EU MACHINERY REGULATION
TEST REPORT

For

X-ray machine

Model: SHO-HX02, SHO-PXM01, SHO-SMP18, SHO-SP18, SHO-PX series, SHO-PXU series, SHO-PXD series, SHO-PXF series, SHO-PXS series, SHO-MDR Series, SHO-UDX series, SHO-DDX01, SHO-DDX02, SHO-DDX03, SHO-DDX04, SHO-DDR01, SHO-DDR02, SHO-CMX01, SHO-DMS01, SHO-DMS01, SHO-MAX series, SHO-V32-B, SHOCII-C3.5KW, SHOCII-3.5KW, SHOCII-5KW, SHOC-5KW, SHOC-15KW, SHO-SFC5KW, SHOC-SFC15KW, SHOC-CS01, SHO-DIP-001, SHO-IJP-001, RC-SLI6000, RC-SLI8000, SHO-FPD02, SHO-FPD03, SHO-FPD04, SHO-FPD05, SHO-FPD06

Brand Name: Shoimage

Report No.: ENC2506098GZ50L1

Date of Issue: Jun. 10, 2025

Prepared For

Suzhou Shoimage Medical Equipment Co., Ltd.

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Prepared By

East Notice Certification Service Co., Ltd.

1/F, Haohui Commercial Building, Zhuji Street, Dongpu Town, Tianhe District, Guangzhou City, China

TEST REPORT

EN ISO 12100, EN 60204-1:2018

Safety of machinery - General principles for design - Risk assessment and risk reduction

Safety of Machinery - Electrical Equipment of Machines Part 1: General Requirements

Report reference No.	:	ENC2506098GZ50L1
Tested by	:	Sam Liu
Review by (+ Signature).	:	Yemig
Approved by (+ signature)	:	Ray Zhou
Date of issue	:	Jun. 10, 2025
Contents	:	Total 73 pages

Testing laboratory

Name	:	East Notice Certification Service Co., Ltd.
Address	:	1/F, Haohui Commercial Building, Zhuji Street, Dongpu Town, Tianhe District, Guangzhou City, China
Testing location	:	Same as above

Application

Name	:	Suzhou Shoimage Medical Equipment Co., Ltd.
Address	:	Room 404, 4th Floor, Building A, Zhongke Innovation Plaza, No. 1555 Greenland Avenue, Huaqiao Town, Kunshan City, Suzhou City, Jiangsu Province, China

Manufacturer

Name	:	Suzhou Shoimage Medical Equipment Co., Ltd.
Address	:	Room 404, 4th Floor, Building A, Zhongke Innovation Plaza, No. 1555 Greenland Avenue, Huaqiao Town, Kunshan City, Suzhou City, Jiangsu Province, China

Test specification

Standard	:	EN ISO 12100:2010, EN 60204-1:2018
Test procedure	:	CE-MR
Procedure deviation	:	N/A
Non-standard test method	:	N/A

Test item

Description	:	X-ray machine
Model and/or type reference	:	SHO-DDX04 (Additional models: see the next page)
Brand Name	:	Shoimage
Rating(s)	:	3N~380V, 50Hz, 40KW, 500mA

Test case verdicts

Test case does not apply to the test object……..: N(/A)

Test item does meet the requirement ……..: P(ass)

Test item does not meet the requirement……..: F(ail)

Testing

Date of receipt of test item ……..……: Jun. 2, 2025

Date(s) of performance of test ……..: Jun. 2, 2025 – Jun. 10, 2025

General remarks

This test 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 tested.

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

"(see appended table)" refers to a table appended to the report.

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

When determining the test result, measurement uncertainty has been considered.

Should any objections to the test reports occurred, should submit it to the Company within ten days since the issuing of the report, Fail to accept.

Special description:

1. All tests are basic on model: SHO-DDX04.
2. Additional models: SHO-HX02, SHO-PXM01, SHO-SMP18, SHO-SP18, SHO-PX series, SHO-PXU series, SHO-PXD series, SHO-PXF series, SHO-PXS series, SHO-MDR Series, SHO-UDX series, SHO-DDX01, SHO-DDX02, SHO-DDX03, SHO-DDX04, SHO-DDR01, SHO-DDR02, SHO-CMX01, SHO-DMS01, SHO-DMS01, SHO-MAX series, SHO-V32-B, SHOCII-C3.5KW, SHOCII-3.5KW, SHOCII-5KW, SHOC-5KW, SHOC-15KW, SHO-SFC5KW, SHOC-SFC15KW, SHOC-CS01, SHO-DIP-001, SHO-IJP-001, RC-SLI6000, RC-SLI8000, SHO-FPD02, SHO-FPD03, SHO-FPD04, SHO-FPD05, SHO-FPD06.
3. The series models have same electrical structure as SHO-DDX04, only the different size of operation control panel.
4. Specified maximum ambient temperature is 40°C.

Summary of testing

All tests were found satisfactory in accordance with EN ISO 12100:2010, EN 60204-1:2018.

Marking on the appliance:

X-ray machine
Model: SHO-DDX04
Rated Voltage: 3N~380V, 50Hz
Rated Power: 40KW
2025-XX
Suzhou Shoimage Medical Equipment Co., Ltd.
MADE IN CHINA

Remark:

The height of mark shall be at least 7mm.

The additional markings which do not give rise to misunderstanding maybe added.

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
6	**Risk reduction**		**P**
6.1	General		--
	The objective of risk reduction can be achieved by the elimination of hazards, or by separately or simultaneously reducing each of the two elements that determine the associated risk:	This requirement is complied with.	P
	- severity of harm from the hazard under consideration;		P
	- probability of occurrence of that harm.		P
	All protective measures intended for reaching this objective shall be applied in the following sequence, referred to as the three-step method (see also Figures 1 and 2).		P
6.2	Inherently safe design measures		--
6.2.1	General		--
	Inherently safe design measures are the first and most important step in the risk reduction process because protective measures inherent to the characteristics of the machine are likely to remain effective, whereas experience has shown that even well-designed safeguarding may fail or be violated and information for use may not be followed.	Appropriate machine design has been performed by the manufacturer.	P
	Inherently safe design measures are achieved by avoiding hazards or reducing risks by a suitable choice of design features of the machine itself and/or interaction between the exposed persons and the machine.		P
6.2.2	Consideration of geometrical factors and physical aspects		P
6.2.2.1	Geometrical factors		--
	Such factors include the following.		--
	a) The form of machinery is designed to maximize direct visibility of the working areas and hazard zones from the control position — reducing blind spots	Appropriate machine design has been performed by the manufacturer.	P
	b) The form and the relative location of the mechanical components parts: for instance, crushing and shearing hazards are avoided by increasing the minimum gap between the moving parts, such that the part of the body under consideration can enter the gap safely, or by reducing the gap so that no part of the body can enter it (see ISO 13854 and ISO 13857).		N

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	c) Avoiding sharp edges and corners, protruding parts: in so far as their purpose allows, accessible parts of the machinery shall have no sharp edges, no sharp angles, no rough surfaces, no protruding parts likely to cause injury, and no openings which can "trap" parts of the body or clothing. In particular, sheet metal edges shall be deburred, flanged or trimmed, and open ends of tubes which can cause a "trap" shall be capped		P
	d) The form of the machine is designed so as to achieve a suitable working position and provide accessible manual controls (actuators).		P
6.2.2.2	Physical aspects		P
	Such aspects include the following:		--
	a) limiting the actuating force to a sufficiently low value so that the actuated part does not generate a mechanical hazard;	The actuating force has been limited to be a sufficiently low value so that the actuated part does not generate a mechanical hazard.	P
	b)limiting the mass and/or velocity of the movable elements, and hence their kinetic energy;	The mass and/or velocity of the movable elements, and hence their kinetic energy have been limited.	P
	c) limiting the emissions by acting on the characteristics of the source using measures for reducing	The emissions by acting on the characteristics of the source have been limited.	P
	1) noise emission at source (see ISO/TR 11688-1), 2) the emission of vibration at source, such as redistribution or addition of mass and changes of process parameters [for example, frequency and/or amplitude of movements (for hand-held and hand-guided machinery, see CR 1030-1)], 3) the emission of hazardous substances, including the use of less hazardous substances or dust-reducing processes (granules instead of powders, milling instead of grinding), and 4) radiation emissions, including, for example, avoiding the use of hazardous radiation sources, limiting the power of radiation to the lowest level sufficient for the proper functioning of the machine, designing the source so that the beam is concentrated on the target, increasing the distance between the source and the operator or providing for remote operation of the machinery [measures for reducing emission of non-ionizing radiation are given in 6.3.4.5 (see also EN 12198-1 and EN 12198-3)].		P
6.2.3	Taking into account the general technical knowledge regarding machine design		P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	This general technical knowledge can be derived from technical specifications for design (e.g. standards, design codes, calculation rules).These should be used to cover :		--
	a) mechanical stresses such as		--
	- stress limitation by implementation of correct calculation, construction and fastening methods as regards, e.g. bolted assemblies, welded assemblies	The appropriate technical knowledge of mechanical has been taken into account.	P
	- stress limitation by overload prevention, (e.g. “fusible” plugs, pressure-limiting valve, breakage points, torque-limiting devices);		P
	- avoiding fatigue in elements under variable stresses (notably cyclic stresses);		P
	- static and dynamic balancing of rotating elements;		P
	b) materials and their properties such as		--
	- resistance to corrosion, ageing, abrasion and wear;	The materials have been treated by appropriate methods.	P
	- hardness, ductility, brittleness;		P
	- homogeneity;		P
	- toxicity;		P
	- flammability.		P
	c) emission values for :		--
	- noise;		P
	- vibration;		P
	- hazardous substances;		P
	- radiation.		P
6.2.4	Choice of an appropriate technology		--
	One or more hazards can be eliminated or risks reduced by the choice of the technology to be used in certain applications, e.g. :		N
	a) on machines intended for use in explosive atmospheres: - fully pneumatic or hydraulic control system and machine actuators; - “intrinsically safe” electrical equipment (see IEC 60079-11)		N
	b) for particular products to be processed such as a solvent: equipment assuring that the temperature will remain far below the flash point		N
	c) alternative equipment to avoid high noise level, e.g.: - electrical instead of pneumatic equipment - in certain conditions, water cutting instead of mechanical equipment.		N
6.2.5	Applying the principle of the positive mechanical action		--

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	Positive mechanical action is achieved when a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements. An example of this is positive opening operation of switching devices in an electrical circuit (see IEC 60947-5-1 and ISO 14119).		N
6.2.6	Provisions for stability		P
	Machines shall be designed to have sufficient stability to allow them to be used safely in their specified conditions of use.	These machines have been designed to have sufficient stability to allow them to be used safely in their specified conditions of use.	P
	Factors to be taken into account include		P
	- geometry of the base;		P
	- weight distribution, including loading		P
	- dynamic forces due to movements of parts of the machine, of the machine itself, or of elements held by the machine which may result in an overturning moment;		P
	- vibration		P
	- oscillations of the centre of gravity;		N
	- characteristics of the supporting surface in case of traveling or installation on different sites (e.g. ground conditions, slope);		P
	- external forces (e.g. wind pressure, manual forces)		N
	Stability shall be considered in all phases of the life of the machine, including handling, traveling, installation, use, de-commissioning and dismantling.		P
	Other protective measures for stability relevant to safeguarding are given in 6.3.2.6		P
6.2.7	Provision for maintainability		P
	When designing a machine, the following maintainability factors shall be taken into account		P
	- accessibility, taking into account the environment and the human body measurements, including the dimensions of the working clothes and tools used;	These factors have been taken into account during design.	P
	- ease of handling, taking into account human capabilities;		P
	- limitation of the number of special tools and equipment		P
6.2.8	Observing ergonomic principles		P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	Ergonomic principles shall be taken into account in designing machinery to reduce mental or physical stress and strain of the operator	Appropriate ergonomic principles have been taken into account in designing machinery to reduce mental or physical stress and strain of the	P
6.2.9	Preventing electrical hazard		P
	For the design of the electrical equipment of machines IEC 60204-1 gives general provisions, especially in clause 6 for protection against electric shock.	Please also make reference to EN 60204-1 test report.	P
6.2.10	Preventing and hydraulic hazards		N
	Pneumatic and hydraulic equipment of machinery shall be designed so that :		N
	- the maximum rated pressure cannot be exceeded in the circuits (e.g. by means of pressure limiting devices)		N
	- no hazard results from pressure surges or rises, pressure losses or drops or losses of vacuum;		N
	- no hazardous fluid jet or sudden hazardous movement of the hose (whiplash)results from leakage or component failures;		N
	air receivers, air reservoirs or similar vessels (e.g. in gas loaded accumulators) comply with the design rules for these elements;		N
	- air elements of the equipment, and especially pipes and hoses, be protected against harmful external effects;		N
6.2.11	Applying inherently safe design measures to control system		P
6.2.11.1	General		P
	The design measures of the control system shall be chosen so that their safety-related performance provides a sufficient amount of risk reduction (see ISO 13849-1 or IEC 62061)	Inherently safe design measures to control system have applied.	P
6.2.11.2	Starting of internal power source/switching on an external power supply		N
	The starting of an internal power source or switching-on of an external power supply shall not result in a hazardous situation. For example: - starting the internal combustion engine shall not lead to movement of a mobile machine; - connection to mains electricity supply shall not result in the starting of working parts of a machine. See IEC 60204-1:2005, 7.5 (see also Annexes A and B).		N
6.2.11.3	Starting/stopping of a mechanism		P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	The primary action for starting or accelerating the movement of a mechanism should be performed by application or increase of voltage or fluid pressure, or, if binary logic elements are considered, by passage from state 0 to state 1(if state 1 represents the highest energy state)	This requirement has been taken into account during design.	P
6.2.11.4	Restart after power interruption		P
	If it may generate a hazard, the spontaneous restart of a machine when it is re-energized after power interruption shall be prevented (e.g. by use of a self-maintained relay, contactor or valve).	The spontaneous restart of a machine when it is re-energized after power interruption has been prevented by contactor.	P
6.2.11.5	Interruption of power supply		P
	Machinery shall be designed to prevent hazardous situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met:	The hazardous situations resulting from interruption or excessive fluctuation of the power supply has been prevented.	P
6.2.11.6	Use of automatic monitoring		P
	Automatic monitoring is intended to ensure that a safety function(s) implemented by a protective measure do(es) not fail to be performed if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed in such a way that hazards are generated	Appropriate automatic monitoring has been used.	P
6.2.11.7	Safety functions implemented by programmable electronic control systems		--
6.2.11.7.1	General		N
	A control system including programmable electronic equipment (e.g. programmable controllers) can be used to implement safety functions t machinery		N
6.2.11.7.2	Hardware aspects		P
	The hardware (including e.g. sensors, actuators, logic solvers) shall be selected (and/or designed) and installed to meet both the functional and performance requirements of the safety function(s) to be performed, in particular, by means of :	The hardware has been selected and installed to meet both the functional and performance requirements of the safety functions to be performed.	P
6.2.11.7.3	Software aspects		P
	The software (including internal operating software (or system software) and application software) shall be designed so as to satisfy the performance specification for the safety functions (see also IEC 61508-3)		P
6.2.11.8	Principles relating to manual control		P
	a) Manual control devices shall be designed and located according to the relevant ergonomic principles given in 6.2.8		P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	b) A stop control device shall be placed near each start control device. Where the start/stop function is performed by means of a hold-to-run control, a separate stop control device shall be provided when a risk can result from the hold-to-run control device failing to deliver a stop command when released.	A stop control device has been placed near each start control device.	P
	c) Manual controls shall be located out of reach of the danger zones (see IEC 61310-3), except for certain controls where, of necessity, they are located within a danger zone, such as emergency stop or teach pendant	Manual controls have been located out of reach of the danger zones.	P
	d) Whenever possible, control devices and control positions shall be located so that the operator is able to observe the working area or hazard zone.		P
	e) if it is possible to start the same hazardous element by means of several controls, the control circuit shall be so arranged that only one control is effective at a given time. This applies especially to machines which can be manually controlled by means among others of a portable control unit (teach pendant, for instance), with which the operator may enter danger zones.		N
	f) Control actuators shall be designed or guarded so that their effect, where a risk is involved, cannot occur without intentional operation (see ISO 9355-1 and ISO 447)		P
	g) For machine functions whose safe operation depends on permanent, direct control by the operator, measures shall be taken to ensure the presence of the operator at the control position , e.g. by the design and location of control devices.		P
	h) For cableless control an automatic stop shall be performed when correct control signals are not received, including loss of communication (see IEC 60204-1)		N
6.2.11.9	Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance		--
	Where, for setting, teaching, process changeover, fault-finding, cleaning or maintenance of machinery, a guard has to displaced or removed and/or a protective device has to be disabled, and where it is necessary for the purpose of these operations for the machinery or part of the machinery to be put in operation, safety of the operator shall be achieved using a specific control mode which simultaneously:		P
6.2.11.10	Selection of control and operating modes		P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	If machinery has been designed and built to allow for its use in several control or operating modes requiring different protective measures and/or work procedures (e.g. to allow for adjustment , setting, maintenance, inspection), it shall be fitted with a mode selector which can be locked in each position.		P
6.2.11.11	Applying measures achieve electromagnetic compatibility (EMC)		P
	For guidance on electromagnetic compatibility, see IEC 60204-1, and IEC 61000-6 series.		P
6.2.11.12	Provision of diagnostic systems to aid fault-finding		P
	Diagnostic systems to aid fault finding should be included in the control system so that there is no need to disable any protective measures.	Diagnostic systems are provided.	P
6.2.12	Minimizing the probability of failure of safety functions		P
6.2.12.1	General		P
	Safety of machinery is not only dependent on the reliability of the control systems but also on the reliability of all parts of the machine.The continued operation of the safety functions is essential for the safe use of the machine. This can be achieved by :		P
6.2.12.2	Use of reliable components		P
	“Reliable components” means components which are capable of withstanding all disturbances and stresses associated with the usage of the equipment in the conditions of intended use (including the environmental conditions), for the period of time or the number of operations fixed for the use, with a low probability of failures generating a hazardous malfunctioning of the machine. Components shall be selected taking into account all factors mentioned above(see also 6.213)	Reliable components have been used.	P
6.2.12.3	Use of “oriented failure mode” components		N
	“Oriented failure mode” components or systems are those in which the predominant failure mode is known in advance and which can be used so that such a failure leads to a non-hazardous alteration of the machine function.		N
6.2.12.4	Duplication (or redundancy) of components or subsystems		N
	In the design of safety-related parts of the machine, duplication (or redundancy) of components may be used so that, if one component fails, another component (or other components) continue(s) to perform its (their) function, thereby ensuring that the safety function remains available.		N

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
6.2.13	Limiting exposure to hazards through reliability of equipment		P
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring rectification, thereby reducing exposure to hazards.		P
6.2.14	Limiting exposure to hazards through mechanization or automation of loading(feeding) /unloading (removal) operations		N
	Mechanization and automation of machine loading/unloading operations and more generally of handling operations (of workpieces, materials, substances) limit the risk generated by these operations by reducing the exposure of persons to hazards at the operating points		N
6.2.15	Limiting exposure to hazards through location of the setting and maintenance points outside of danger zones		N
	The need for access to danger zones shall be minimized by locating maintenance, lubrication and setting points outside these zones		N
6.3	Safeguarding and complementary protective measures		P
6.3.1	General		--
	Guards and protective devices shall be used to protect persons whenever inherently safe design does not reasonably make it possible either to remove hazards or to sufficiently reduce risks. Complementary protective measures involving additional equipment (e.g. emergency stop equipment)may have to be implemented.	Appropriate guards and protective devices have been used to protect persons whenever inherently safe design does not reasonably make it possible either to remove hazards or to sufficiently reduce risks.	P
6.3.2	Selection and implementation of guards and protective devices		P
6.3.2.1	General		P
	This subclause gives guidelines for the selection and the implementation of guards and protective devices the primary purpose of which is to protect persons against hazard generated by moving parts, according to the nature of those parts (see figure 4) and to the need for access to the danger zone(s).	Please see the related clause.	P
6.3.2.2	Where access to the hazard zone is not required during normal operation		P
	Where access to the hazard zone is not required during normal operation of the machinery, safeguard should be selected from the following:		P
	a) fixed guard (see also ISO 14120)	Fixed guards are provided.	P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	b) interlocking guard with or without guard locking (see also 6.3.3.2.3, ISO 14119, ISO 14120);		P
	c) self-closing guard (see ISO 14120:2002, 3.3.2)		N
	d) sensitive protective equipment, e.g. electro-sensitive protective equipment (see IEC 61496) or pressure sensitive mat (see ISO 13856)		N
6.3.2.3	Where access to the hazard zone is required during normal operation		--
	Where access to the hazard zone is required during normal operation of the machinery , safeguards should be selected from the following:		--
	a) interlocking guard with or without guard locking (see also ISO 14119, ISO 14120 and 6.3.3.2.3 of this standard);		N
	b) sensitive protective equipment, e.g electro-sensitive protective equipment (see IEC 61496)		N
	c) adjustable guard;		N
	d) self-closing guard (see ISO 14120:2002, 3.3.2)		N
	e) two-hand control device (see ISO 13851)		N
	f) interlocking guard with a start function (control guard) (see 6.3.3.2.5 of this standard)		P
6.3.2.4	Where access to the hazard zone is required for machine setting, teaching, process changeover, fault finding, cleaning or maintenance		N
	As far as possible, machines shall be designed so that the safeguards provided for the protection of the production operator may ensure also the protection of personnel in charge of setting, teaching, process changeover, fault finding, cleaning or maintenance without hindering them in performing their task.		N
6.3.2.5	Selection and implementation of sensitive protective equipment		--
6.3.2.5.1	Selection		N
	Due to the great diversity of the technologies on which their detection function is based, all types of sensitive protective equipment are far from being equally suitable for safety applications.		N
6.3.2.5.2	Implementation		N
	consideration should be given to :		N
	a) - size, characteristics and positioning of the detection zone (see ISO 13855, which deals with the positioning of some types of sensitive protective equipment)		N
	b) - reaction of the device to fault conditions (see IEC 61496for electro-sensitive protective equipment)		N

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	c)- possibility of circumvention		N
	d)- detection capability and its variation over the course of time (e.g. as a result of its susceptibility to different environmental conditions such as the presence of reflecting surfaces, other artificial light sources, sunlight or impurities in the air.		N
6.3.2.5.3	Additional requirements for sensitive protective equipment when used for cycle initiation.		N
	In this exceptional application, starting of the machine cycle is initiated by the withdrawal of a person or of the detected part of a person from the sensing field of the sensitive protective equipment, without any additional start command, hence deviating from the general requirement given in the second point of the dashed list in 6.3.2.5.2, above. After switching on the power supply, or when the machine has been stopped by the tripping function of the sensitive protective equipment, the machine cycle shall be initiated only by voluntary actuation of a start control.		N
6.3.2.6	Protective measures for stability		--
	If stability cannot be achieved by inherently safe design measures such as weight distribution (see 4.6), it will be necessary to maintain it by protective measures such as the use of :		--
	- anchorage bolts;		N
	- locking devices;		P
	- movement limiters or mechanical stops;		P
	- acceleration or deceleration limiters;		N
	- load limiters;		P
	- alarms warning of the approach to stability or tipping limits;		N
6.3.2.7	Other protective devices		--
	When a machine requires continuous control by the operator(e.g. mobile machines, cranes) and an error of the operator can generate a hazardous situation, this machine shall be equipped with the necessary devices to enable the operation to remain within specified limits , in particular:		N
6.3.3	Requirements for the design of guards and protective devices		--
6.3.3.1	General requirements		--

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	Guards and protective devices shall be designed to be suitable for the intended use, taking into account mechanical and other hazards involved. Guards and protective devices shall be compatible with the working environment of the machine and designed so that they cannot be easily defeated. They shall provide the minimum possible interference with activities during operation and other phases of machine life, in order to reduce any incentive to defeat them.	Guards and protective devices have been appropriately designed.	P
6.3.3.2	Requirements for fixed guards		P
6.3.3.2.1	Functions of guards		P
	The functions that guards can achieve are:		P
	- prevention of access to the space enclosed by guard and/or	These functions are achieved by fixed guards.	P
	- containment/capture of materials, workpieces, chips, liquids which may be ejected or dropped by the machine and reduction of emissions(noise, radiation, hazardous substances such as dust, fumes, gases) which may be generated by the machine.		P
6.3.3.2.2	Requirements for fixed guards		P
	Fixed guards shall be securely held in place:		P
	- either permanently (e.g. by welding)		P
	- or by means of fasteners (screws, nuts removal/opening impossible without using tools; they should not remain closed without their fasteners (see ISO 14120)		P
6.3.3.2.3	Requirements for movable guards		P
	a) movable guards which provide protection against hazards generated by moving transmission parts shall		P
	b) movable guards against hazards generated by non-transmission moving parts shall be designed and associated with the machine control system so that:		P
6.3.3.2.4	Requirements for adjustable guards		N
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed;		N
6.3.3.2.5	Requirements for interlocking guards with a start function (control guards)		N
	An interlocking guard with a start function may be used provided that		N
6.3.3.2.6	Hazards from guards		P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	Care shall be taken to prevent hazards which might be generated by :		P
	- the guard construction (e.g. sharp edges or corners, material);	No such hazards exist in this machine.	P
	- the movements of the guards (shearing or crushing zones generated by power-operated guards and by heavy guards which are liable to fall)		N
6.3.3.3	Technical characteristics of protective devices		P
	Protective devices shall be selected or designed and connected to the control system so as to ensure correct implementation of their safety function (s) is ensured.		P
6.3.3.4	Provisions for alternative types of safeguards.		N
	Provisions should be made to facilitate the fitting of alternative types of safeguards on machinery where it's known that this fitting will be necessary because the work to be done on it will vary.		N
6.3.4	Safeguarding for reducing emissions		P
6.3.4.1	General		P
	If the measures for the reduction of emissions at source mentioned in 6.2.2.2 are not adequate, the machine shall be provided with additional protective measures (see 6.3.4.2 to 6.3.4.5).		P
6.3.4.2	Noise		P
	Additional protective measures include, for example:		P
	- enclosures (see ISO 15667)		P
	- screens fitted to the machine; - silencers (see ISO 14163)		P
6.3.4.3	Vibration		P
	Additional protective measures include, for example, damping devices for vibration isolation between the source and the exposed person such as resilient mounting or suspended seats.		P
6.3.4.4	Hazardous substances		--
	Additional protective measures include, for example:		N
	- encapsulation of the machine (enclosure with negative pressure);		N
	- local exhaust ventilation with filtration.		N
	- wetting with liquids;		N
	- special ventilation in the area of the machine (air curtains , cabins for operators)		N
6.3.4.5	Radiation		P
	Additional protective measures include, for example:		P
	- use of filtering and absorption;		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- use of attenuating screens or guards	use guards	P
6.3.5	Complementary protective measures		P
6.3.5.1	General		P
	Protective measures which are neither inherently safe design measures, nor safeguarding (implementation of guards and/or protective devices), nor information for use may have to be implemented as required by the intended use and the reasonably foreseeable misuse of the machine.Such measures include, but are not limited to , the ones dealt with in 6.3.5.2 to 6.3.5.6		P
6.3.5.2	Components and elements to achieve the emergency stop function		P
	If following a risk assessment, a machine needs to be fitted with components and elements to achieve an emergency stop function to enable actual or impending emergency situations to be averted, the following requirements apply:		P
6.3.5.3	Measures for the escape and rescue of trapped persons		N
	Measures for the escape and rescue of trapped persons may consist e.g. of :		N
	- escape routes and shelters in installations generating operator-trapping hazards’		N
	- arrangements for moving some elements by hand, after an emergency stop		N
	- arrangements for reversing the movement of some elements		N
	- anchorage points for descender devices;		N
	- means of communication to enable trapped operators to call for help		N
6.3.5.4	Measures for isolation and energy dissipation		P
	Especially with regard to their maintenance and repair , machines shall be equipped with the technical means to achieve the isolation from power supply(ies) and dissipation of stored energy as a result of following actions:		P
	a) isolating (disconnecting, separating) the machine (or defined parts of the machine) from all power supplies;		P
	b) locking (or otherwise securing) all the isolating units in the isolating position;		P
	c) dissipating or , if this is not possible or practicable, restraining (containing) any stored energy which may give rise to a hazard;		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	d) verifying, by means of a safe working procedure, that the actions taken according to a), b) and c) above have produced the desired effect.		P
6.3.5.5	Provisions for easy and safe handling of machines and their heavy component parts		P
	Machines and their component parts which cannot be moved or transported by hand shall be provided or capable of being provided with suitable attachment devices for transport by means of lifting gear.		P
6.3.5.6	Measures for safe access to machinery		P
	Machinery shall be so designed as to enable operation and all routine tasks relating to setting and/or maintenance, to be carried out, as far as possible, by a person remaining at ground level		P
6.4	Information for use		P
6.4.1	General requirements		P
	Drafting information for use is an integral part of the design of a machine (see figure 2).		P
6.4.1.2	Information shall be provided to the user about the intended use of the machine, taking into account, notably, all its operating modes.		P
	The information shall contain all directions required to ensure safe and correct use of the machine. With this in view, it shall inform and warn the user about residual risk.		P
	The information shall indicate, as appropriate,		P
	- the need for training,		P
	- the need for personal protective equipment,		P
	- the possible need for additional guards or protective devices (see Figure 2, Footnote d).		P
6.4.1.3	Information for use shall cover, separately or in combination, transport, assembly and installation, commissioning, use of the machine (setting, teaching/programming or process changeover, operation, cleaning, fault-finding and maintenance) and, if necessary, dismantling, disabling and scrapping.		P
6.4.2	Location and nature of the information for use		P
	Depending on the risk , the time when the information is needed by the user and the machine design , it shall be decided whether the information – or parts thereof – are to be given:		P
	- in /on the machine itself (see 6.3 and 6.4.4)		P
	- in accompanying documents (in particular instruction handbook , see 6.4.5)		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- on the packaging		P
	- by other means such as signals and warnings outside the machine		P
6.4.3	Signals and warning devices		P
	Visual signals (e.g. flashing lights) and audible signals (e.g. sirens) may be used to warn of an impending hazardous event such as machine start-up or overspeed		P
6.4.4	Markings, signs (pictograms), written warnings		P
	Machinery shall bear all markings which are necessary		P
	a) for its unambiguous identification, at least :		P
	- name and address of the manufacturer		P
	- designation of series or type;		P
	- serial number, if any.		P
	b) in order to indicate its compliance with mandatory requirements;		P
	- marking;		P
	- written indications (e.g. for machines intended for use in potentially explosive atmosphere)		P
	c) for its safe use, e.g. :		--
	- maximum speed of rotating parts;		N
	- maximum diameter of tools;		N
	- mass (expressed in kilograms) of the machine itself and/or of removable parts		P
	- maximum working load;		N
	- necessity of wearing personal protective equipment;		N
	- guard adjustment data;		N
	- frequency of inspection		N
6.4.5	Accompanying documents (in particular, instruction handbook)		P
6.4.5.1	Contents		P
	The instruction handbook or other written instructions (e.g. on the packaging) shall contain among others:		P
	a) information relating to transport, handling and storage of the machine e.g. :		P
	- storage conditions for the machine;		P
	- dimensions , mass value(s), position of the centre (s) of gravity;		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- indications for handling (e.g. drawings indicating application points for lifting equipment)		P
	b) information relating to installation and commissioning of the machine, e.g.		P
	- fixing/anchoring and vibration dampening requirements;		P
	- assembly and mounting conditions;		P
	- space needed for use and maintenance;		P
	- permissible environmental conditions (e.g. temperature, moisture, vibration, electromagnetic radiation);		P
	- instructions for connecting the machine to power supply (particularly about protection against electrical overloading);		P
	- advice about waste removal /disposal;		P
	c) information relating to the machine itself, e.g. :		P
	- detailed description of the machine, its fittings, its guards and/or protective devices;		P
	- comprehensive range of applications for which the machine is intended, including prohibited usages, if any , taking into account variations of the original machine if appropriate.		P
	- diagrams (especially schematic representation of safety functions);		P
	- data about noise and vibration generated by the machine, about radiation , gases, vapours, dust emitted by it, with reference to the measuring methods used.		P
	- technical documentation about electrical equipment (see IEC 60204 series)		P
	- documents attesting that the machine complies with mandatory requirements;		P
	d) information relating to the use of the machine, e.g. about:		P
	- intended use;		P
	- description of manual controls (actuators);		P
	- setting and adjustment;		P
	- modes and means for stopping (especially emergency stop)		P
	- risks which could not be eliminated by the protective measures taken by the designer;		P
	- particular risks which may be generated by certain applications, by the use of certain fittings, and about specific safeguards which are necessary for such applications.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- reasonably foreseeable misuse and prohibited usages;		P
	- fault identification and location , repair, and re-starting after an intervention;		P
	e) information for maintenance e.g.		P
	- nature and frequency of inspections for safety functions		P
	- instructions relating to maintenance operations which require a definite technical knowledge or particular skills and hence should be carried out exclusively by skilled persons (e.g. maintenance staff, specialists)		P
	- instructions relating to maintenance actions (e.g. replacement of parts) which do not require specific skills and hence may be carried out by users (e.g. operators)		P
	- drawings and diagrams enabling maintenance personnel to carry out their task rationally (especially fault-finding tasks)		P
	f) information relating to de-commissioning , dismantling and disposal		P
	g) information for emergency situations , e.g. :		P
	- type of fire-fighting equipment to be used.		P
	- warning about possible emission or leakage of harmful substance(s), and if possible, indication of means to fight their effects.		P
	h) maintenance instructions provided for skilled persons (second dash in e))and maintenance instructions provided for unskilled persons (third dash in e)), that should appear clearly separated from each other.		P
6.4.5.2	Production of the instruction handbook		P
	a) type and size of print shall ensure the best possible legibility. Safety warnings and/or cautions should be emphasized b the use of colours, symbols and/or large print.		P
	b) information for use shall be given in the language(s) of the country in which the machine will be used for the first time and in the original version. If more than one language are to be used, each language should be readily distinguished from the other(s), and efforts should be made to keep the translated text and the relevant illustration together.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	c) whenever helpful to the understanding, text should be supplemented with written details enabling , for instance, manual controls (actuators) to be located and identified; they should not be separated from the accompanying text and should follow sequential operations.		P
	d) consideration should be given to presenting information in tabular form where this will aid understanding.		P
	e) the use of colours should be considered, particularly in relation to components requiring quick identification		P
	f) when information for use is lengthy, a table of contents and/or an index should be given.		P
	g) safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator.		P
6.4.5.3	Drafting and editing information for use		P
	a) relationship to model : the information shall clearly relate to the specific model of machine and, if necessary, other appropriate identification (for example, by serial number).		P
	b) communicate principles : when information for use is being prepared, the communication process “see-think-use” should be followed in order to achieve the maximum effect and should follow sequential operations. The questions “how ?” and “why ?” should be anticipated and the answers provided.		P
	c) information for use shall be as simple and as brief as possible, and should be expressed in consistent terms and units with a clear explanation of unusual technical terms.		P
	d) when it is foreseen that a machine will b put to non-professional use, the instructions should be written in a form that is readily understood by the non-professional users. If personal protective equipment is required for the safe use of the machine, clear advice should be given, e.g. on the packaging as well as on the machine, so that this information is prominently displayed at the point of sale.		P

EN ISO 12100:2010			
Clause	**Requirement - Test**	**Result**	**Verdict**
	e) durability and availability of the documents : documents giving instructions for use should be produced in durable form (i.e. they should be able to survive frequent handling by the user). It may be useful to mark them “keep for future reference”. Where information for use is kept in electronic form (e.g. CD, DVD, tape) information on safety-related issues that need immediate action shall always be backed up with a hand copy that is readily available.		P

7	**Documentation of risk assessment and risk reduction**		**P**
	The documentation shall demonstrate the procedure that has been followed and the results that have been achieved. This includes, when relevant, documentation of	See the risk assessment report in detail.	--
	a) the machinery for which the risk assessment has been made (for example, specifications, limits, intended use);		P
	b) any relevant assumptions that have been made (loads, strengths, safety factors, etc.);		P
	c) the hazards and hazardous situations identified and the hazardous events considered in the risk assessment;		P
	d) the information on which risk assessment was based		P
	e) the risk reduction objectives to be achieved by protective measures;		P
	f) the protective measures implemented to eliminate identified hazards or to reduce risk;		P
	g) residual risks associated with the machinery;		P
	h) the result of the risk assessment (see Figure 1);		P
	i) any forms completed during the risk assessment.		P
	Standards or other specifications used to select protective measures referred to in f) above should be referenced.		P

This risk assessment report is based on the methods in the EN ISO 12100:2010 standards, and the 4 factors S-A-G-W have been used for evaluating the level of risks.

S：Severity of possible harm
- S1：Slight（normally reversible）
- S2：Serious（normally irreversible）
- S3：Cause a few men die
- S4：Calamity or cause many men die

A：Frequency any duration of exposure
- A1：Seldom to very often
- A2：Frequent to continuous

G：Possibilities of avoidance
- G1：Possible
- G2：Impossible

W：Probability of occurrence of harm
- W1：Low
- W2：Medium
- W3：High

Solutions for the level of hazards
1：Protected by warning sign
2：Protected by guard and warning sign
3：Consider the other design, choose the best one, add both guard and warning sign
4：Consider another two design, choose the best one, add both guard and warning sign
5：Consider another three design, choose the best one, add both guard and warning sign

NO.		S	A	G	W	Level
Mechanical hazards						
1.0.1	Mechanical hazards due to machine parts or work pieces	*1*	*1*	*1*	*1*	-
1.0.2	Mechanical hazards due to accumulation of energy inside the machinery					
1.1	Crushing					
1.2	Shearing					
1.3	Cutting or severing					
1.4	Entanglement					
1.5	Drawing-in or trapping					
1.6	Impact					
1.7	Stabbing or puncture					
1.8	Friction or abrasion	*1*	*1*	*1*	*1*	-
1.9	High pressure fluid injection or ejection					
Electrical hazards						
2.1	Contact with live parts	*1*	*1*	*1*	*1*	-
2.2	Contact with parts which have become live under faulty conditions	*1*	*1*	*1*	*1*	-
2.3	Approach to live part under high voltage	*1*	*1*	*1*	*1*	-
2.4	Electrostatic phenomena					

NO.		S	A	G	W	Level
2.5	Thermal radiation or other phenomena such as projection of molten particles and chemical effects form short-circuits, overloads etc.					
Thermal hazards						
3.1	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources					
3.2	Damage to health by hot or cold working environment					
Hazards generated by noise						
4.1	Hearing loss (deafness), other physiological disorders					
4.2	Interference with speech communication, acoustic signals, etc.	*1*	*1*	*1*	*1*	-
Hazards generated by vibration						
5.1	Use of hand-help machines resulting in a variety of neurological and vascular disorder					
5.2	Whole body vibration, particular when combined with poor postures	*1*	*1*	*1*	*1*	-
Hazards generated by radiation						
6.1	Low frequency, radio frequency radiation, microwaves					
6.2	Infrared, visible and ultraviolet light					
6.3	X and gamma rays	*1*	*1*	*1*	*1*	-
6.4	Alpha, beta rays, electron or ion beams, neutrons					
6.5	Lasers					
Hazards generated by materials and substances processed or used by the machinery						
7.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts					
7.2	Fire and explosion hazard					
7.3	Biological and micro-biological (viral or bacterial) hazards					
Hazards generated by neglecting ergonomic principles in machine design						
8.1	Unhealthy postures or excessive effort					
8.2	Inadequate consideration of hand-arm or foot-leg anatomy					
8.3	Neglected use of personal protection equipment					
8.4	Inadequate local lighting					
8.5	Mental overload or underload, stress					
8.6	Human error, human behavior	*1*	*1*	*1*	*1*	-
8.7	Inadequate design, location or identification of manual controls					
8.8	Inadequate design, location or identification of manual controls					
Combination of hazards						
9	Combination of hazards					

NO.		S	A	G	W	Level
Unexpected start-up, unexpected overrun/over-speed						
10.1	Failure/disorder of the control system	*1*	*1*	*1*	*1*	-
10.2	Restoration of energy on supply after an interruption					
10.3	External influences on electrical equipment	*1*	*1*	*1*	*1*	-
10.4	Other external influences (gravity, wind, etc.)					
10.5	Errors in the software					
10.6	Error made by the operator (due to mismatch of machinery with human characteristics and abilities, see 8.6)	*1*	*1*	*1*	*1*	-
Impossibility of stopping the machine in the best possible conditions						
11	Impossibility of stopping the machine in the best possible Conditions					
Variations in the rotational speed of tools						
12	Variations in the rotational speed of tools					
Failure of the power supply						
13	Failure of the power supply	*1*	*1*	*1*	*1*	-
Failure of the control circuit						
14	Failure of the control circuit	*1*	*1*	*1*	*1*	-
Errors of fitting						
15	Errors of fitting	*1*	*1*	*1*	*1*	-
Break-up during operation						
16	Break-up during operation	*1*	*1*	*1*	*1*	-
Falling or ejected objects or fluids						
17	Falling or ejected objects or fluids	*1*	*1*	*1*	*1*	-
Loss of stability / overturning of machinery						
18	Loss of stability / overturning of machinery					
Slip, trip and fall of persons (related to machinery)						
19	Slip, trip and fall of persons(related to machinery)	*1*	*1*	*1*	*1*	-
Additional hazards, hazardous situations and hazardous events due to mobility						
20	Relating to the traveling function					
20.1	Movement when starting the engine					
20.2	Movement without a driver at the driving position					
20.3	Movement without all parts in a safe position					
20.4	Excessive speed of pedestrian controlled machinery					
20.5	Excessive oscillations when moving					
20.6	Insufficient ability of machinery to be slowed down, stopped and immobilisated					
	Linked to the work position (including driving station) on the					

NO.		S	A	G	W	Level
	machine					
21.1	Fall of persons during access to (or at/from) the work position					
21.2	Exhaust gases/lack of oxygen at the work position					
21.3	Fire（flammability of the cab, lack of extinguishing means）					
21.4	Mechanical hazards at the work position： contact with the wheels;					
	rollover; fall of objects, penetration by objects; break-up of parts rotation at high speed; contact of persons with machine parts or tools (pedestrian controlled machines)					
21.5	Insufficient visibility form the work positions					
21.6	Inadequate lighting					
21.7	Inadequate seating					
21.8	Noise at the work position					
21.9	Vibration at the work position					
21.10	Insufficient means for evacuation/emergency exit					
Due to the control system						
22.1	Inadequate location of manual controls					
22.2	Inadequate design of manual controls and their mode of operation					
Form handling the machine（lack of stability）						
23	Form handling the machine（lack of stability）					
Due to the power source and to the transmission of power						
24.1	Hazards form the engine and the batteries					
24.2	Hazards form the transmission of power between machines	*1*	*1*	*1*	*1*	-
24.3	Hazards form coupling and towing	*1*	*1*	*1*	*1*	-
Form/to third persons						
25.1	Unauthorized start-up/use	*1*	*1*	*1*	*2*	-
25.2	Drift of a part away from its stopping position					
25.3	Lack or inadequacy of visual or acoustic warning means					
Insufficient instructions for the driver/operator						
26	Insufficient instructions for the driver/operator	*1*	*1*	*1*	*1*	-
Additional hazards, hazardous situations and hazardous events due to lifting						
27	Mechanical hazards and hazardous events					
27.1	Form load falls, collisions, machine tipping caused by：					
27.1.1	Lack of stability					
27.1.2	Uncontrolled loading-overloading-overturning moments exceeded					
27.1.3	Uncontrolled amplitude of movements					

NO.		S	A	G	W	Level
27.1.4	Unexpected/unintended movement of loads					
27.1.5	Inadequate holding devices/accessories					
27.1.6	Collision of more then one machine					
27.2	Form access of persons to load support					
27.3	Form derailment					
27.4	Form insufficient mechanical strength of parts					
27.5	Form inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine					
27.6	Form inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine					
27.7	Form lowering of the load under the control of friction brake					
27.8	Form abnormal conditions of assembly/testing/use/maintenance					
27.9	Form the effect of load on persons (impact by load or counterweight)					
Electrical hazards						
28.1	Form lightning					
Hazards generated by neglecting ergonomic principles						
29.1	Insufficient visibility from the driving position					
Additional hazards, hazardous and situations and hazardous events due to underground work						
30	Mechanical hazards and hazardous events due to:					
30.1	Lack of stability of powered roof supports					
30.2	Failing accelerator or brake control of machinery running on rails					
30.3	Failing or lack of dead man’s control of machinery running on rails					
31	Restricted movement of persons					
32	Fire and explosion					
33	Emission of dust, gases etc.					
Additional hazards, hazardous situations and hazardous events due to the lifting or moving of persons						
34	Mechanical hazards and hazardous events due to:					
34.1	Inadequate mechanical strength-inadequate working coefficients					
34.2	Failing of loading control					
34.3	Failing of controls in person carrier (function, priority)					
34.4	Over speed of person carrier 35 Falling of person from person carrier					
36	Falling or overturning of person carrier					

NO.		S	A	G	W	Level
37	Human error, human behavior					

NO.	Hazards source	S	A	G	W	Level
1.1	**Crushing**					
Where	*The moving part of the machine*					
When	*The machine is working*					
Method	*1. Affixing suitable warning signs.* *2. Only operation by training/authorized persons.* *3. Operation of the machine shall conform to the instructions of the instruction manual*					
1.3	**Cutting or severing**					
Where	*The tools*					
When	*The machine is working*					
Method	*1. Affixing suitable warning signs.* *2. Only operation by training/authorized persons.* *3. Operation of the machine shall conform to the instructions of the instruction manual.*					
Where	*Whole power and control systems*					
When	*The machine is power on*					
Method	*1.Only operation by training/authorized persons.* *2.Operation of the machine shall conform to the instructions of the instruction manual.* *3.Check and inspection according to the specified durations of the instruction manual.* *4.Using safety components in accordance with those relevant international standards.* *5.Use of warning label*					
2.2	**Contact with parts which have become live under faulty conditions**	1	1	1	1	-
Where	*Whole power and control systems*					
When	*The machine is power on*					
Method	*1. Only operation by training/authorized persons.* *2. Operation of the machine shall conform to the instructions of the instruction manual.* *3. Check and inspection according to the specified durations of the instruction manual.* *4. Using safety components in accordance with those relevant international standards.* *5.Use of warning label*	1	1	1	1	-
7.1	**Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts**	1	1	1	1	-

NO.	Hazards source	S	A	G	W	Level
Where	*At the work possion*					
When	*Processing Materials*					
Method	1.*Use of warning label.* 2.*Use the necessary protective measures.*	1	1	1	1	-
8.3	**Neglected use of personal protection equipment**	1	1	1	1	-
Where	*From working process*					
When	*Taking out the carbide powder*					
Method	1. *Only wear the heat insulation gloves.* 2. *Operation of the machine shall conform to the instructions of the instruction manual.* 3.*Use of warning label*	1	1	1	1	-
8.6	**Human error, human behavior**	2	1	1	1	-
Where	*Whole machine*					
When	*Operation, adjustment or maintenance of the machine*					
Method	*1. Only authorized person can use the machine.* *2. Training before using this machine.* 3. *Make reference to the instruction manual before using this machine.*	1	1	1	1	-
10.1	**Failure/disorder of the control system**	1	1	1	1	-
Where	*Control circuit/control components*					
When	*During operation of the machine*					
Method	*1. Only authorized person can use the machine.* *2. Make reference to the instruction manual before using this machine.* *3. Check before operation.* 4. *Periodic maintenance*	1	1	1	1	-
10.3	**External influences on electrical equipment**	1	1	1	1	-
Where	*All electrical equipments equipped on the machine*					
When	*Working of the electrical equipments*					
Method	*1. Connection of protective earthing indeed.* *2. Excellent electrical shielded housing.*	1	1	1	1	-
13	**Failure of the power supply**	1	1	1	1	-
Where	*All electrical equipments equipped on the machine*					
When	*Before work the electrical equipments*					
Method	*1. Make reference to the instruction manual about power supply before using this machine.* *2. Check before operation.*	1	1	1	1	-
14	**Failure of the control circuit**	1	1	1	1	-
Where	*Control circuit/control components*					

NO.	Hazards source	S	A	G	W	Level
When	*During operation of the machine*					
Method	*1. Checking before operation. 2. Make reference to the instruction manual before operate this machine.* 3. *Daily/periodic inspection and maintenance.*	1	1	1	1	-
25.1	**Unauthorized start-up/use**	1	1	1	1	-
Where	*Control system*					
When	*Operation, adjustment or maintenance of the machine*					
Method	*1. Always starting the machine by training/authorized persons.* *2. During adjustment or maintenance, put a warning nameplate near the working area.* 3. *Lock the power switch of the machine*	1	1	1	1	-
26	**Insufficient instructions for the driver/operator**	1	1	1	1	-
Where	*Whole machine*					
When	*Installation, assembly/disassembly, operation, adjustment or maintenance of the machine*					
Method	*1. Edit the instruction manual in conformity with those requirement of Machinery Directive and EN ISO 12100:2010 standard.* *2. Each machine accompanied with a complete instruction manual*	1	1	1	1	-

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Clause	**Requirement - Test**	**Result**	**Verdict**
4	**General requirements**		**P**
4.1	General considerations:		--
	This part of EN 60204 is intended to apply to electrical equipment used with a wide variety of machines and a group of machines working together in a coordinated manner	(Hazards, safeguarding, inquiry form etc.)	P
4.2	Selection of equipment:		--
	Electrical components and devices shall be suitable for their intended use, and shall comply with the relevant European Standards where such exists	see attached component list	P
4.3	Electrical supply:		--
	Shall operate correctly under full load as well as no load unless otherwise specified by the user		P
4.3.1	General:		--
	The electrical equipment shall be designed to operate correctly with the conditions of the supply:		P
	- as specified in 4.3.2 or 4.3.3, or	as specified in 4.3.2	P
	- as otherwise specified by the user (see annex B), or		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- as specified by the supplier in the case of special source of supply		N
4.3.2	AC supply	380V AC	P
4.3.3	DC supply		N
4.3.4	On-board power supply		N
4.4	Physical environment and operating conditions:		--
4.4.1	General:		--
	The electrical equipment shall be suitable for use in the physical environment and operating conditions as specified below.		P
4.4.2	Electromagnetic compatibility:		--
	The electrical equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended use, and It shall have adequate level of immunity to electromagnetic disturbances	See EMC – test report	N
4.4.3	Ambient air temperature:		--
	Enclosed electrical equipment shall be capable of operating correctly in an ambient temperature between +5°C and +40°C		P
4.4.4	Humidity:		--
	The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at maximum temperature of +40°C		P
4.4.5	Altitude:		--
	Electrical equipm. shall be capable of operating corr. at altitudes up to 1000 m above mean sea level		P
4.4.6	Contaminants:		--
	Electrical equipment shall be adequately protected against the ingress of solid bodies and liquids (12.3)	IP20	P
4.4.7	Ionizing and non-ionizing radiation:		--
	When equipment is subject to radiation (microwave, lasers, X-rays etc.), additional measures shall be taken to avoid malfunctioning and accelerated deterioration of the insulation	X-rays	P
4.4.8	Vibration, shock and bump:		--
	Undesirable effects of vibration, shock and bump shall be avoided by the selection of suitable equipm. or by:		P
	- mounting it away from the machine;		P
	- use of anti-vibration mountings		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
4.5	Transportation and storage:		--
	Electrical equipment shall be designed to withstand transportation and storage temperatures within a range of -25°C to +55 °C.		N
	For short periods not exceeding 24h up to 70 °C.		N
4.6	Provisions for handling:		N
	Heavy or bulky electrical equipment which have to be removed from the machine for transport shall be provided with suitable means for handling by cranes or similar equipment		N
4.7	Installation and operation:		N
	Electrical equipment shall be installed and operated in accordance with the supplier's instructions	See instructions	N

5	**Incoming supply conductor terminations and devices for disconnecting and switching off**		**P**
5.1	Incoming supply conductor terminations:		--
	Electrical equipment of a machine connected to one single power supply (For large complex machinery comprising a number of widely-spaced machines working together in a coordinated manner, there can be a need for more than one incoming supply depending upon the site supply arrangements)		N
	Power supply conductors terminated to main disconnecting device of electrical equipment (unless a plug is provided for disconnection)		P
	Neutral conductor clearly indicated in technical documentation with “N” (see cl. 16.1)		P
	No connection between neutral conductor and protective bonding circuit nor combined PENterminals.		P
	Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the power supply to the machine for TN-C systems.		N
	All terminals of incoming supply clearly marked in ac. with cl. 16.1 (symbols acc. to EN 60445)		N
5.2	External protective conductor terminal:		P
	A terminal for the connection of the external protective conductor shall:		P
	- be provided in the vicinity of the associated phase cord. terminals and in acc, with the relevant installation standards.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- be of such size as to enable the connection of an external cu-conductor with a cross sectional area in accordance with table I		P
	- conductor other than copper, the terminal size shall be accordingly		N
	The terminal shall be designated by the marking with the letters PE in order to avoid confusion at the point(s) of connection between machine and fixed installation.		N
	The other terminals used for connection of machine components to the protective bonding circuit shall be designated either by the symbol 417-IEC-5019 or by the letters PE or by the use of the bicolour combination GREEN-AND-YELLOW		P
5.3	Supply disconnecting (isolating) device:		P
5.3.1	A supply disconnecting device shall be provided:		P
	– for each incoming source of supply to a machine		P
	– for each on-board power supply.		N
5.3.2	Type of power supply disconnecting device:		P
	a) Switch-disconnector, acc. to EN 60947-3 for appliance category AC-23 B or DC-23 B		P
	b) Disconnector with or without fuses, with aux. contact (acc. to EN 60947-3)		N
	c) Power circuit breaker suitable for isolation (acc. to EN 60947-2)		N
	d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1as well as a utilization category		N
	e) Plug/socket combination for electrical load (requirements see cl. 5.3.3)		P
5.3.3	Disconnection device has to fulfil all of the following requirements		P
	isolate the electrical equipment from the supply and have only one OFF (isolated) and only one ON position marked with "O" and "I"		P
	- visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating function have been satisfied		P
	- have an external operating means e.g.a handle (except power operated CB's)		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- coloured black or grey recommended (If used as an emergency stop, red/yellow combination selected)		P
	- 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		N
	Requirements for plug/socket combination as a disconnection device:		N
	- Breaking capacity of the plug/socket combination: sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads.		N
	- further see. cl. 13.4.5 a) to f)		N
5.3.4	Operating handle:		P
	The handle of the supply disconnecting device shall be easily accessible and located between 0,6 and 1,9 m above the servicing level.		P
	A maximum height of 1,7 m is preferred		P
5.3.5	Excepted circuits:		N
	The following circuits need not be disconnected by the supply disconnecting device:		N
	- lighting circuits for lighting needed during maintenance or repair;		N
	- plug and socket outlets for the exclusive connection of repair or maintenance tools and equipment;		N
	- undervoltage protection circuits which are only used for automatic tripping in case of supply failure;		N
	- circuits supplying equipment which should normally remain energized for satisfactory operation;		N
	- control circuits for interlocking in accordance with 15.1.3		N
	Where such a circuit is not disconnected by the supply disconnecting device:		N
	- a permanent warning label shall be appropriately placed in proximity to the supply disconnecting device;		N
	- a permanent warning label shall be placed in proximity to each excepted circuit, and;		N
	- a corresponding statement shall be inserted in the maintenance manual;		N
	- a permanent warning label shall be placed in proximity to each excepted circuits.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
5.4	Devices for switching off for prevention of unexpected start-up:		P
	Devices for switching off for the prevention of unexpected start-up shall be provided. A supply disconnecting device may fulfil this function.		P
	Such devices shall be:		--
	- appropriate and convenient for the intended use;		P
	- suitably placed and readily identifiable		P
	- means shall be provided to prevent inadvertent, and/or mistaken closure of the disconnecting device		P
	When devices other than supply disconnecting devices are used, such means for switching off shall be employed only where there is:		--
	- no significant dismantling of the machine;		N
	- adjustments requiring a relatively short time;		N
	no work being carried out on the electrical equipment except when:		N
	- there is no hazard arising from electric shock and burn;		N
	- the switching off means cannot be negated by the work, or;		N
	- the work is of a minor nature.		N
5.5	Devices for disconnecting electrical equipment:		--
	Devices shall be provided for disconnecting electrical equipment to enable work to be carried out without risk from electric shock or burn		P
	Where it is necessary to work on individual parts of the machine, a disconnecting device shall be provided for each part or machine. Devices described in 5.3.2 may fulfil that function.		P
	Such disconnection devices shall be:		--
	- appropriate and convenient for intended use		P
	- suitably located		P
	- readily identifiable		P
	- provided with adequate means to prevent unauthorized, and/or mistaken closure		N
5.6.	Protection against unauthorized, and/or mistaken connection:		--
	The devices described in 5.4 and 5.5 that are not capable of being equipped with means to lock them in the OFF position, shall be equipped with such means.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	However, plug/socket combinations so positioned that it can be under supervision, means for locking need not to be provided.		P

6	**Protection against electric shock**		**P**
6.1	General:	Class I	--
	The electric equipment shall provide protection of persons against electric shock from:	3N~380V	--
	- direct contact, and;		N
	- indirect contact		P
6.2	Protection against direct contact:		P
6.2.1	General:		N
	For each circuit or part of the electrical equipment, the measures of either 6.2.2, 6.2.3, and where applicable 6.2.4 shall be applied		N
	When the equipment is located in places open to all persons, measures of either 6.2.3, 6.2.2 with a minimum degree of protection corresponding to IPX4 or IPXXD shall be applied	IP20	N
6.2.2	Protection by enclosures:		N
	Live parts that are located inside enclosures have to bee conform to the relevant requirements of Clauses 4, 11, and 14 and have to have a protection against direct contact of at least IP2X or IPXXB.		N
	Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against direct contact provided by the top surfaces shall be IP4X or IPXXD.		N
6.2.2 a	Opening an enclosure (i.e. opening doors, lids, covers, and the like) is possible only when:		P
	a) Either the use of a key or tool is necessary for access and:		P
	- all live parts, that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected are protected against direct contact to at least IP2X or IPXXB		N
	- live parts on the inside of doors are protected against direct contact to at least IP1X or IPXXA.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
6.2.2 b	b) Or the opening of an enclosure (i.e. opening doors, lids, covers, and the like) is possible only if disconnection is provided for all live parts inside the enclosure before it can be opened.		N
	Exception: If a special device or tool (intended for use only by skilled or instructed persons) as prescribed by the supplier is provided that can be used to defeat the interlock and that intends that:		N
	- 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;		N
	- upon closing the door, the interlock is automatically restored		N
	- all live parts, that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected are protected against direct contact to at least IP2X or IPXXB		N
	- live parts on the inside of doors shall be protected against direct contact to at least IP1X or IPXXA		N
	- relevant information is provided with the electrical equipment like instructions on the procedures for securing the machine for safe maintenance and information on the residual risks.		N
	- means are provided to restrict access to live parts behind doors not directly interlocked with the disconnecting means to skilled or instructed persons.		N
	- parts still alive after switching off are protected at least IP 2X or IP XXB and marked with a warning sign in accordance with 16.2.1		N
	Excepted from this marking are:		N
	- 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		N
	- the supply terminals of the supply disconnecting device when the latter is mounted alone in a separate enclosure.		N
6.2.2 c	c) Or the opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against direct contact to at least IP2X or IPXXB.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	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.		N
6.2.3	Protection by insulation of live parts:		P
	Live parts completely covered with insulation which can only be removed by destruction.		P
	Such insulation shall be capable of withstanding the stresses to which it can be subjected.		N
6.2.4	Protection against residual voltages:		N
	Live parts having residual voltage > 60V discharged to 60V or less within 5 s after disconnection of power supply		N
	For plugs or similar devices, the discharge time shall not exceed 1 s		N
6.2.5	Protection by barriers:		P
	For protection by barriers, see IEC 60364-4-41.		P
6.2.6	Protection by placing out of reach or protection by obstacles:		P
	For protection by placing out of reach, see IEC 60364-4-41, for protection by obstacles, see IEC 60364-4-41.		P
6.3	Protection against indirect contact:		P
6.3.1	General:		--
	For each circuit or part of the electrical equipment, at least one of the measures according to 6.3.2 to 6.3.3 shall be applied		P
6.3.2	Measures to prevent the occurrence of a hazardous touch voltage:		P
6.3.2.1	General:		N
	Measures to prevent the occurrence of a hazardous touch voltage include the following:		N
6.3.2.2	Protection by use of class II equipment or by equivalent insulation:		N
	This measure of protection shall be provided by one or more of the following means:		N
	- use of class II electrical devices or apparatus;		N
	- use of switchgear and contr.gear assemblies having total insulation;		N
	- application of supplementary or reinforced insulation;		N
6.3.2.3	Protection by electrical separation:		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Intended to prevent hazardous touch voltage through contact with exposed conductive parts which can be energized by a failure in the basic insulation of the live parts of that circuit		P
6.3.2.4	Supply system design:		N
	This protection is provided by the user of a supply system designed with its neutral point either insulated from or having a high impedance to earth so that an earth fault will not result in a hazardous touch voltage		N
6.3.3	Protection by automatic disconnection of supply:		N
	This protective measures comprises both:		N
	- the connection of exposed conductive parts to the protective bonding circuit		N
	- either:		N
	a) automatic disconnection of the supply in the event of an insulation failure in TN or TT systems, or		N
	b) the use of an earth fault detection or residual current detection to initiate automatic disconnection of IT systems		N
6.4	Protection by the use of PELV: (Protective Extra Low Voltage)		N
6.4.1 a)	PELV circuits shall satisfy all of the following conditions:		N
	-the nominal voltage does not exceed:		N
	- 25 V a.c. r.m.s. or 60 V ripple-free d.c. 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		N
	- 6 V a.c. r.m.s. or 15 V ripple-free d.c. in all other cases;		N
6.4.1 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
6.4.1 c)	live parts of PELV circuits is electrically separated from other live circuits		N
6.4.1 d)	Conductors of each PELV circuit are physically separated from those of any other circuit.		N
	If this requirement is impracticable, the insulation provisions of 13.1.3 are fulfilled;		N
6.4.1 e)	plugs and socket-outlets for a PELV circuit are conform to the following:		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	1) plugs do not to enter socket-outlets of other voltage systems;		N
	2) socket-outlets do not admit plugs of other voltage systems.		N
6.4.2	Sources of PELV:		--
	The source of a PELV shall be one of the following:		N
	- a safety isolating transformer		N
	- a source of current providing a degree of safety equivalent to that of a safety isolating transformer		N
	- an electrochemical source or another source independent of a higher voltage circuit		N
	- an electric power supply conforming to appropriate standards specifying measures to be taken to ensure that, the voltage at he outgoing terminals cannot exceed the values specified in 6.4.1.		N

7	**Protection of equipment**		**P**
7.1	General:		--
	Measures to be taken to protect equipment against the effects of:		P
	- over current arising from a short circuit;		P
	- over load currents;		P
	- earth fault;		N
	- over voltage due to lightning and switching sources;		N
	- abnormal temperatures;		P
	- loss of or reduction in the supply voltage;		P
	- over speed of machines/machine elements;		P
	- incorrect phase sequence.		N
7.2.1	General:		--
	Overcurrent protection shall be provided where the current in a machine circuit can exceed either the rating of any component or the current-carrying capacity of the conductors.		P
7.2.2	Overcurrent protection		--
	Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the overcurrent protective device for the supply conductors to the electrical equipment (see Annex B).		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	On the installation diagram data necessary for selecting the overcurrent protective device are stated for each incoming feeder. (see 7.2.10 and 17.4)		P
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.		P
	And, none of the following conductors, as applicable, is disconnected without disconnecting all associated live conductors:		P
	– the neutral conductor of a.c. power circuits;		P
	– the earthed conductor of d.c. power circuits;		N
	– d.c. power conductors bonded to exposed conductive parts of mobile machines.		N
	Cross section area of neutral conductor is at least equal to the phase conductor. No overcurrent protective/ disconnecting device is required.		P
	(For a neutral conductor with a cross sectional area smaller than that of the associated phase conductors, the measures detailed in 524 of IEC 60364-5-52 shall apply.)		P
	IT-Systems:, no neutral conductor is used. Or, when it is used, the measures detailed in 431.2.2 of IEC 60364-4-43 are applied.		N
7.2.4	Control circuits:		--
	Conductors of control circuits directly connected to the supply voltage or circuits feeding control circuit transformers shall be protected against over current acc.to 7.2.3		P
	Conductors of control circuits supplied by a control circuit transformer or d.c. supply: see 9.4.3.1		P
7.2.5	Socket outlets and their associated conductors:		N
	Overcurrent protective devices shall be provided in the unearthed live conductors of each circuit feeding such socket outlets		N
7.2.6	Lighting circuits:		N
	All unearthed conductors of circuits supplying lighting shall be protected against the effects of short circuits by overcurrent devices separate from those protecting other circuits		N
7.2.7	Transformers:		--

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Transformers shall be protected against overcurrent. Such protection shall:		P
	- avoid nuisance tripping due to transf. magnetizing inrush curr.;		P
	- avoid a winding temp. rise in excess of the permitted value for the insulation class of transf. when it is subject to short circuit at its secondary terminals		P
	- type and setting of the overcurrent protective device in accordance with the recommendations of the transformer supplier.		P
7.2.8	Location of overcurrent protective devices:		--
	- 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.		P
	Exceptions:		--
	- current carrying capacity of the conductors is at least equal to that of the load and		P
	- conductors between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is ? 3 m and		N
	- the conductor is protected e.g. by an enclosure or duct.		P
7.2.9	Overcurrent protective devices:		--
	The rated short-circuit breaking capacity Icn is at least equal to the prospective fault current at the point of installation.		P
	Additional currents other than from the supply (e.g. from motors, from power factor correction capacitors) shall be taken into consideration.		N
	Reduced breaking capacity is permitted, where another protective device is installed at supply side with the necessary breaking capacity.		N
	(In that case, the characteristics of the two devices shall be co-ordinated so that the let-through energy (I2t) of the two devices in series does not exceed that which can be withstood without damage to the overcurrent protective device on the load side and to the conductors protected by that device. See Annex A of IEC 60947-2).		N
	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.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
7.2.10	Rating and setting of overcurrent protective devices:		--
	Rated current of fuses or the setting current of other overcurrent protective devices selected to be:		P
	The rated current of overcurrent protective device 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, taking into account the needs of coordination with other electrical devices in the protected circuit.		N
7.3	Protection of motors against overheating		--
7.3.1	Overload protection of the motor(s) provided for each motor > 0,5 kW		P
	Protective device may be omitted for motors, which cannot be overloaded.		P
	Exceptions:		--
	In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps), the means of detection shall give a warning signal to which the operator can respond.		N
7.3.2	Protection achieved by overload protection device:		--
	- detection in each live conductor		P
	- switching off of all live conductors (not necessary to switch of neutral conductor)		P
	For special duty motors, appropriate protective devices are recommended		N
7.3.3	Protection achieved by over-temperature protection device:		P
	Is recommended in situations where the cooling can be impaired (for example dusty environments)		P
7.3.4	Protection achieved by current limiting protection: Where protection against the effects of overheating in three phase motors is achieved by current limitation, the number of current limitation devices may be reduced from 3 to 2.		N
7.4	Abnormal temperature protection:		N
	Resistance heated circuits (or other) provided with suitable detection to initiate an appropriate control response		N
7.5	Protection against supply interruption or voltage reduction and subsequent restoration		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Upon restoration of supply voltage, automatic or unexpected restarting of machine prevented.		P
	Undervoltage device installed to ensure appropriate protection at a predetermined voltage level		N
7.6	Motor overspeed protection:		N
	Overspeed protection provided for the machine		N
	Appropriate control responses initiated		N
	Automatic restarting prevented		N
7.7	Earth fault/residual current protection:		N
	In addition to providing earth fault/residual current protection as described in 6.3, this protection can be used to reduce damage to equipment.		N
7.8	Phase sequence protection:		N
	Where an incorrect phase sequence of the supply voltage can cause hazardous condition or damage to machine, protection shall be provided.		N
7.9	Protection against overvoltages due to lightning and to switching surges:		N
	- Devices are connected to the incoming terminals of the supply disconnecting device.		N

8	**Equipotential bonding**		**--**
8.2	Protective bonding circuit:		--
8.2.1	Where the conductance of structural parts of the electrical equipment or of the machine is less than that of the smallest protective conductor connected to the exposed conductive parts, a supplementary bonding conductor is provided.		P
	In IT distribution systems, the machine structure is part of the protective bonding circuit and insulation monitoring is provided.		N
	Exposed conductive parts of equipment in accordance with 6.3.2.3 (Protection by electrical separation) are not connected to the protective bonding circuit.		N
	(For this type of protection, the requirements of 413.5 of IEC 60364-4-41 apply.)		N
8.2.2	Protective conductors:		--
	Protective conductors shall be identified in accordance with 13.2.2.		P
	Copper conductors are preferred.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	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
	The cross-sectional area of protective conductors shall be determined in accordance with the requirements of:		P
	– 543 of IEC 60364-5-54; or		P
	– 7.4.3.1.7 of IEC 60439-1, as appropriate.		P
	This requirement is met in most cases if it is in accordance with Table 1 of this standard (see 5.2).		P
8.2.3	Continuity of the protective bonding circuit:		--
	All exposed conductive parts are connected to the protective bonding circuit in accordance with 8.2.1.		P
	Parts that are mounted so that they do not constitute a hazard because cannot be touched on large surfaces or grasped with the hand and they are small in size (less than approximately 50 mm × 50 mm) or they are located so that either contact with live parts, or an insulation failure is unlikely need not be connected to the protective bonding circuit		P
	Where a part is removed the protective bonding circuit for the remaining parts isn't interrupted.		P
	Current-carrying capacity of connection and bonding points cannot impaired by mechanical, chemical, or electrochemical influences (e.g. electrolytic corrosion on aluminium parts)		P
	Metal ducts of flexible or rigid construction and metallic cable sheaths are not used as protective conductors. Nevertheless they are connected to the protective bonding circuit.		N
	Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured.		P
	The use of a protective conductor (see 8.2.2) is recommended.		P
	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).		P
8.2.4	No means of interruption of the protective bonding conductor are provided.		P
	Exception: links for test or measurement purposes that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	As well the protective bonding circuit does not incorporate a switching device or an over current protective device (for example switch, fuse).		P
	Removable current collectors, plug/socket combinations or withdrawable plug-in units: The protective bonding circuit is interrupted by a first make last break contact. (see also 13.4.5)		N
8.2.5	Parts which need not be connected to the protective bonding circuit:		N
	Exposed conductive parts not connected to the protective bonding circuit must:		N
	- be untouchable on large surfaces or grasped with the hand;		N
	- be small in size;		N
	- be located so that cont. with live parts or an insulation failure is unlikely.		N
8.2.6	Protective conductor connecting points: have no other function and are not intended to attach or connect appliances or parts.		P
	Each protective conductor connecting point is marked or labelled as such using the symbol IEC 60417-5019 or the letters PE or by use of bicolour GREEN / YELLOW		P
8.2.7	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
8.2.8	Electrical equipment having earth leakage currents higher than 10 mA a.c. or d.c.:		N
	Additional protective bonding requirements: - Cross section of protective conductor 10 mm^2 CU or 16 mm^2 AL		N
	- OR Second protective conductor of at least the same cross sectional area if above cross section is impracticable		N
	- OR monitoring of continuity of protective conductor with automatic disconnection function.		N

9	**Control circuits and control functions**		**--**
9.1	Control circuits:		--
9.1.1	Control circuit supply:		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Control transformers mandatory only when more then one motor starter or two control devices are used.		P
	Control transformers with separate windings are used for supplying the control circuits.		P
	Where several transformers are used, the secondary voltages are in phase.		N
	Separate windings on transformer for DC supplies connected to PE.		N
	Switch-mode units fitted with transformers in accordance with IEC 61558-2-17		N
9.1.2	The nominal voltage of control supply does not exceed 277 V when supplied from a transformer.		P
9.1.3	Control circuits are provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.	Fused	P
9.2	Control functions:		--
	Safety related control functions in accordance with ISO 13849-1 (2006), ISO 13849-2 (2003) and /or IEC 62061 (see 9.4.1)		--
9.2.1	Start functions:		--
	Start functions operating by energizing the relevant circuit (see 9.2.5.2).		P
9.2.2	Stop functions:		P
	Stop function category 0, 1 or 2		P
9.2.3	Operating modes:		P
	Suitable means are prevented for unauthorized or inadvertent mode selection if hazardous situations can result.		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 is provided (e.g. the position of a mode selector, the provision of an indicating light, a visual display indication).	Status LED on main unit	P
9.2.4	Suspension of safeguards:		P
	Where suspension of safeguards is necessary, means shall be provided to prevent automatic operation		P
9.2.5	Operation:		--
	Prevention of movement of the machine in an unintended or unexpected manner is taken after any stopping of the machine. (e.g. due to locked-off condition, power supply fault, battery replacement, lost signal condition with cableless control)		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	When a machine has more than one control station, measures are provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.		P
9.2.5.2	Start of an operation is 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.		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
	The conditions to initiate a start are:		P
	- all required conditions for machine operation are met		P
	- and all start control devices are in the released (off) position		P
	- then all start control devices have to be actuated concurrently (see 3.6).		P
9.2.5.3	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 functions override related start functions		P
	Facilities to connect protective devices and interlocks are provided, where required. If such a protective device or interlock causes a stop of the machine, it may be necessary for that condition to be signalled to the logic of the control system.		P
	The reset of the stop function does not initiate any hazardous situation.		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.		P
9.2.5.4	Emergency operations (emergency stop, emergency switching off)		--
	Emergency stop or emergency switching off commands are sustained until it is reset.		P
	This reset is possible only by a manual action at that location where the command has been initiated.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	The reset of the command does not restart the machinery but only permit restarting.		P
	It is not be possible to restart the machinery until all emergency stop commands are reset.		P
	It is not be possible to reenergize the machinery until all emergency switching off commands are reset.		P
9.2.5.4.2	The emergency stop does function either as a stop category 0 or as a stop category 1.		P
	- it overrides all other functions and operations in all modes;		P
9.2.5.4.3	Emergency switching off is provided where:		P
	-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		P
	Emergency switching off is accomplished by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply.		P
9.2.6	Other control functions		N
9.2.6.2	No type 1 two-hand control device is used for the initiation of hazardous operation. It need type 2 or type 3 two-hand control devices for such operations.		N
9.2.6.3	Enabling control:		N
	Enabling control are arranged in the way to minimize the possibility of defeating, e. g. by requiring the deactivation of the enabling control device before machine operation may be reinitiated. It is not possible to defeat the enabling function by simple means.		N
9.2.6.4	Combined start and stop controls:		N
	Push-buttons etc. that alternately initiate and stop motion are provided only for functions, which cannot result in a hazardous situation.		N
9.2.7	Cable less control		P
9.2.7.1	Means shall be provided to readily remove or disconnect the power supply of the operator control station (see also 9.2.7.3).		P
	Means (for example key operated switch, access code) are provided, as necessary, to prevent unauthorized use of the operator control station.		P
	Each operator control station carries an unambiguous indication of which machine(s) is (are) intended to be controlled by that operator control station.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
9.2.7.2	Measures shall be taken to ensure that control commands:		P
	– affect only the intended machine;		P
	– affect only the intended functions.		P
	Measures are taken to prevent the machine from responding to signals other than those from the intended operator control station(s).		P
	Where necessary, means are provided so that the machine can only be controlled from operator control stations in one or more predetermined zones or locations.		P
9.2.7.3	Operator control stations include a separate and clearly identifiable means to initiate the stop function of the machine or of all the operations that can cause a hazardous situation.	Emergency stop	P
	The actuating means to initiate this stop function are not marked or labelled as an emergency stop device, even though the stop function initiated on the machine can fulfil an emergency stop function.		P
	Stopping of the machine and preventing a potentially hazardous operation is automatically initiated in the following situations:		P
	– when a stop signal is received;		P
	– when a fault is detected in the cableless control system;		P
	– when a valid signal (which includes a signal that communication is established and maintained) has not been detected within a specified period of time (see Annex B), except when a machine is executing a pre-programmed task taking it outside the range of the cableless control where no hazardous situation can occur.		P
9.2.7.4	Machines having more than one operator control station, including one or more cableless control stations, have measures provided to ensure that only one of the control stations can be enabled at a given time.		P
	An indication of which operator control station is in control of the machine is provided at suitable locations as determined by the risk assessment of the machine.		P
	Exception: a stop command from any one of the control stations are effective when required by the risk assessment of the machine.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
9.2.7.5	Battery-powered cableless operator control stations: A variation in the battery voltage does not cause a hazardous situation.		N
	A clear warning is given to the operator when a variation in battery voltage exceeds specified limits.		N
	Under those circumstances, the cableless operator control station remains functional long enough for the operator to put the machine into a non- hazardous situation.		N
9.3	Protective interlocks:		--
9.3.1	Reclosing or resetting of interlocked safeguards:		N
	Shall not initiate machine motion or operation where this can give rise to a hazardous condition		N
9.3.2	Overtravel limits:		N
	Fitted with a limiting device to initiate appropriate control action		N
9.3.3	Operation of auxillary functions:		N
	Checked by appropriate devices		N
9.3.4	Interlocks between different operations and for contrary motions are provided if this operations lead to hazardous situations.		P
9.3.5	Reverse current braking:		N
	Where braking of a motor is accomplished by current reversal, measures 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 are arranged that rotation of a motor shaft, for example manually, does not result in a hazardous situation.		N
9.4	Control functions in case of failure:		--
9.4.1	The safety related electrical control circuits have an appropriate level of safety performance that has been determined from the risk assessment at the machine. The requirements of IEC 62061 and/or ISO 13849-1, ISO 13849-2 are met.		P
	Where memory retention is achieved for example, by battery power, measures are taken to prevent hazardous situations arising from failure or removal of the battery		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Means are provided to prevent unauthorized or inadvertent memory alteration by, e.g. requiring the use of a key, access code or tool.		N
9.4.2	Measures to minimize risk in case of failure:		--
9.4.2.1	- Use of proven circuit techniques and components		P
9.4.2.2	- Provisions of partial or complete redundancy		N
9.4.2.3	- Provision of diversity		N
9.4.2.4	- Provision for functional tests		N
9.4.3	Protection against maloperations due to earth faults, voltage interruptions and loss of circuit continuity		--
9.4.3.1	Earth faults on any control circuit don't cause unintentional starting, potentially hazardous motions, or prevent stopping of the machine.		--
	Methods to meet these requirements include but are not limited to the following:		--
	a) 1) Control circuits, fed by control transformers and connected to the protective bonding circuit at the point of supply. (PELV) (see Figure 3 of this standard)		P
	a) 2) Control circuits, fed by control transformers without connection to the protective bonding circuit at the point of supply in the arrangement according to figure 3 and having a device that interrupts the circuit automatically in the event of an earth fault		N
	b) Control circuits fed by a control transformer with a centre-tapped winding, this centre tap connected to the protective bonding circuit, arranged as shown in Figure 4 of this standard with the overcurrent protective device having switching elements in all control circuit supply conductors.		N
	c) Where the control circuit is not fed from a control transformer and is either:		N
	1) directly connected between the phase conductors of an earthed supply, or;		N
	2) directly connected between the phase conductors or between a phase conductor and a neutral conductor of a supply that is not earthed or is earthed through a high impedance, multpole switch that switch all live conductors are used for those functions that can cause hazardous situations or damage to the machine.		N
	Or in case of c) 2), a device is provided that interrupts the circuit automatically in the event of an earth fault.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
9.4.3.2	For control systems using a memory device(s), proper functioning in the event of power failure is ensured (e.g. by using a non-volatile memory) to prevent any loss of memory that can result in a hazardous situation.		P
9.4.3.3	Upon sliding contacts the loss of continuity of safetyrelated control circuits depending on, can result in a hazardous situation. Appropriate measures are taken (for example by duplication of the sliding contacts).		P

10	**Operator interface and machine mounted control devices**		**--**
10.1	General:		--
10.1.1	As far as is practicable, those devices are selected, mounted, and identified or coded in accordance with relevant parts of IEC 61310.		P
10.1.2	As far as is practicable, machine-mounted control devices are:		--
	– readily accessible for service and maintenance;		N
	– 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:		N
	– they are not less than 0,6 m above the servicing level and		N
	– 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:		N
	– they are within easy reach of the normal working position of the operator;		N
	– the operator is not placed in a hazardous situation when operating them.		P
10.1.3	The degree of protection (see IEC 60529) together with other appropriate measures does afford protection against:		--
	– the effects of aggressive liquids, vapours, or gases found in the physical environment or used on the machine;		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	– the ingress of contaminants (for example swarf, dust, particulate matter).		N
	The operator interface control devices has a minimum degree of protection against direct contact of IPXXD (see IEC 60529).		N
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.		N
	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).		N
10.1.5	Portable and pendant operator control stations and their control devices are so selected and arranged as to minimize the possibility of inadvertent machine operations caused by shocks and vibrations		P
10.2	Push-buttons		P
10.2.1	Mandatory: The colour RED is used only for emergency stop and emergency switching off actuators.	Red	P
	The recommend colours of push-buttons are as shown in table 2 of this standard.		P
10.2.2	The recommend markings on push-buttons are as shown in table 3 of this standard.		P
10.3	Indicator lights and displays		P
10.3.1	Indicator lights and displays are selected and installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310- 1).		P
	Indicator light circuits used for warning lights are fitted with facilities to check the operability of these lights.		N
	The recommend colours on Indicator light are as shown in table 4 of this standard		P
	Indicating towers on machines have the applicable colours in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.		P
	Where flashing lights or displays are used to provide higher priority information, audible warning devices should also be provided.		N
10.4	illuminated push-button actuators are colour-coded in accordance with Tables 2 and 4. Where there is difficulty in assigning an appropriate colour, WHITE is used.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	The colour RED for the emergency stop actuator shall not depend on the illumination of its light.		P
10.5	Devices having a rotational member, such as potentiometers and selector switches, 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 (for example slides, spindles, carriers) are constructed and mounted so as to minimize inadvertent operation.		P
	However, mushroom-type actuators are used for twohand control only. (see also ISO 13851).		N
10.7	Devices for emergency stop		P
10.7.1	Devices for emergency stop are readily accessible.		P
	They are located at each operator control station and at other locations where the initiation of an emergency stop can be required (exception: see 9.2.7.3).		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.		N
10.7.2	Allowed types of device for emergency stop:		P
	– a push-button operated switch with a palm or mushroom head type;		P
	– a pull-cord operated switch;		N
	– a pedal-operated switch without mechanical guard.		N
	The devices are direct opening operation (see IEC 60947-5-1, Annex K).		N
10.7.3	Actuators are coloured RED. If a background exists immediately around the actuator, then this background is coloured YELLOW. See also ISO 13850.		P
10.7.4	Actuators (red and yellow)		P
	The supply disconnecting device may be locally operated to serve the function of emergency stop when:		P
	– it is readily accessible to the operator; and		P
	– it is of the type described in 5.3.2 a), b), c), or d).		P
	When also intended for this use, the supply disconnecting device meets the colours RED/YELLOW.		P
10.8	Emergency switing off device		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
10.8.1	Means are provided, where necessary, to avoid confusion between these devices.		P
10.8.2	The types of device for emergency switching off include:		P
	– a push-button operated switch with a palm or mushroom head type of actuator;		P
	– a pull-cord operated switch.		N
	The devices are direct opening action (see IEC 60947-5-1, Annex K).		N
	The push-button operated switch may be in a breakglass enclosure.		N
10.8.3	Actuators are coloured RED. If a background exists immediately around the actuator, then this background is coloured YELLOW. See also ISO 13850.	Yellow	P
10.8.4	Where the supply disconnecting device is to be locally operated for emergency switching off, it is be readily accessible and meets the colours RED/YELLOW.		P
10.9	Enabling control device		P
	An enabling control device as a part of a system, does allow operation when actuated in one position only. In any other position, operation is stopped or prevented.		P
	Functions of two-position types:		--
	position 1: off-function of the switch (actuator is not operated);		N
	position 2: enabling function (actuator is operated)		N
	Functions of three-position types:		--
	position 1: off-function of the switch (actuator is not operated);		N
	position 2: enabling function (actuator is operated in its mid position);		N
	position 3: off-function (actuator is operated past its mid position);		N
	when returning from position 3 to position 2, the enabling function is not activated.		N

11	**Electronic Equipment**		**P**
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

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Clause	**Requirement - Test**	**Result**	**Verdict**
	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 from the front.		P
	Necessary tools to adjust, maintain, or remove a device are supplied.		N
	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
	Terminals are least 0,2 m above the servicing level and so placed that conductors and cables can be easily connected to them.		N
	Only operating, indicating, measuring, and cooling devices are mounted on doors or on normally removable access covers of enclosures		P
	Plug-in arrangements of control devices and plug-in-devices:		N
	The connection is clearly identified by shape, marking or reference designation, singly or in combination		N
	When they have to bee handled during normal operation means are provided with non-interchangeable features where the lack of such a facility can result in malfunctioning.		N
	Plug/socket combinations that are handled during normal operation are unobstructedly accessible.		N
	Test points for connection of test equipment are:		N
	– unobstructedly accessible;		N
	– clearly identified to correspond with the		N
	documentation;		N
	– adequately insulated;		N
	– sufficiently spaced.		N
11.2.2	Non-electrical parts and devices, not directly associated with the electrical equipment, are not located within enclosures containing controlgear.		P
	Devices such as solenoid valves are separated from the other electrical equipment (for example in a separate compartment).		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Control devices mounted in the same location and connected to the supply voltage, or to both supply and control voltages, are grouped separately from those connected only to the control voltages.		P
	Terminals shall be separated into groups for: – power circuits;		P
	– associated control circuits;		P
	– other control circuits, fed from external sources (for example for interlocking).		N
	The clearances and creepage distances specified by the supplier are maintained, taking into account the external influences or conditions of the physical environment.		P
11.2.3	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	Controlgears are sufficiently protected against:		P
	- ingress of solid foreign objects		P
	- liquids		N
	- dust, coolants, and swarf,		P
	taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental conditions).		N
	Enclosures of controlgear provide a degree of protection of at least IP22 (see IEC 60529).		P
	Exceptions:		N
	a) specific electrical operating area		N
	b) When with removable collectors on conductor wire or conductor bar systems do not achieve IP22 measures of 6.2.5 are applied.		N
11.4	Enclosures, doors and openings		--
	Enclosures (inclusively screens of windows (windows: toughened glass or polycarbonate sheet of not less than 3 mm thickness), joints, gaskets of doors and lids) do withstand the foreseeable mechanical, electrical and thermal stresses and other environmental factors and of the aggressive liquids, vapours, or gases used on the machine.		P
	Fasteners used to secure doors and covers are of the captive type.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Enclosure doors are not wider than 0,9 m and have vertical hinges, with an angle of opening > 95°.		P
	Openings in enclosures (for example, for cable access), including those towards the floor or foundation or to other parts of the machine are equipped with means to ensure the degree of protection specified for the equipment.		P
	A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away.		N
	Openings for cable entries shall be easily re-opened on site.		N
	No openings between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate.		N
	Holes in an enclosure for mounting do not impair the required protection.		N
	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 is:		N
	– located within an enclosure that will withstand, such temperatures; and		N
	– is located at a sufficient distance from adjacent equipment allowing safe dissipation of heat (see also 11.2.3); or		N
	– is otherwise screened by material that can withstand to the harmful effect.		N
11.5	Access to control gear		P
	Doors in gangways for access to electrical operating areas:		P
	– are at least 0,7 m wide and 2,1 m high;		P
	– do open outwards;		P
	– have a means (for example panic bolts) to allow opening from the inside without the use of a key or tool.		P
	Enclosures which readily allow a person to fully enter are be provided with means to allow escape, e.g. panic bolts on the inside of doors		N
	Enclosures intended for such access, for example for resetting, adjusting, maintenance, shall have a clear width of at least 0,7 m and a clear height of at least 2,1 m		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	When equipment is likely to be live during access with > 1,0m and when on both side with > 1.5m.		N

12	**Conductors and Cables**		**--**
12.1	IMPORTANT: The following 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 60439-1).		P
12.2	In general, conductors are of copper. Where aluminium conductors are used, the crosssectional area is at least 16 mm^2.	Copper	P
	The cross-sectional areas of conductors are according to Table 5 and its notes.		P
	All conductors that are often in movement (> one movement per hour of machine operation) have flexible stranding of class 5 or class 6.		N
	Where the insulation of conductors and cables (for example PVC) can constitute hazards due to the propagation of a fire or the emission of toxic or corrosive fumes adequate means are provided.		N
	Special attention is given to the integrity of a circuit having a safety-related function		N
12.3	Minimum insulation test voltages for used cables are:		N
	– ≥ 2 000 V a.c. for a duration of 5 min for operation at voltages higher than 50 V a.c. or 120 V d.c., or		P
	– ≥ 500 V a.c. for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment).		P
	Insulation strong enough to withstand damage due to operation or during laying, especially for cables pulled into ducts.		P
12.4	Current-carrying capacity in normal service in accordance with table 6.		P
	Or in accordance with suppliers recommendation		P
12.6	Flexible cables		P
12.6.1	All flexible cables have Class 5 or Class 6 conductors.	Class 5	P
	Cables under severe duties are adequately protected against:		P
	- abrasion due to mechanical handling and dragging across rough surfaces;		N
	- kinking due to operation without guides;		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	- stress resulting from guide rollers and forced guiding, being wound and re-wound on cable drums.		N
12.6.2	The tensile stress applied to copper conductors does not exceed 15 N/mm^2 of cross-sectional area.		N
	Or special measures are taken to withstand the applied stress.		N
	For material other than copper the applied stress is within the cable manufacturer's specification.		N
12.6.3	For cables installed on drums, the maximum currentcarrying capacity in free air is derated in accordance with Table 7.		N
12.7	Conductor wires, conductor bars and slip-ring assemblies		N
12.7.1	During normal access to the machine, protection against direct contact to conductor wires, conductor bars and slip-ring assemblies is 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.		N
	Horizontal top surfaces of barriers or enclosures that are readily accessible provide a degree of protection of at least IP4X.		N
	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 is applied.		N
	Conductor wires and conductor bars are so placed / protected as to:		N
	– prevent contact with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains;		N
	– 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 is ensured by taking appropriate measures (for example, duplication of the current collector, continuity monitoring)		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
12.7.3	Protective conductor current collectors 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 (e.g. swivelingable) with disconnector 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 are suitable at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1 (For example 4 kV for 230/400 V systems → clearances 3mm)		N
12.7.6	Creepage distances between conductors and adjacent systems are suitable suitable for operation in the intended environment, e.g. open air (IEC 60664-1), inside buildings, protected by enclosures. In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply:		N
	– unprotected conductor etc.: minimum creepage dist. of 60 mm		N
	– enclosed conductor etc.: minimum creepage distance of 30 mm		N
12.7.7	Conductor system divided into isolated sections: suitable design measures are employed to prevent the energization of adjacent sections by the current collectors themselves.		N
12.7.8	Construction of conductor wires etc.:		N
	- power circuits are grouped separately from those in control circuits.		N
	- do withstand the foreseeable mechanical forces and thermal effects of short-circuit current.		N
	- covers can not be opened without the use of a tool		N
	- all conductive parts of accompanying enclosures are connected to the protective bonding circuit		N
	- underground and underfloor conductor bar ducts have drainage facilities		N

13	**Wiring Practices**		**P**
13.1	Connections and routing		P
13.1.1	All connections are secured against accidental loosening.		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	The means of connection are suitable for the crosssectional areas and nature of the conductors being terminated.		P
	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.		P
	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.		N
	Retaining means for conductor strand and shields provided (no soldering for that purpose)		N
	Indentification tags legible, permanent, and appropriate for the physical environment.		P
	Terminal blocks mounted and wired so that the internal and external wiring does not cross over the terminals (see IEC 60947-7-1).		P
13.1.2	13.1.2 Conductors and cables 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 joints for the purpose of this subclause.		N
	Terminations of cables are adequately supported to prevent mechanical stresses at the terminations of the conductors.		P
	Protective conductor 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
13.2	Connections and routing		P
13.2.1	Each conductor is identifiable at each termination in accordance with the technical documentation.		P
13.2.2	The protective conductor has the bicolour combination GREEN-AND-YELLOW		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	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.		P
13.2.3	Neutral conductors are identified by the colour LIGHT BLUE. That colour is not used for identifying any other conductor where confusion is possible.		N
	Bare conductors used as neutral conductors 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	Identification by colour for other conductors: Colours GREEN or YELLOW are not used. (Details to colour coding see this norm Cl. 13.2.3)		P
13.3	Wiring inside enclosures		--
	Conductors inside enclosures are supported where necessary.		P
	Conductors and cables that do not run in ducts are adequately supported.		N
	Non-metallic supports are made with a flameretardant insulating material (see IEC 60332 series)		N
	Connections to devices mounted on doors or to other movable parts are using flexible conductors in accordance with 12.2 and 12.6.		P
13.4	Wiring outside enclosures		--
13.4.2	Conductors and their connections external to the electrical equipment are placed in suitable ducts (see cl.13.5).		P
	Exceptions:		N
	- Cables with special suitable protection.		P
	- Position switches or proximity switches supplied with a dedicated cable which is sufficiently short.		N
13.4.3	Connections to moving elements of the machine are made of flexible cable in accordance with 12.2 and 12.6.		N
	Bending radius of the cable are of at least 10 times the diameter of the cable		N
	Cables close to moving parts, maintain a space of at least 25 mm between the moving parts and the cables or barriers are provided.		N
	Cable handling systems:		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Lateral cable angles do not exceeding 5°, at being wound on and off cable drums or approaching and leaving cable guidance devices. The bending radius is in accordance with table 8.		N
	Flexible conduit:		N
	- is not used for connections to rapidly or frequently moving parts, except when specifically designed for that purpose.		N
	- is supported when adjacent to moving parts		N
13.4.4	Interconnection of devices on the machine is made through adequate terminals.		P
13.4.5	Requirements to plug/socket combinations outside of enclosures:		N
	Exceptions: components connected to a bus system by a plug/socket combination		N
	a) Prevention for unintentional contact with live parts at any time.		N
	At least IPXXB. (PELV circuits are excepted from this requirement.)		N
	b) First make last break protective bonding contact if used in TN- or TT-systems.		N
	c) Sufficient load-breaking capacity, when intended to be disconnected under running conditions.		N
	When rated at ? 30 A interlocked with a switching device		N
	d) When rated at ? 16 A having a retaining means to prevent unintended or accidental disconnection.		N
	e) when unintended or accidental disconnection +can cause a hazardous situation, having a retaining means.		N
	f) Component remaining live after disconnection having at least IP2X or IPXXB, taking into account the required clearance and creepage distances.(PELV circuits are excepted from this requirement.)		N
	g) Metallic housings of plug/socket combinations being connected to the protective bonding circuit. (PELV circuits are excepted from this requirement.)		N
	h) Having retaining means to prevent unintended or accidental disconnection and being marked that they are not intended to be disconnected under load.		N
	i) Clearly identifiable if more then one plug / socket per device. It is recommended that mechanical coding being used.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	j) When used in control circuits fulfilling the applicable requirements of IEC 61984. Exception: see item k).		N
	k) No plug/socket combinations intended for household and similar general purposes used for control circuits. In plug/socket combinations in accordance with IEC 60309-1, only those contacts shall be used for control circuits which are intended for those purposes.		N
	Exception: The requirements of item k) do not apply to control functions using high frequency signals on the power supply.		N
13.4.6	Protection of Plug / socket from the physical environment during transportation and storage.		P
13.5	Ducts, connection boxes and other boxes		--
	Provided with a degree of protection suitable for the application.		N
	No sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come into contact.		P
	Where human passage is required, least 2 m above the working surface.		N
	Not used as connection for protective bonding circuit.		N
	Where cable trays are a.s.o. are only partially covered, the cables used are of a suitable type.		N
13.5.2	Filling the percentage of ducts adapted to the straightness and length of the duct and the flexibility of the conductors.		N
13.5.3	Rigid metal conduit and fittings shall galvanized steel or of a corrosion-resistant material		N
	Fittings compatible with the conduit.		N
	Conduit bends properly made		N
13.5.4	Flexible metal tubing or woven wire armour suitable for the expected physical environment.		N
13.5.5	Flexible non-metallic conduit resistant to kinking and suitable for the expected physical environment.		P
13.5.6	Requirements to cable trunking systems:		N
	- Rigidly supported and clear of all moving or contaminating portions of the machine		N
	- Covers overlapping the sides and attached.		N
13.5.7	The compartments of machine used as cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed, and the conductors are secured.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
13.5.8	Connection boxes and other boxes used for wiring:		--
	- Are accessible for maintenance.		N
	- Provide protection against the ingress of solid bodies and liquids, taking into account the external influences under which the machine is intended to operate (see 11.3).		P
	- Do not have unused knockouts etc.		N
13.5.9	Motor connection boxes: Encloses only connections to the motor and motormounted devices (e.g brakes, temperature sensors)		N

14	**Electric Motors and associated Equipment**		P
14.1	General requirements (EN 60034-1, 7.3, 7.6, 7.2, 5.3, 5.4, 5.5, 7.5, 7.6, 9.4, 12...)		P
	There protection is conform to the requirements given in 7.2 for overcurrent protection, in 7.3 for overload protection, and in 7.6 for overspeed protection.		P
	Motor control equipment is located and mounted in accordance with Clause 11.		P
14.2	Minimal IP23 protection for all motors. More stringent requirements depending on the application and the physical environment.		N
14.3	Motor dimensions (IEC 60072-1, IEC 60072-2...)		P
14.4	Motors incorporated as an integral part of the machine are adequately protected from mechanical damage.		P
	motors and its associated parts (inclusively motor connection box) are easily accessible for inspection and maintenance etc		P
	Cooling is ensured and the temperature rise remains within the limits of the insulation class (see IEC 60034-1)		P
	No opening between the motor compartment and any other compartment that does not meet the motor compartment requirements.		P
14.5	The characteristics of motors and associated equipment are selected in accordance with the anticipated service and physical environmental conditions (see 4.4).		P
	Detailed criteria see 14.5 of this norm.		P
14.6	Overload and overcurrent protective devices for mechanical brake actuators initiate simultaneously the deenergization (release) of the associated motors.		N

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Clause	**Requirement - Test**	**Result**	**Verdict**

15	**Accessories and Lightning**		**P**
15.1	Accessories (socket-outlets based on EN 60309-1, see 6.4, 7.2, 7.3, 5.3.5...)		P
	Requirements for socket-outlets for accessory equipment:		N
	– conform to IEC 60309-1 (Where that is not practicable, they are clearly marked with voltage and current ratings);		N
	–continuity of the protective bonding circuit to the socket-outlet is ensured, except where protected by PELV;		N
	– unearthed conductors connected to the socketoutlet are overcurrent- and if required overloadprotected		N
	– protection is separately from other circuits;		N
	– power supply to the socket-outlet is not		N
	disconnected by the supply disconnecting device for the machine or the section of the machine, the requirements of 5.3.5 apply.		N
15.2	Local lightning of the machine and equipment		P
15.2.1	Requirements for local lighting of the machine and equipment:		P
	- protective bonding circuit in accordance with 8.2.2.		P
	- ON/OFF switch incorporated in the lamp-holder or in the flexible connecting cords.		P
	- Stroboscopic effects avoided.		P
	- Where fixed lighting electromagnetic compatibility is taken into account.		P
15.2.2	Requirements to the power supply for local lighting:		P
	– Nominal voltage not exceeding 250 V between conductors		P
	– isolating transformer connected to the load side of the supply with overcurrent protection in the secondary circuit; or		P
	– isolating transformer connected to the line side of the supply disconnecting device with overcurrent protection in the secondary circuit. That source is permitted for maintenance lighting circuits in control enclosures only; or		P
	– from a machine circuit with dedicated overcurrent protection; or		P

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Clause	**Requirement - Test**	**Result**	**Verdict**
	– from an isolating transformer connected to the line side of the supply disconnecting device, provided with a dedicated primary disconnecting means and secondary overcurrent protection, and mounted within the control enclosure adjacent to the supply disconnecting device; or		P
	– from 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.		P
	Exception: Where fixed lighting is out of reach of operators during normal operations, the provisions of this subclause do not apply		P
15.2.3	All unearthed conductors of circuits supplying lighting have their own overcurrent protecting devices.		P
15.2.4	Requirements to the fittings for local lighting:		P
	– Adjustable lighting fittings are suitable for the physical environment.		P
	– lamp holders are in accordance with the relevant IEC standard;		P
	– lamp holders are constructed with an insulating material protecting the lamp cap		P
	– Reflectors are supported by a bracket and not by the lamp holder.		P
	Exception: where fixed lighting is out of reach of operators during normal operation, the provisions of this subclause do not apply.		N

16	**Marking, warning signs and reference designations**		**P**
16.1	Warning signs, nameplates, markings, and identification plates are of sufficient durability to withstand the physical environment.	See label	P
16.2	Warning signs (60417-2-IEC-5036, no disconnect, ...)		P
16.3	Functional identification (IEC 60417, ISO 7000...)		N
16.4	Marking of control equipment (name, mark, ratings, IEC 61082...)		N
16.5	Reference designation (IEC 61346-1...)		N

17	**Technical Documentation**		**--**
17.1	General:		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
	Necessary information for installation, operation and maintenance for the electrical equipment available		N
17.2	Information to be provided:		N
	Information provided with the electrical equipment shall include:		N
	a) a clear, comprehensive description of the equipment, installation and mounting, and the connection to the electrical supplies;		N
	b) electrical supply requirements;		N
	c) information in the physical environment;		N
	overview diagrams;		N
	e) circuit diagrams;		N
	f) information on:		N
	- programming;		N
	- sequence of operation;		N
	- frequency of inspection;		N
	- frequency and method on functional testing;		N
	- guidance on adjustment, maintenance and repair;		N
	- part lists, and in particular, spare parts.		N
	g) description of the safeguards, interactive functions ;		N
	h) description of the safeguarding means and methods where the primary safeguards are suspended.		N
17.3	Requirements applicable to all documentation:		N
	Documents prepared in accordance with IEC 1082-1 and 18.4 to 18.10		N
17.4	Basic information:		N
	Minimum technical information as follows:		N
	- normal operation conditions of the electrical equipment;		N
	- handling, transportation and storage;		N
	- Inappropriate use of the equipment.		N
17.5	Installation diagram:		N
	All information given for setting up the machine		N
17.6	System (block) diagram:		N
	System diagram provided		N
17.7	Circuit diagrams:		N
	Circuit diagrams provided showing the electrical circuits on the machine		N

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Clause	**Requirement - Test**	**Result**	**Verdict**
17.8	Operating manual:		N
	Operating manual provided to detail proper procedures for set-up and use of the equipment		N
17.9	Maintenance manual:		N
	Technical documentation containing a maintenance manual detailing proper procedures for adjustment, servicing and preventive inspection and repair		N
17.10	Part list:		N
	The part list shall comprise information necessary for ordering spare or replacement parts required for preventive or corrective maintenance		N

18	**Testing and verification**		P
18.1	General:		--
	The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no dedicated product standard for the machine, the verifications shall always include the items a), b) and f) and may include one or more of the items c) to e):		P
	a) verification that the electrical equipment complies with its technical documentation;		P
	b) in case of protection against indirect contact by automatic disconnection, conditions for protection by automatic disconnection shall be verified according to 18.2;		P
	c) insulation resistance test (see 18.3);		P
	d) voltage test (see 18.4);		P
	e) protection against residual voltage (see 18.5);		N
	f) functional tests (see 18.6).		P
	When the electrical equipment is connected to the machine, it shall be tested after clauses 19.2 - 19.7		P
18.2	Verification of conditions for protection by automatic disconnection of supply		--
18.2.2	Test 1: Verification of the continuity of the protective bonding circuit		P
	The resistance of each protective bonding circuit between the PE terminal and relevant points that are part of each protective bonding circuit is measured with a current between at least 0,2 A.	0,024Ω	P

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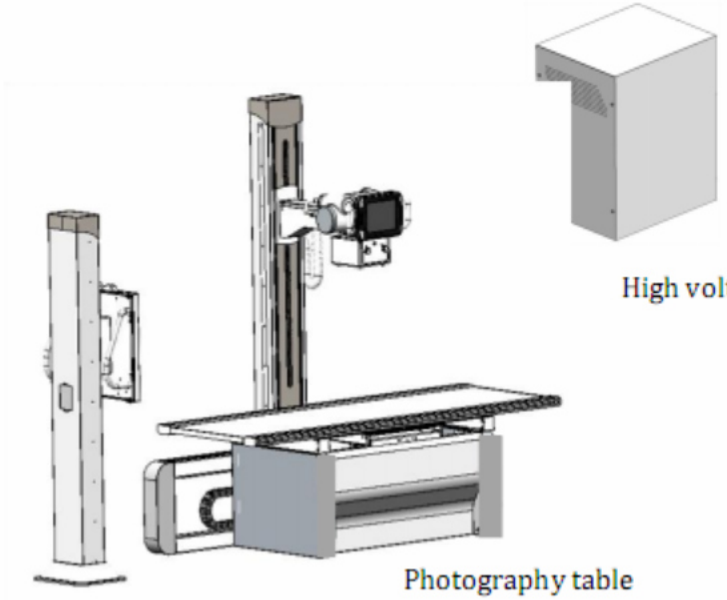
Clause	**Requirement - Test**	**Result**	**Verdict**
	And the resistance measured is in the expected range according to the length, the cross sectional area and the material of the related protective bonding conductor		P
	Test 2: Fault loop impedance verification and suitability of the associated overcurrent protective device.		P
	The connections of the power supply and of the incoming external protective conductor to the PE terminal of the machine are verified by inspection.		P
	The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A a verified by both:		N
	1) A verification of the fault loop impedance by		N
	- calculation, or		N
	- measurement in accordance with A.4, and		N
	2) A confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A or table 10		N
18.3	Insulation resistance tests (facultative) The insulation resistance measured at 500 V d.c. between the power circuit conductors and the protective bonding circuit are not less than 1 MΩ.	*800 MΩ*	P
18.4	Voltage tests:		P
	Voltage: 2 x U0 or 1000V, 50Hz Duration min. 1s		P
	No flashover		P
18.5	Protection against residual voltages:		N
	Tests shall be performed to ensure compliance with 6.2.3		N
18.6	Functional tests:		P
	Functions of electrical equipment, in particular those related to safety and safeguarding, tested		P
18.7	Retesting:		N
	After changes or modifications, tests acc. to 19.2 to 19.7 performed		N

Annex B	Inquiry Form (Annex B of EN 60204-1) (for information between supplier and user only) · Name of manufacturer: · Name of end user, if applicable: · Order number, if applicable: · Type/Model of machine: · Serial number:	N

APPENDIX A

PHOTOS OF PRODUCT



High voltage generator

Photography table

Vertical Frame

Console

----- End of Report -----