated control devices are 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		P
	- the operator is not placed in a hazardous situation when operating them		P
	The actuators of foot-operated control devices are selected and installed so that:		—
	- they are within easy reach of the normal working position of the operator		P
	- the operator is not placed in a hazardous situation when operating them		P
10.1.3	The degree of protection (IP rating in accordance with IEC 60529) together with other appropriate measures shall provide protection against:		P
	- the effects of liquids, vapours, or gases found in the physical environment or used on the machine		N
	- the ingress of contaminants (for example swarf, dust, particulate matter)		P
	The operator interface control devices shall have a minimum degree of protection against contact with live parts of IPXXD (see IEC 60529)	IP43	P

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Clause	Requirement - Test	Result - Remark	Verdict
10.1.4	Position sensors (for example position switches, proximity switches) are so arranged that they will not be damaged in the event of overtravel		P
	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
10.1.5	Portable and pendant operator control stations and their control devices are so selected and arranged as to minimize the possibility of machine operations caused by inadvertent actuation, shocks and vibrations		N
10.2	Actuators		—
10.2.1	Actuators shall be colour-coded as follows:		P
	The colours for START/ON actuators should be WHITE, GREY, BLACK or GREEN with a preference for WHITE. RED shall not be used		P
	The colour RED shall be used for emergency stop and emergency switching off actuators		P
	If a background exists, it shall be coloured YELLOW		P
	The colours for STOP/OFF actuators should be BLACK, GREY, or WHITE with a preference for BLACK. GREEN shall not be used. RED is permitted		P
	WHITE, GREY, or BLACK are the preferred colours for actuators that alternately act as START/ON and STOP/OFF actuators. The colours RED, YELLOW, or GREEN shall not be used		P
	The same is applicable for “hold-to-run” actuators		N
	Reset actuators shall be BLUE, WHITE, GREY, or BLACK. Where they also act as a STOP/OFF actuator, the colours WHITE, GREY, or BLACK are preferred with the main preference being for BLACK. GREEN shall not be used.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	The colour YELLOW is reserved for use in abnormal conditions		N
	Where the same colours are used for various functions, a supplementary means of coding shall be used for the identification		N
10.2.2	Recommended markings for actuators are given in table 2 and 3		P
10.3	Indicator lights and displays		—
10.3.1	Indicator lights and displays shall be selected and installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310-1).		P
	Circuits used for visual or audible devices used to warn persons of an impending hazardous event shall be fitted with facilities to check the operability of these devices		P
10.3.2	Indicator lights should be colour-coded with respect to the condition (status) of the machine in accordance with Table 4.		N
	Indicating towers on machines have the applicable colours in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.		N
10.3.3	For further distinction or information and especially to give additional emphasis, flashing lights and displays can be provided	provided displays	P
	Where flashing lights or displays are used to provide higher priority information, additional acoustic warnings should be considered	additional acoustic warnings	P
10.4	illuminated push-button actuators shall be colour-coded in accordance with Tables 2 and 4. Where there is difficulty in assigning an appropriate colour, WHITE is used.		N
	The colour RED for the emergency stop actuator shall not depend on the illumination of its light.		N

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Clause	Requirement - Test	Result - Remark	Verdict
10.5	Devices having a rotational member, such as potentiometers and selector switches, shall have means of prevention of rotation of the stationary member. Friction alone isn't considered sufficient.		N
10.6	Actuators used to initiate a start function or the movement of machine elements shall be constructed and mounted so as to minimize inadvertent operation	Use the shell defend	P
10.7	Emergency stop devices		—
10.7.1	Devices for emergency stop are readily accessible		P
	Emergency stop devices shall be provided at each location where the initiation of an emergency stop can be required		P
	In circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station, means (for example, information for use) are provided to minimise confusion.		P
10.7.2	The types of device for emergency stop include, but are not limited to: – a push-button device for actuation by the palm or the fist (e.g. mushroom) – a pull-cord operated switch – a pedal-operated switch without mechanical guard	mushroom	P
	The devices shall be in accordance with IEC 60947-5-5.		P
10.7.3	Where a stop category 0 is suitable, the supply disconnecting device may serve the function of emergency stop where: – it is readily accessible to the operator; and – it is of the type described in 5.3.2 a), b), c), or d)	stop category 0	P
	Where intended for emergency use, the supply disconnecting device shall meet the colour requirements of 10.2.1		P

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Clause	Requirement - Test	Result - Remark	Verdict
10.8	Emergency switching off devices		—
10.8.1	Such devices shall be located as necessary for the given application.		N
	Means are provided, where necessary, to avoid confusion between these devices.		N
10.8.2	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		N
	The devices shall have direct opening action		N
10.8.3	Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and shall meet the colour requirements of 10.2.1		N
10.9	Enabling control device		—
	Enabling control devices shall be selected and arranged so as to minimize the possibility of defeating		N
	They shall be designed in accordance with ergonomic principles		N
	Functions of two-position types: – position 1: off-function of the switch (actuator is not operated); – position 2: enabling function (actuator is operated)		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Functions of three-position types: <ul style="list-style-type: none"> - 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 		N
11	CONTROLGEAR: LOCATION, MOUNTING AND ENCLOSURES		—
11.2.1	All items of controlgear (inclusively terminals that are not part of controlgear components or devices) are placed and oriented so that they can be identified without moving them or the wiring		P
	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)		P
	All controlgear are mounted so as to facilitate its operation and maintenance		P
	Necessary tools to adjust, maintain, or remove a device are supplied		P
	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		N
	Recommendation, that terminals be least 0.2 m above the servicing level and so placed that conductors and cables can be easily connected		P
	Only operating, indicating, measuring, and cooling devices are mounted on doors or on normally removable access covers of enclosures		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Where connected through plug-in arrangements, their association shall be made clear by type (shape), marking or reference designation		N
	Plug-in devices that are handled during normal operation shall be provided with non-interchangeable features		N
	Plug/socket combinations that are handled during normal operation are unobstructedly accessible.		P
	Test points for connection of test equipment shall be: <ul style="list-style-type: none"> – mounted to provide unobstructed access – clearly identified to correspond with the documentation – adequately insulated – sufficiently spaced 		N
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 controlgear		N
	Devices such as solenoid valves should be separated from the other electrical equipment (for example in a separate compartment)		N
	Control devices mounted in the same location and connected to the supply voltage, or to both supply and control voltages, should be grouped separately from those connected only to the control voltages		P
	Terminals shall be separated into groups for: <ul style="list-style-type: none"> – power circuits – associated control circuits – other control circuits, fed from external sources (for example for interlocking) 		P
	The clearances and creepage distances specified by the supplier shall be maintained, taking into account the external influences or conditions of the physical environment.		P

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Clause	Requirement - Test	Result - Remark	Verdict
11.2.3	The temperature rise inside electrical equipment enclosures shall not exceed the ambient temperature specified by the component manufacturers		P
	Heat generating components (for example heat sinks, power resistors) are located so, that the temperature of each component in the vicinity remains within the permitted limit		P
11.3	Degrees of protection		—
	The protection of controlgear 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 and shall be sufficient against dust, coolants, lubricants and swarf		P
	Enclosures of controlgear provide a degree of protection of at least IP22 (see IEC 60529)	IP43	P
	Exception, where: a) an electrical operating area provides an appropriate degree of protection b) removable collectors on conductor wire or conductor bar systems are used and the measures of 12.7.1 are applied		N
11.4	Enclosures, doors and openings		—
	Enclosures shall be constructed using materials capable of withstanding the mechanical, electrical and thermal stresses as well as the effects of humidity and other environmental factors that are likely to be encountered in normal service		P
	Fasteners used to secure doors and covers should be of the captive type		P
	Windows of enclosures shall be of a material suitable to withstand expected mechanical stress and chemical attack		P

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Clause	Requirement - Test	Result - Remark	Verdict
	It is recommended that enclosure doors having vertical hinges be not wider than 0,9 m, with an angle of opening of at least 95°	The control device is enclosed in the entire enclosure, which is locked with screws.	N
	Joints or gaskets of doors, lids, etc. shall withstand the chemical effects of the aggressive liquids, vapours, or gases used on the machine.		P
	They shall: <ul style="list-style-type: none"> - be securely attached - not deteriorate due to removal or replacement of the door 		P
	Openings in enclosures (for example, for cable access), including those towards the floor or foundation or to other parts of the machine shall be equipped with means to ensure the degree of protection specified for the equipment.		N
	A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away		P
	Openings for cable entries shall be easily re-opened on site	No cable entries	N
	There shall be no opening between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate.	No lubricating or hydraulic fluids, or those into which oil, other liquids, or dust	N
	Holes in an enclosure for mounting shall not impair the required protection.		P

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Clause	Requirement - Test	Result - Remark	Verdict
	Equipment that, in normal or abnormal operation, can attain a surface temperature sufficient to cause a risk of fire or harmful effect to an enclosure material shall: <ul style="list-style-type: none"> – be located within an enclosure that will withstand, such temperatures; and – be located at a sufficient distance from adjacent equipment allowing safe dissipation of heat (see also 11.2.3); or – be otherwise screened by material that can withstand to the harmful effect. 		P
11.5	Access to electrical equipment		—
	Doors in gangways for access to electrical operating areas shall: <ul style="list-style-type: none"> – be at least 0.7 m wide and 2.0 m high – open outwards – have a means (for example panic bolts) to allow opening from the inside without the use of a key or tool 		N
12	CONDUCTORS AND CABLES		—
12.1	Conductors and cables shall be selected so as to be suitable for the operating conditions and external Influences that can exist		P
	These requirements do not apply to the integral wiring of assemblies, subassemblies, and devices that are manufactured and tested in accordance with their relevant IEC standard (for example IEC 61800 series).		—
12.2	Conductors should be of copper. Where aluminium conductors are used, the cross-sectional area shall be at least 16 mm ² .	No aluminium conductors	P
	The cross-sectional area of conductors should not be less than as shown in Table 5	meet the requirement	P
	Smaller cross-sectional areas or other constructions than shown in Table 5 may be used, provided adequate mechanical strength is achieved by other means		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Class 1 and class 2 conductors are primarily intended for use between rigid, non-moving parts where vibration is not likely to cause damage		N
	All conductors that are subject to frequent movement should have flexible stranding of class 5 or class 6.		N
12.3	Where the insulation of conductors and cables can constitute hazards due for example to the propagation of a fire or the emission of toxic or corrosive fumes adequate means are provided. Special attention is given to the integrity of a circuit having a safety-related function		P
	The insulation of cables and conductors used, shall be suitable for a test voltage:		—
	- not less than 2 000 V AC for a duration of 5 min for operation at voltages higher than 50 V AC or 120 V DC, or		P
	- not less than 500 V AC for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment).		P
	The insulation shall be such that it cannot be damaged in operation or during laying, especially for cables pulled into ducts.		P
12.4	Current-carrying capacity in normal service in accordance with table 6. Or in accordance with suppliers recommendation.		P
12.5	The voltage drop from the point of supply to the load in any power circuit cable shall not exceed 5 % of the nominal voltage under normal operating conditions.		P
	In control circuits, the voltage drop shall not reduce the voltage at any device below the manufacturer's specification for that device, taking into account inrush currents.		P
12.6	Flexible cables		—

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Clause	Requirement - Test	Result - Remark	Verdict
12.6.1	Flexible cables shall have Class 5 or Class 6 conductors		P
	<p>Cables that are subjected to severe duties shall be of adequate construction to protect against:</p> <ul style="list-style-type: none"> - abrasion due to mechanical handling and dragging across rough surfaces - kinking due to operation without guides - stress resulting from guide rollers and forced guiding, being wound and re-wound on cable drums 		N
12.6.2	<p>The tensile stress applied to copper conductors shall not exceed 15 N/mm² of cross-sectional area</p> <p>Or special measures are taken to withstand the applied stress</p>		N
	For material other than copper the applied stress shall be within the cable manufacturer's specification		N
12.6.3	For cables of circular cross-sectional area installed on drums, the maximum current should be derated in accordance with Table 7		N
12.7	Conductor wires, conductor bars and slip-ring assemblies		—
12.7.1	During normal access to the machine, protection to conductor wires, conductor bars and slip-ring assemblies shall be achieved by the application of one of the following protective measures:		N
	- protection by partial insulation of live parts, or where this is not practicable		N
	- protection by enclosures or barriers of at least IP2X or IPXXB		N
	Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X or IPXXD		N

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Clause	Requirement - Test	Result - Remark	Verdict
	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		N
	Conductor wires and conductor bars shall be so placed and/or protected as to:		—
	<ul style="list-style-type: none"> - 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 		N
	<ul style="list-style-type: none"> - prevent damage from a swinging load 		N
12.7.2	Protective conductor circuit (PE) and the neutral conductor (N) each use a separate conductor wire, conductor bar or slip-ring		N
	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)		N
12.7.3	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 disconnecter function: The protective conductor circuit interrupts after and reconnects before any live conductor		N
12.7.5	Clearances in air between conductors and adjacent systems shall be suitable for at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1		N
12.7.6	Creepage distances between conductors and adjacent systems shall be suitable suitable for operation in the intended environment, e.g. open air, inside buildings, protected by enclosures		N

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Clause	Requirement - Test	Result - Remark	Verdict
	In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply:		N
	- unprotected conductor wires, conductor bars, and slip-ring assemblies: 60 mm		N
	- enclosed conductor wires, insulated multipole conductor bars and insulated individual conductor bars: 30 mm		N
12.7.7	Conductor system divided into isolated sections: suitable design measures shall be employed to prevent the energization of adjacent sections by the current collectors themselves		N
12.7.8	Conductor wires, conductor bars and slip-ring assemblies in power circuits shall be grouped separately from those in control circuits		N
	They shall be capable of withstanding, without damage, the mechanical forces and thermal effects of short-circuit currents		N
	Removable covers cannot be opened by one person without the aid of a tool		N
	Where common metal enclosures are used, the individual sections shall be bonded together and connected to the protective bonding circuit		N
	Conductor bar ducts that can be subject to accumulation of liquid shall have drainage facilities		N
13	WIRING PRACTICES		—
13.1	Connections and routing		—
13.1.1	All connections shall be secured against accidental loosening		P
	The means of connection shall be suitable for the cross-sectional areas and nature of the conductors being terminated		P

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Clause	Requirement - Test	Result - Remark	Verdict
	No connection of two or more conductors to one terminal, unless the terminal is designed for it		P
	No soldered connections to terminals unless they are suitable for it		N
	Terminals on terminal blocks are plainly marked or labelled corresponding with the diagrams		P
	Installations of flexible conduits and cables are such that liquids drain away from the fittings		P
	Retaining means for conductor strand and shields provided (no soldering for that purpose)		P
	Identification tags shall be legible, permanent, and appropriate for the physical environment		P
	Terminal blocks mounted and wired so that the wiring does not cross over the terminals		P
13.1.2	Conductors and cables shall be run from terminal to terminal without splices or joints		P
	Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be splices or joints for the purpose of this subclause		P
	Exceptions are possible as described		N
	Terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors		P
	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 for circuits that operate at different voltages are separated by suitable barriers, or are insulated for the highest voltage that occurs within the same duct		P

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Clause	Requirement - Test	Result - Remark	Verdict
13.1.4	Conductors of AC circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit, including the protective conductor of each circuit, are contained in the same enclosure		P
	Single-core cables armoured with steel wire or steel tape should not be used for AC circuits		P
13.2	The cable between the pick-up and the pick-up converter of an inductive power supply system shall be:		—
	- as short as practicable		N
	- adequately protected against mechanical damage		N
13.2.1	Each conductor shall be identifiable at each termination in accordance with the technical documentation		P
13.2.2	When identification of the protective conductor is by colour alone, the bicolour combination GREEN-AND-YELLOW shall be used throughout the length of the conductor		N
	Where the protective conductor can be easily identified colour coding throughout its length is not necessary, but the ends or accessible locations are clearly identified by the graphical symbol or by the bicolour combination GREEN-AND-YELLOW		N
	Exception: Protective bonding conductors may be marked with the letters PB and/or the symbol IEC 60417-5021		N
13.2.3	Where a neutral conductor is identified by colour alone, the colour shall be BLUE (preferably light blue)		N
	In this case that colour shall not be used for identifying any other conductor where confusion is possible		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Bare conductors used as neutral conductors shall have at minimum a stripe in LIGHT BLUE 15 mm to 100 mm wide in each compartment or unit and at each accessible location		N
13.2.4	Where colour-coding is used, BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE may be used		N
	GREEN and YELLOW should not be used where there is a possibility of confusion with the bicolour combination GREEN-AND-YELLOW		N
13.3	Wiring inside enclosures		—
	Conductors inside enclosures shall be supported where necessary		P
	Non-metallic supports shall be made with a flame-retardant insulating material (see IEC 60332 series)		P
	Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors in accordance with 12.2 and 12.6.		P
	Conductors and cables that do not run in ducts shall be adequately supported		P
13.4	Wiring outside enclosures		—
13.4.1	Conductors of a circuit shall not be distributed over different multi-core cables, conduits, etc.		N
13.4.2	Conductors and their connections external to the electrical equipment shall be placed in suitable ducts (see cl.13.5) Exceptions: <ul style="list-style-type: none"> - Cables with special suitable protection. - Position switches or proximity switches supplied with a dedicated cable which is sufficiently short 		N

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Clause	Requirement - Test	Result - Remark	Verdict
13.4.3	Connections to moving parts shall take into account the foreseeable frequency of movement and shall be made using conductors in accordance with 12.2 and 12.6		N
	The bending radius of the cable shall be at least 10 times the diameter of the cable		N
	Flexible cables of machines shall be so installed or protected as to minimize the possibility of external damage (run over, forces, rubbing, heat, etc.)		N
	Cables close to moving parts, shall maintain a space of at least 25 mm between the moving parts and the cables or barriers are provided		N
	Cable handling systems: Lateral cable angles not exceeding 5°, at being wound on and off cable drums or approaching and leaving cable guidance devices. The bending radius shall be in accordance with Table 8		N
	Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically designed for that purpose		N
13.4.4	Where several machine-mounted devices are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points		N
13.4.5	Plug/socket combinations		—
	Components or devices inside an enclosure, terminated by fixed plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination, are excluded		N
	Where the plug/socket contains a contact for the protective bonding circuit, it shall have a first make last break contact (see also 8.2.4).		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Plug/socket combinations intended to be connected or disconnected during load conditions shall have sufficient load-breaking capacity		N
	Where the plug/socket combination is rated at 30 A, or greater, it shall be interlocked		N
	Plug/socket combinations that are rated at more than 16 A shall have a retaining means to prevent unintended or accidental disconnection.		N
	Where an unintended or accidental disconnection of plug/socket combinations can cause a hazardous situation, they shall have a retaining means.		N



Clause	Requirement - Test	Result - Remark	Verdict
	<p>The installation of plug/socket combinations shall fulfil the following requirements as applicable:</p> <ul style="list-style-type: none"> a) The component which remains live after disconnection shall have a degree of protection of at least IP2X or IPXXB b) Metallic housings of plug/socket combinations shall be connected to the protective bonding circuit c) Plug/socket combinations intended to carry power loads but not to be disconnected during load conditions shall have a retaining means to prevent unintended or accidental disconnection and shall be clearly marked accordingly d) Where more than one plug/socket combination is provided in the same electrical equipment, the associated combinations shall be clearly identifiable. Mechanical coding is recommended e) Plug/socket combinations used in control circuits shall fulfil the applicable requirements of IEC 61984. Exception: combinations in accordance with IEC 60309-1, only those contacts shall be used for control circuits which are intended for those purposes. This exception does not apply to control circuits using high frequency signals superimposed on the power circuits. 		N
13.4.6	Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points.		N
13.4.7	When spare conductors are provided, they shall be connected to spare terminals or isolated to prevent contact with live parts		N
13.5	Ducts, connection boxes and other boxes		—
	Ducts shall provide a degree of protection (see IEC 60529) suitable for the application		N

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Clause	Requirement - Test	Result - Remark	Verdict
	No sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come into contact		N
	Where human passage is required, least 2 m above the working surface		N
	Where cable trays are only partially covered, the cables used shall be of a type suitable for installation on open cable trays.		N
13.5.2	Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material		N
	Fittings shall be compatible with the conduit and should be threaded		N
	Conduit bends shall be properly made		N
13.5.3	A flexible metal conduit shall consist of a flexible metal tubing or woven wire armour		N
13.5.4	Flexible non-metallic conduit shall be resistant to kinking		N
13.5.5	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving and of sources of contamination		N
	Where furnished in sections, the joints shall fit tightly but need not be gasketed		N
	The only openings permitted shall be those required for wiring or for drainage		N
13.5.6	The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided they are isolated from coolant or oil reservoirs and are entirely enclosed		N
	Conductors shall be so secured		N
13.5.7	Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance.		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Those boxes shall provide protection against the ingress of solid bodies and liquids		N
	They shall not have opened but unused knockouts nor any other openings		N
13.5.8	Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (e.g. brakes, temperature sensors)		N
14	ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT		—
14.1	Electric motors should conform to the relevant parts of IEC 60034 series		P
14.2	Enclosures for motors should be in accordance with IEC 60034-5		N
	The degree of protection shall be dependent on the application and the physical environment		P
	The dimensions of motors shall conform to those given in the IEC 60072 series		N
14.4	Motors and its accessories shall be so mounted that they are adequately protected and are easily accessible for inspection, maintenance, etc.		P
	Proper cooling shall be ensured and the temperature rise shall remain within the limits of the insulation class (see IEC 60034-1)		P
	There shall be no opening between the motor compartment and any other compartment that does not meet the motor compartment requirements		N
14.5	The characteristics of motors and associated equipment shall be selected in accordance with the anticipated service and physical environmental conditions		P

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Clause	Requirement - Test	Result - Remark	Verdict
14.6	Operation of the overload and overcurrent protective devices for mechanical brake actuators shall initiate the simultaneous de-energization (release) of the associated machine actuators		P
15	SOCKET-OUTLETS AND LIGHTING		—
15.1	For socket-outlets intended for accessory equipment, the following apply:		N
	- they should conform to IEC 60309-1. Where not practicable, they should be clearly marked with the voltage and current ratings		N
	- the continuity of the protective bonding circuit to the socket-outlet shall be ensured		N
	- all unearthed conductors connected to the socket-outlet shall be protected against overcurrent and, when required, overload		N
	– 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
	– where fault protection is provided by automatic disconnection of supply, the disconnection time shall be in accordance with Table A.1 for TN systems or Table A.2 for TT systems		N
	–socket-outlets with a rating not exceeding 20 A shall be provided with an RCD not exceeding 30 mA		N
15.2	Local lighting of the machine and of the equipment		—
15.2.1	The ON/OFF switch shall not be incorporated in the lampholder or in the flexible connecting cord		N
	Stroboscopic effects from lights shall be avoided		N
15.2.2	The nominal voltage of the local lighting circuit shall not exceed 250 V between conductors. A voltage not exceeding 50 V is recommended		N
	Lighting circuits shall be supplied from one of the following sources:		—

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Clause	Requirement - Test	Result - Remark	Verdict
	– a dedicated isolating transformer connected to the supply disconnecting device. Overcurrent protection shall be provided in the secondary circuit		N
	– a dedicated isolating transformer connected before the supply disconnecting device. This is permitted for maintenance lighting in control enclosures only. Overcurrent protection shall be provided in the secondary circuit		N
	– a circuit of the electrical equipment of the machine for lighting, with dedicated overcurrent protection		N
	– an isolating transformer connected before the supply disconnecting device, provided with a dedicated primary disconnecting means (see 5.3.5) and secondary overcurrent protection, and mounted within the control enclosure adjacent to the supply disconnecting device		N
	– an externally supplied lighting circuit (for example factory lighting supply). This shall be permitted in control enclosures only, and for the machine work light(s) where their total power rating is not more than 3 kW		N
	– power supply units, for DC supply to LED light sources, fitted with isolating transformers		N
	Exception: where fixed lighting is out of reach of operators during normal operations, the provisions of this 15.2.2 do not apply		N
15.2.3	Local lighting circuits shall be protected in accordance with 7.2.6		N
15.2.4	Adjustable lighting fittings shall be suitable for the physical environment		N
	The lampholders shall be:		N
	– in accordance with the relevant IEC standard		N
	– 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 lampholder		N
	Exception: where fixed lighting is out of reach of operators during normal operations, the provisions of this 15.2.4 do not apply		N
16	MARKING, WARNING SIGNS AND REFERENCE DESIGNATIONS		—
16.1	Warning signs, nameplates, markings, labels and identification plates shall be of sufficient durability	Marked clearly and visible	P
16.2.1	Enclosures that do not otherwise clearly show that they contain electrical shall be marked with the graphical symbol ISO 7010-W012 		N
	It may be omitted (see also 6.2.2 b)) for: <ul style="list-style-type: none"> – 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) 		N
16.2.2	Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures, the graphical symbol ISO 7010-W017 shall be used 		N
16.3	Control devices and visual indicators, shall be clearly and durably marked with regard to their functions		P

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Clause	Requirement - Test	Result - Remark	Verdict
16.4	<p>The following information shall be legibly and durably marked - plainly visible after installation on enclosures that receive incoming power supplies:</p> <ul style="list-style-type: none"> • name or trade mark of supplier • certification mark or other marking where applicable • type designation or model, where applicable • serial number where applicable • main document number (see IEC 62023) where applicable • rated voltage, number of phases and frequency (if AC), and full-load current for each incoming supply <p>It is recommended that this information is provided adjacent to the main incoming supply(ies)</p>	See product nameplate	P
16.5	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	The information necessary for identification, transport, installation, use, maintenance, decommissioning and disposal of the electrical equipment shall be supplied	See the product manual	P
	Annex I should be considered as guidance for the preparation of information and documents	See the product manual	P
17.2	Information related to the electrical equipment		P
	The following shall be supplied:		P
	a) where more than one document is provided, a main document for the electrical equipment as a whole, listing the complementary documents	See the product manual	P
	b) identification of the electrical equipment		P

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Clause	Requirement - Test	Result - Remark	Verdict
	<p>c) information on installation and mounting including:</p> <ul style="list-style-type: none"> • a description of installation and mounting, and its connection to the electrical and other supplies • short-circuit current rating for each incoming power supply • rated voltage, number of phases and frequency (if AC.), type of distribution system (TT, TN, IT) and full-load current for each incoming supply • any additional electrical supply(ies) requirements (for example maximum supply source impedance, leakage current) for each incoming supply • space required for servicing • installation requirements regarding cooling • environmental limitations (for example lighting, vibration, EMC environment, atmospheric contaminants) • functional limitations (for example peak starting currents and permitted voltage drops) • precautions to be taken for the installation regarding electromagnetic compatibility 	<p>See the product manual</p>	<p>P</p>
	<p>d) an instruction for the connection of conductive-parts in the vicinity of the machine to the protective bonding circuit:</p> <ul style="list-style-type: none"> • metallic pipes • fences • ladders • handrails 		<p>N</p>
	<p>e) information on the functioning and operation as applicable:</p> <ul style="list-style-type: none"> • an overview of the structure of the electrical equipment • procedures for programming or configuring • procedures for restarting after an unexpected stop • a sequence of operation 	<p>See the product manual</p>	<p>P</p>

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Clause	Requirement - Test	Result - Remark	Verdict
	f) information on maintenance, as appropriate: <ul style="list-style-type: none"> • frequency and method of functional testing • instructions for safe maintenance and where necessary suspend a safety function and/or protective measure (see 9.3.6) • guidance on the adjustment, repair, and frequency and method of preventive maintenance • details of the interconnections subject to replacement • required special devices or tools; • spare parts; • possible residual risks, indication of particular training and specification of personal protective equipment • instructions to restrict availability of keys or too(s to skilled or instructed persons • settings (DIP-switches, programmable parameter values, etc); • information for validation of safety related control functions after repair or modification, and for periodic testing where necessary; 	See the product manual	P
	g) information on handling, transportation and storage	See the product manual	P
	h) information for proper disassembly and handling of components	See the product manual	P

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Clause	Requirement - Test	Result - Remark	Verdict
18	VERIFICATION		—
18.1	<p>The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no such standard, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g):</p> <p>a) verification that the electrical equipment complies with its technical documentation b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2) c) in case of fault protection by automatic disconnection of supply, conditions shall be verified according to 18.2; d) insulation resistance test (see 18.3) e) voltage test (see 18.4) f) protection against residual voltage (see 18.5) g) verification that the relevant requirements of 8.2.6 are met h) functional tests (see 18.6)</p>		—
	The results of the verification shall be documented		P
18.2	Verification of conditions for protection by automatic disconnection of supply		—
18.2.1	<p>Test 1 verifies the continuity of the protective bonding circuit.</p> <p>Test 2 verifies the conditions for protection by automatic disconnection of the supply in TN systems</p> <p>For TN-systems, those test methods are described in 18.2.2 and 18.2.3; their application for different conditions of supply are specified in 18.2.4</p> <p>For TT systems, see Clause A.2</p> <p>For IT systems, see IEC 60364-6</p>		N
	Where RCDs are used in the electrical equipment, their function shall be verified in accordance with the manufacturer's instructions. The test procedure and test interval shall be specified in the maintenance instructions		N
18.2.2	Test 1: Verification of the continuity of the protective bonding circuit		—

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Clause	Requirement - Test	Result - Remark	Verdict
	The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between 0.2 A and approximately 10 A derived from an electrically separated supply source having a maximum no-load voltage of 24 V	See appended table	N
	The resistance measured shall be in the expected range		N
18.2.3	Test 2: Fault loop impedance verification and suitability of the associated overcurrent protective device		—
	The connections of each power supply including the connection of the associated protective conductor to the PE terminal of the machine, shall be verified by inspection		N
	The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A shall be verified by both		N
	a) verification of the fault loop impedance by - calculation, or - measurement in accordance with A.4, and		N
	b) confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A, and		N
	Where a power drive system (PDS) is used, confirmation that the setting and characteristics of the protective device(s) are in accordance with the converter manufacturer's and protective device manufacturer's instructions		N
18.2.4	Application of the test methods for TN-systems		—
	When Test 2 of 18.2.3 is carried out by measurement, it shall always be preceded by Test 1 of 18.2.2		N

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Clause	Requirement - Test	Result - Remark	Verdict
	The tests that are necessary for machines of different status are specified in Table 9		N
18.3	Insulation resistance tests (optional)		—
	When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ	See Appendix_1	P
	If the electrical equipment of the machine contains surge protection devices which are likely to operate during the test, it is permitted to either: <ul style="list-style-type: none"> – disconnect these devices, or – reduce the test voltage to a value lower than the voltage protection level of the surge protection devices 		P
18.4	Voltage tests (optional)		P
	The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.		P
	The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater		P
	The test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s		P
	Components and devices that are not rated to withstand the test voltage and surge protection devices shall be disconnected		P
18.5	Protection against residual voltages		N
	Where appropriate, tests shall be performed to ensure compliance with 6.2.4		N
18.6	Functional tests		P
	The functions of electrical equipment shall be tested		P
18.7	Retesting		N

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Clause	Requirement - Test	Result - Remark	Verdict
	Where a portion of the machine or its associated equipment is changed or modified, the need for re-verification and testing of the electrical equipment shall be considered	No portion of the machine or its associated equipment is changed or modified.	N

Appendix_1: Datasheet of test

18.3	TABLE: insulation resistance tests				P
Location	Voltage(V)d.c	Frequency(Hz)	Time(s)	Measured insulation resistance(MΩ)	
Between power circuit conductors + and protective bonding circuit	500	--	60	537	
Between power circuit conductors - and protective bonding circuit	500	--	60	522	
Note:					

18.4	TABLE: Withstand voltage test		P
Test voltage applied between:	Test voltage (V) a.c. / d.c.		Breakdown Yes / No
Between power circuit conductors + and protective bonding circuit	1000V a.c.		No
Between power circuit conductors - and protective bonding circuit	1000V a.c.		No
Supplementary information:			

Conformity of Relevant Components

No.	Part name	Manufacturer/trademark	Type/model	Technical Data	Certification
1	Battery Pack	博力威	C400-A-10S8P	37V/20800 mAh	CE
2	Power Supply Board	锐曼	KTV-POWER BoardV3.6	--	CE
3	Computer Main Board	拓思	DL-4200UE	--	CE
4	Upper computer motherboard	锐曼	RK3128 +WIFI	--	CE
5	Key switch	VaneAims	19-11KZX2(3)/J/S	--	CE
6	Rectifier	施凯威	PL1-425-40 D24V	Input voltage : 24V; Power : 40W	CE
7	Ultraviolet Disinfection Lamp	飞利浦0.9M	T8	30W	CE
8	5.5 "wheel hub motor	雅腾电机	BL14060D002	Locked-rotor torque:30W \cong 9.2kgf.cm	CE
9	Motor drive	MAX	MAX485	--	CE
10	Emergency stop switch		GQ16-11ZS	2NC	CE
11	Single-wire lidar		LTME-02	Working area:270°	CE
12	4G router	MTK7628	4GCPE-M6	--	CE
13	Gyroscope	维特智能	WT901C (TTL) WT901C(2)	9 axis with housing digital attitude sensor	CE



Photo1 HBOT11U Front Side



Photo 2 HBOT11U Back Side



Photo3 WBOT11U Front Side



Photo 4 WBOT11U Side



Photo 5 interior circuit



Photo 6 Operating display

The photos are limited to the use of the original report.

***** END *****