TEST REPORT

For

Chaohan Intelligent Equipment Co., Ltd

Cutting machine

Model(s):

T3、T5、T6、T7、CNC Router cutting machine 、C2516

Prepared For:	Chaohan Intelligent Equipment Co., Ltd 7 Qianshan Road, Anxi Industrial Park, Yuhang District, Hangzhou City, Zhejiang Province
Prepared By:	Zhejiang NewRay Test&Certification Technology Co., Ltd. 5th Floor,No.9 Fengling Road,Wuchang Street, Yuhang District,Hangzhou City,Zhejiang

Report No.:	ZNCT251017005
Date of Test:	2025-10-19
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Date of issue.....:	2025-10-20
Testing Laboratory.....:	Zhejiang NewRay Test&Certification Technology Co.,Ltd.
Address..... :	5th Floor,No.9 Fengling Road,Wuchang Street,Yuhang District,Hangzhou City,Zhejiang
Applicant name.....:	Chaohan Intelligent Equipment Co., Ltd
Address..... :	7 Qianshan Road, Anxi Industrial Park, Yuhang District, Hangzhou City, Zhejiang Province
Testing specification:	
Standards.....:	EN ISO 12100:2010; EN 60204-1:2018/A1:2025; EN ISO 11553-1:2020/A11:2020; EN 60825-1:2014/A11:2021
Non-standard test method.....:	N/A
Test Report Form No.....:	--
Test Report Form(s) Originator.....:	
Master TRF.....:	Dated: 2022-07
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Test item description.....:	**Cutting machine**
Trade Mark.....:	美耐特
Manufacturer.....:	Chaohan Intelligent Equipment Co., Ltd 7 Qianshan Road, Anxi Industrial Park, Yuhang District, Hangzhou City, Zhejiang Province
Test Model.....:	T3
Specifications.....:	

Test procedure and location:

Testing Laboratory.....:	**Zhejiang NewRay Test&Certification Technology Co.,Ltd.**
Address.....:	5th Floor, No.9 Fengling Road, Wuchang Street, Yuhang District, Hangzhou City, Zhejiang
Date of Issue.....:	2025-10-20
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EN 12100 report			
6	Risk reduction		-
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: -severity of harm from the hazard under consideration -probability of occurrence of that harm 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)	This requirement is complied with. See related clauses.	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. NOTE See 6.3 for safeguarding and complementary measures that can be used to achieve the risk reduction objectives in the case where inherently safe design measures are not sufficient (see 6.1 for the three-step method).	Appropriate machine design has been performed by the manufacturer.	P
6.2	Consideration of geometrical factors and physical aspects		-
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, for example—and choosing and locating means of indirect vision where necessary(mirrors, etc.) so as to take into account the characteristics of humanvision, particularly when safe operation requires permanent direct control by the operator, for example: -the travelling and working area of mobile machines; -the zone of movement of lifted loads or of the carrier of machinery for lifting persons: -the area of contact of the tool of a hand-held or	Appropriate machine design has been performed by the manufacturer.	P

	hand-guided machine with the material being worked. The design of the machine shall be such that, from the main control position, the operator is able to ensure that there are no exposed persons in the danger zones.		
	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).	Appropriate machine design has been performed by the manufacturer.	P
	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 angels, 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.	Appropriate machine design has been performed by the manufacturer.	P
	d) The form of the machine is designed so as to achieve a suitable working position and provide accessible manual controls (actuators).	Appropriate machine design has been performed by the manufacturer.	P
6.2.2.2	Physical aspects		-
	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 dose not generate a mechanical hazard.	P
	b)limiting the mass and/or velocity of the movable elements, and hence their kinetic energy;	This have been limited.	P
	- c) limiting the emissions by acting on the characteristics of the source using measures for reducing noise emission at source (see ISO/TR 11688-1), 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)], the emission of hazardous substances, including the use of less hazardous substances or dust-reducing processes (granules instead of powders, milling instead of grinding),	The emissions by acting on the characteristics of the source have been limited.	P

	and 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)].		
6.2.3	Taking into account the general technical knowledge regarding machine design 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	Has been taken into account.	P
	-stress limitation by overload prevention, (e.g. "fusible" plugs, pressure-limiting valve, breakage points, torque-limiting devices);	Has been taken into account.	P
	- avoiding fatigue in elements under variable stresses（notably cyclic stresses）;	Has been taken into account	P
	- static and dynamic balancing of rotating elements;	Has been taken into account	P
	b) materials and their properties such as		-
	- resistance to corrosion, ageing, abrasion and wear;	It has appropriate coating	P
	- hardness, ductility, brittleness;	The materials have been treated by appropriate methods	P
	- homogeneity	The materials have been treated by appropriate methods	P
	- toxicity	The materials is non-toxicity	P
	- flammability	The materials no flammability	P
	c) emission values for:		-
	- noise;	No noise will result in hazard in this machine.	P
	- vibration;	No vibration will result in hazard in this	P

		machine.	
	- hazardous substances;	No hazardous substances will result in hazard in this machine.	P
	- radiation.	No radiation will result in hazard in this machine.	P
	When the reliability of particular components or assemblies is critical for safety (e.g. ropes, chains, lifting accessories for lifting loads or persons), stress values shall be multiplied by appropriate working coefficients.	Appropriate working coefficients have been taken into account during design and calculation.	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.:		-
	a)on machines intended for use in explosive atmospheres: -fully pneumatic or hydraulic control system and machine actuators: -"intrinsically safe" electrical equipment (see IEC60079-11)		N/A
	b)for particular products to be processed such as a solvent:equipment assuring that the temperature will remain far below the flash point.		N/A
	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/A
6.2.5	Applying the principle of the positive mechanical action		-
	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 positive opening operation of switching devices in an electrical circuit (see IEC 60947-5-1 and ISO 14119)	The principle of the positive mechanical action of a component on another component has been applied	P
6.2.6	Provisions for stability		-
	Machines shall be designed to have sufficient stability to allow them to be used safely in their specified conditions of use.	Satisfied it.	P
	Factors to be taken into account include		-
	-geometry of the base; -weight distribution,including loading; -dynamic forces due to movements of parts of the machine itself,or of elements held by the machine which may result	Taken into account during design.	P

	in an overturning moment; -vibration		
	-oscillations of the centre of gravity;		N/A
	-characteristics of the supporting surface in case of traveling or installation on different sites (e.g.ground conditions,slope);	Taken into account during design.	P
	-external forces (e.g.wind pressure,manual forces)	Taken into account during design.	P
	Stability shall be considered in all phases of the life of the machine,including handling, traveling,installation,use,de-commissioning and dismantling.	Taken into account during design.	P
	Other protective measures for stability relevant to safeguarding are given in 6.3.2.6	Please see the related clause.	P
6.2.7	Provision for maintainability		-
	When designing a machine,the following maintainability factors shall be taken into account:		-
	-accessibility,taking into account the environment and the human boby 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;	These factors have been taken into account during design.	P
	-limitation of the number of special tools and equipment;	These factors have been taken into account during design.	P
6.2.8	Observing ergonomic principles	-	-
	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	P
	These principles shall be considered when allocating functions to operator and machine(degree of automation) in the basic design.	These principles have been taken into account during allocating functions to operator and machine.	P
	Account shall be taken of body sizes likely to be found in the intended user population, strengths and postures, movement amplitudes, frequency of cyclic actions (see ISO 10075 and ISO 10075-2)	All these factors have been taken into account during design.	P
	All elements of the “operator-machine” interface such as controls, signaling or data display elements, shall be designed to easily understood so that clear and unambiguous interaction between the operator and the	All arrangement and design of manual controls have been checked in compliance	P

	machine is possible.(see EN 614-1, ISO 6385, EN 13861 and IEC 61310-1)	with.	
	Designer's attention is especially drawn to following ergonomic aspects of machine design		-
	a)Avoiding stressful postures and movements during use of the machine(e.g.by providing facilities to adjust the machine to suit the various operators).	Stressful postures and movements during use of the machine have been avoided.	P
	b) Designing machines, and more especially hand-held and mobile machines to enable them to be operated easily taking into account human effort, actuation of controls and hand, arm and leg anatomy.	This machine has been adjusted to the human strength and convenient movement.	P
	c) Limit as far as possible noise, vibration and thermal effects such as extreme temperature	This machine with low noise, low vibration.	P
	d) Avoid linking the operator's working rhythm to an automatic succession of cycles.	This situation has been avoided.	P
	e) Providing local lighting on or in the machine for the illumination of the working area and of adjusting, setting-up, and frequent maintenance zones when the design features of the machine and/or its guards render the ambient lighting inadequate. Flicker, dazzling, shadows and stroboscopic effects shall be avoided if they can cause a risk. If the position of the lighting source has to be adjusted, its location shall be such that it does not cause any risk to persons making the adjustment.		N/A
	f) Select, locate and identify manual controls(actuators) so that		-
	- they are clearly visible and identifiable and appropriately marked where necessary(see 6.4.4)	All design and arrangement are compliance with this requirement.	P
	- they can be safely operated without hesitation or loss of time and without ambiguity(e.g. a standard layout of controls reduces the possibility of error when an operator changes from a machine to another one of similar type having the same pattern of operation)	All design and arrangement of the control logic have been checked in compliance with this requirement.	P
	-their location(for push-buttons) and their movement (for levers and handwheels) are consistent with their effect (see IEC 61310-3)	All the function has been checked in compliance with this requirement.	P
	Where a control is designed and constructed to perform several different actions, namely where there is no one-to-one correspondence (e.g. keyboards), the action to be performed shall be clearly displayed and subject to		N/A

	confirmation where necessary.		
	Controls shall be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles.	All the arrangement of the control logic has been checked in compliance with this requirement	P
	Constraints due to the necessary or foreseeable use of personal protective equipment(such as footwear, gloves)shall be taken into account.	The factors have been taken into account during design.	P
	g)Select, design and locate indicators, dials and visual display units so that		-
	-they fit within the parameters and characteristics of human perception		P
	-information displayed can be detected, identified and interpreted conveniently, i.e. long lasting, distinct, unambiguous and understandable with respect to the operator's requirements and the intended use;	All the information displayed comply with this requirement	P
	-the operator is able to perceive them form the control position		P
6.2.9	Preventing electrical hazard		-
	For the design of the electrical equipment of machines IEC 60201-1 gives general provisions, especially in clause 6 for protection against electric shock.	Please also make reference to EN 60204-1 test report.	-
	For requirements related to specific machines, see corresponding IEC standards(e.g. series of IEC 61029, IEC 60745, IEC 60335).		N/A
6.2.10	Preventing and hydraulic hazards		-
	Pneumatic and hydraulic equipment of machinery shall be designed so that:		-
	-the maximum rated pressure cannot be exceeded in the circuits(e.g. by means of pressure limiting devices)	Appropriate limiting devices have been provided.	P
	-no hazard results from pressure surges or rises, pressure losses or drops or losses of vacuum;	No such hazards exist.	P
	-no hazardous fluid jet or sudden hazardous movement of the hose (whiplash)results from leakage or component failures;		N/A
	-air receivers, air reservoirs or similar vessels(e.g. in gas loaded accumulators)comply with the design rules for these elements;	The devices are designed appropriately.	P
	-air elements of the equipment, and especially pipes and hoses, be protected against harmful external effects;	The pipes have been protected by appropriated devices.	P
	-as far as possible, reservoirs and similar vessels (e.g. in	This requirement is	P

	gas loaded accumulators)are automatically depressurized when isolating the machine from its power supply (see 6.3.5.4) and, if it is not possible, means are provided for their isolation, local depressurizing and pressure indication (see also ISO 14118, clause 5)	complied with	
	- all elements which remain under pressure after isolation of machine from its power supply be provided with clearly identified exhaust devices, and a warning label drawing attention to the necessity of depressurizing those elements before any setting or maintenance activity on the machine. See also ISO 4413 and ISO 4414	This requirement is complied with by appropriate design.	P
6.2.11	Applying inherently safe design measures to control system		-
6.2.11.1	General		-
	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
	The correct measures of the control systems can avoid unforeseen and potentially hazardous machine behaviour.	Inherently safe Design measures to control system have applied.	P
	-an unsuitable design or modification (accidental or deliberate) of the control system logic;	No this kind of hazard in this machine	P
	- a temporary or permanent defect or a failure of one or several components of the control system;		P
	- a variation or a failure in the power supply of the control system;	No this kind of hazard in this machine.	P
	- inappropriate selection, design and location of the control devices;	No this kind of hazard in this machine.	N/A
	Typical examples of hazardous machine behaviour are:		-
	- unintended/unexpected start-up (see ISO 14188)	No this kind of hazard.	P
	- uncontrolled speed change;	No this kind of hazard.	P
	- failure to stop moving parts;	No this kind of hazard.	P
	- dropping or ejection of a mobile part of the machine or of a workpiece clamped by the machine;	No this kind of hazard.	P
	- machine action resulting from inhibition (defeating or failure) of protective devices	No this kind of hazard.	P
	In order to prevent hazardoues machine behaviour and to achieve safety functions, the design of control systems shall comply with the principles and methods presented in this subclause 6.2.11 and in 6.2.12.	The design of control systems comply with the related principles and methods	P
	These principles and methods shall be applied singly or in combination as appropriate to the circumstances (see ISO 13849-1 and EN 60204-1 and IEC 62061).	Please see the related clause.	P
	Control systems shall be designed to enable the operator to		-

	interact with the machine safely and easily; this requires one or several of the following solutions;		
	-systematic analysis of start and stop conditions;	Systematic analysis have been applied.	P
	-provision for specific operating modes (e.g. start-up after normal stop. restart after cycle interruption or after emergency stop. removal of the workpieces contained in the machine, operation of a part of the machine in case of a failure of a machine element)	Enough provisions have been provided.	P
	-clear display of the faults;		P
	-measures to prevent accidental generation of unexpected start commands (e.g. shrouded start device) likely to cause dangerous machine behaviour (see ISO 14118 figure 1)	Main switch with lock and related devices are provided.	P
	-maintained stop commands (e.g. interlock) to prevent restarting that could result in dangerous machine behaviour (see ISO 14118:2000,figure 1)	This requirement is complied with.	P
	An assembly of machines may be divided into several zones for emergency stopping, for stopping as a result of protective devices and/or for isolation and energy dissipation.		N/A
	The different zones shall be clearly defined and it shall be obvious which parts of the machine belong to which zone.		N/A
	Likewise it shall be obvious which control devices (e.g. emergency stop devices, supply disconnecting devices) and/or protective devices belong to which zone.		N/A
	The interfaces between zones shall be designed such that no function in one zone creates hazards in another zone which has been stopped for an intervention.		N/A
	Control systems shall be designed to limit the movements of parts of the machinery, the machine itself, or workpieces and/or loads held by the machinery, to the safe design parameters (e.g. range, speed, acceleration, deceleration, load capacity). Allowance shall be made for dynamic effects (e.g. the swinging of loads).		N/A
	For example:		-
	-the traveling speed of mobile pedestrian controlled machinery other than remote-controlled shall be compatible with walking speed.		N/A
	-the range, speed, acceleration and deceleration of movements of the person-carrier and carrying vehicle for lifting persons shall be limited to non-hazardous values, taking into account the total reaction time of the operator and the machine.		N/A
	-the range of movements of parts of machinery for lifting		N/A

	loads shall be kept within specified limits.		
	When machinery is designed to use synchronously different elements which can also be used independently the control system shall be designed to prevent risks due to lack of synchronization.		N/A
6.211.2	Starting of internal power source/switching on an external power supply.		-
	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 EN 60204-1, 7.5 (see also Annexes A and B).	Please also make reference to EN 60204-1 test report.	-
6.2.11.3	Starting/stopping of a mechanism		-
	The primary action for starting or accelerating the movement of a mechanism should be performed by Page from state 0 to state 1(if state 1 represents the highest energy state)	This requirement has been taken into account during design.	P
	The primary action for stopping or slowing down should be performed by removal or reduction of voltage or fluid pressure, or, if binary logic elements are considered, by Page from state 1 to 0 (if state 1 represents the highest energy state).	The type of stopping of this machine belongs to state 1and state 0.	P
	When, in order for the operator to maintain permanent control of deceleration, this principle not observed(e.g. a hydraulic braking vice of a self-propelled mobile machine),the machine shall be equipped with a means of slowing and stopping in case of failure of the main braking system	No such situation exist.	P
6.2.11.4	Restart after power interruption		-
	If it may generate a hazard,the spontaneous restart of a machine when it is re—energized alter 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.	-
6.2.11.5	Interruption of power supply situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met:	Machinery shall be designed to prevent hazardous	-
	-the stopping function of the machinery shall remain;		-
	-all devices whose permanent operation is required for		-

	safety shall operation an effective way to maintain safety(e.g. locking, clamping devices,cooling or heating devices, power-assisted steering of self-propelled mobile machinery);		
	-parts of machinery or workpieces and/or loads held by machinery which are liable to move as a result of potential energy shall be retained for the time necessary to allow them to be safely lowered	No such situation exists.	-
6.2.11.6	Use of automatic monitoring		-
	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	Appropriate automatic monitoring has been used.	-
	Automatic monitoring either detects a fault immediately or carries out periodic checks so that a fault is detected before the next demand upon the safety function.	Appropriate automatic monitoring has been used	-
	In either case, the protective measure can be initiated immediately or delayed until a specific event occurs (e.g. the beginning of the machine cycle) The protective measures may be, e.g.:	Appropriate automatic monitoring has been used.	-
	-the stopping of the hazardous process;	Emergency stop is provided	-
	-preventing the re-start of this process after the first stop following the failure;	Reset before restart is necessary	-
	-the triggering of an alarm		N/A
6.2.11.7	Safety functions implemented by programmable electronic control systems		-
6.2.11.7.1	General		-
	A control system including programmable electronic equipment(e.g. programmable controllers)can be used to implement safety functions machinery		-
	equipment(e.g. programmable controllers) can be used to implement safety functions machinery	safety functions are considered during design	-
	The design of the programmable electronic control system shall be such that the probability of random hardware failures and the likelihood of systematic failures that can adversely affect the performance of the safety—related control function(s)are sufficiently low	safety functions are considered during design	-
	Where a programmable electronic control system performs a monitoring function, the system behaviour on detection of a fault shall be considered(see also IEC 61508 series for further guidance)	satisfied this	-

	The programmable electronic control system should be installed and validated to ensure that the specified performance(e.g. safety integrity level(SIL)in IEC 61508 series)for each safety function has been achieved	it be installed and validated to ensure that the specified performance	-
	Validation comprises testing an analysis(e.g. static,dynamic or failure analysis)to show that all parts interact correctly to perform the safety function and that unintended functions do not occur	All parts interact correctly to perform the safety function and that unintended functions do not occur	-
6.2.11.7.2	Hardware aspects		-
	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	-
	-architectural constraints(e.g. the configuration of the system, its ability to tolerate faults， its behaviour on detection of a fault):	Appropriate devices are provided	-
	-selecting (and/or designing) equipment and devices with an appropriate probability of dangerous random hardware failure;	Appropriate devices are provided	-
	Incorporating measures and techniques within the hardware to avoid systematic failures and control systematic faults.	Appropriate devices are provided.	-
6.2.11.7.3	Software aspects		-
	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)	It has PLC.	-
	Application software		-
	Application software should not be re-programmable by the user.		N/A
	This may be achieved by use of embedded software in a non re-programmable memory (e.g. micro-controller, application specific integrated circuit (ASIC)		N/A
	When the application requires reprogramming by the user, the access o the software dealing with safety functions should be restricted e.g. by : -locks; -Pwords for the authorized persons		N/A
6.2.11.8	Principles relating to manuai control		-

	a)Manual control devices shall be designed and located according to the relevant ergonomic principles given in 6.2.8	Manual control devices have been designed and located according to the relevant ergonomic principles given in 4.8.7	P
	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.	The control devices and control positions have been located so that the operator is able to observe the working area or hazard zone.	P
	The driver of a ride-on mobile machine shall be able to actuate all control devices required to operate the machine from the driving position, except for functions which can be controlled more safely from other positions.		N/A
	On machinery intended for lifting persons, controls for lifting and lowering and, if appropriate, for moving the carrier, shall generally be located in the carrier. If safe operation requires controls to be situated outside the carrier, the operator in the carrier shall be provided with the means of preventing hazardous movements.		N/A
	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 unit (teach pendant, for instance), with which the operator may enter danger zones.		N/A
	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)	This requirement is complied with.	P
	g) For machine functions whose safe operation depends on permanent, direct control by the operator, measures shall	This requirement is complied with.	P

	be taken to ensure the presence of the operator at the control position, e.g. by the design and location of control devices.		
	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.	This requirement is complied with.	P
	h) For cableless control an automatic stop shall be performed when correct control signals are not received, including loss of communication(see EN 60204-1)		N/A
6.2.11.9	Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance		N/A
	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:		N/A
	-disables all other control modes;		N/A
	-permits operation of the hazardous elements only by continuous actuation of an enabling device, a hold-to-run control device or a two –hand control device;		N/A
	-permits operation of the hazardous elements only in reduced risk conditions (e.g. reduced speed, reduced power/force, step-operation, e. g. with a limited movement control device)		N/A
	Prevents any operation of hazardous functions by voluntary or involuntary action on the machine’s sensors.		N/A
	This control mode shall be associated with one or more of following measures:		N/A
	-restriction of access to the danger zone as far as possible.		N/A
	-emergency stop control within immediate reach of the operator;		N/A
	Portable control unit(teach pendant)and/or local controls allowing sight of the controlled elements.(see IEC60204-1:9.2.4)		N/A
6.2.11.10	Selection of control and operating modes		-
	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		N/A

	fitted with a mode selector which can be locked in each position.		
	Each position of the selector shall be clearly identifiable and shall exclusively allow one control or operating mode.		N/A
	The selector may be replaced by another selection means which restricts the use of certain functions of the machinery to certain categories of operators(e.g. access codes for certain numerically controlled functions).		N/A
6.2.11.11	Applying measures achieve electromagnetic Compatibility		-
	For guidance on electromagnetic compatibility, see IEC60204-1, and IEC61000-6 series		N/A
6.2.11.12	Provision of diagnostic systems to aid fault-finding		-
	Diagnostic systems to aid fault finding should be included in the control system so that there is no need to disable any protective measures		N/A
6.2.12	Minimizing the probability of failure of safety functions		-
6.2.12.1	General		-
	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		-
	“Reliable component”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 probability 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	-
6.2.12.3	Use of“oriented failure mode”components		-
	“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/A
	The use of such components should always be considered particularly in cases where redundancy is (see 6.2.12.4) not employed		N/A
6.2.12.4	Duplication (or redundancy)of components or subsystems		N/A
	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		N/A

	components) continue(s) to perform its(their) function, thereby ensuring that the safety function remains available		
	In order to allow the proper action to be initiated, component failure shall be preferably detected by automatic monitoring (see 6.2.1 1.6) or in some circumstances by regular inspection,		N/A
	provided that the inspection interval is shorter than the expected lifetime of the components.		N/A
	Diversity of design and/or technology can be used to avoid common cause failures (e.g. from electromagnetic disturbance) or common mode failures.		N/A
6.2.13	Limiting exposure to hazards through reliability of equipment		-
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring rectification, thereby reducing exposure to hazards.	This requirement is complied with.	-
	This applies to power systems (operative part) as well as to control systems, to safety functions as well as to other functions of machinery.	This requirement is complied with.	-
	Safety-critical components (as e.g. certain sensors) with known reliability shall be used.	Safety-critical components are used in this machine.	-
	The elements of guards and of protective services shall be particularly reliable, as their failure can expose persons to hazards, and also as poor reliability would encourage attempts to defeat them.	This requirement is complied with.	-
6.2.14	Limiting exposure to hazards through mechanization or automation of loading(feeding) /unloading (removal) operations		-
	Mechanization and automation of machine loading/unloading operations and more generally of handling operations (of work pieces, materials, substances) limit the risk generated by these operations by reducing the exposure of persons to hazards at the operating points.	This requirement is complied with.	-
	Automation can be achieved e.g. by robots, handling devices. transfer mechanisms, air blast equipment.	This requirement has been complied with by design.	-
	Mechanization can be achieved, e.g. by feeding slides, push rods, hand-operated indexing tables.	This requirement has been complied with by design.	-
	While automatic feeding and removal devices have much to offer in preventing accidents to machine operators, they can create danger when any faults are being rectified.	Appropriate provisions have been provided.	-
	Care shall be taken to ensure that the use of these devices	These devices will not	-

	does not introduce further hazards (e.g. trapping, crushing) between the devices and parts of the machine or workpieces/materials being processed.	introduce further hazards	
	Suitable safeguards (see 6.3) shall be provided if this cannot be ensured.	Please see the related clause	-
	Automatic feeding and removal devices with their own control systems and the control systems of the associated machine shall be interconnected after thoroughly studying how all safety functions are performed in all control and operation modes of the whole equipment.	This requirement has been complied with by design	-
6.2.15	Limiting exposure to hazards through location of the setting and maintenance points outside of danger zones.		-
	The need for access to danger zones shall be minimized by locating maintenance, lubrication and setting points outside these zones.	This requirement has been complied with by design.	P
6.3	Safeguarding and complementary protective measures		-
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 inherently safe either to remove hazards or to sufficiently reduce risks.	P
	The different kinds of' guards and protective devices are defined in 3.27 and 3.28.	Please see the related clause	P
	Certain safeguards may be used to avoid exposure to more than one hazard (e.g. a fixed guard preventing access to a zone where a mechanical hazard is present being used to reduce noise level and collect toxic emissions)	Such safeguards exist	P
6.3.2	Selection and implementation of guards and protective devices		-
6.3.2.1	General		-
	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

	The exact choice of a safeguard for a particular machine shall be made on the basis of the risk assessment for that machine	Please see the related clause.	P
	In selecting an appropriate safeguard for a particular type of machinery or hazard zone, it shall be borne in mind that a fixed guard is simple and shall be used where access of an operation (operation without any malfunction) of the machinery.		P
	As the need for frequency of access increase this inevitably leads to the fixed guard not being replaced	This requirement is complied with	P
	This requires the use of an alternative protective measure (movable interlocking guard, sensitive protective equipment.)	Movable interlocking guard is used.	P
	A combination of safeguards may sometimes be required. For example, where, in conjunction with a fixed guard, a mechanical loading(feeding) device is used to feed a workpiece into a machine, thereby removing the need for assess to the primary hazard zone, a trip device may be requiring hazard between the secondary drawing-in or shearing hazard between the mechanical loading(feeding) device, when reachable, and the fixed guard.		N/A
	Consideration shall be given enclosure of control positions or intervention zones to provide combined protection against several hazards which may include:	This requirement has been taken into consideration.	P
	- hazards from falling or ejected objects(e.g. falling object protection structure)	No such hazards exist in this machine.	P
	- emission hazards(e.g. protection against noise, vibration, radiation , harmful substances)	No such hazards exist in this machine.	P
	- hazards due to the environment(e.g. protection against heat, cold, foul weather)	No such hazards exist in this machine.	P
	- hazards due to tipping over or rolling over of machinery(e.g. roll-over or tip-over protection structure)	No such hazards exist in this machine.	P
	The design of such enclosed work stations(e.g. cabs and cabins) shall take into account ergonomic principles concerning visibility,lighting, atmospheric conditions, access, posture.	No such hazards exist in this machine.	P
6.3.2.2	Where access to the hazard zone is not required during normal operation		-
	Where access to the hazard zone is not required during normal operation of the machinery, safeguard should be selected from the following:		-
	a) fixed guard (see also ISO 14120)	Fixed guards are provided.	P
	b) interlocking guard with or without guard locking (see also	Provided.	P

	6.3.3.2.3, ISO 14119, ISO 14120);		
	c) self-closing guard (see ISO 14120, 3.3.2)		N/A
	d) sensitive protective equipment, e.g. electro-sensitive protective equipment (see IEC 61496) or pressure sensitive mat (see ISO 13856)		N/A
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/A
	b)sensitive protective equipment, e.g electro-sensitive protective equipment (see IEC 61496)		N/A
	c)two-hand control device (see ISO 13851)		N/A
6.3.2.4	Where access to the hazard zone is required for machine setting, teaching, process changeover, fault finding, cleaning or maintenance.		-
	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/A
	Such tasks shall be identified and considered in the risk assessment as parts of the use of the machine (see 5.2)		N/A
6.3.2.5	Selection and implementation of sensitive protective equipment		-
6.3.2.5.1	Selection		-
	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/A
	The following provisions are intended to provide the designer with criteria for selecting , for each application, the most suitable device(s).		N/A
	Types of sensitive protective equipment include, e.g.:		-
	- light curtains;		N/A
	- scanning devices as, e.g. laser scanners;		N/A
	- pressure sensitive mats;		N/A
	- trip bars, trip wires.		N/A
	Sensitive protective equipment can be used:		-
	- for tripping purposes;		N/A

	- for presence sensing;		N/A
	- for both tripping and presence sensing		N/A
	- to re-initiate machine operation, a practice which is subject to stringent conditions.		N/A
	The following characteristics of the machinery, among others, can preclude the sole use of sensitive protective equipment:		N/A
	- tendency for the machinery to eject materials or component parts;		N/A
	- necessity to guard against emissions (noise, radiation, dust, etc.)		N/A
	- erratic or excessive machine stopping time;		N/A
	-inability of a machine to stop part-way through a cycle.		N/A
6.3.2.5.2	Implementation		-
	consideration should be given to :		-
	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/A
	b)reaction of the device to fault conditions (see IEC 61496 for electro-sensitive protective equipment)		N/A
	c)possibility of circumvention		N/A
	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/A
	sensitive protective equipment shall be integrated in the operative part and associated with the control system of the machine so that :		-
	- a command is given as soon as a person or part of a person is detected ;		N/A
	- the withdrawal of the person or part of a person detected does not, by itself, restart the hazardous machine function(s);therefore, the command given by the sensitive protective equipment shall be maintained by the control system until a new command is given ;		N/A
	- restarting the hazardous machine function(s) results from the voluntary actuation , by the operator, of a control device placed outside the hazard zone , where this zone can be observed by the operator ;		N/A
	-the machine cannot operate during interruption of the detection function of the sensitive protective equipment,except during muting phases ;		N/A
	- the position and the shape of detection field		N/A

	prevents,possibly together with fixed guards , a person or part of a person from entering the hazard zone ,or being present in it , without being detected .		
6.3.2.5.3	Additional requirements for sensitive protective equipment when used for cycle initiation .		-
	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/A
	Cycle initiation by sensitive protective equipment shall be subject to the following conditions :		-
	a)only active optoelectronic protective devices (AOPDs) complying with IEC 61496 series shall be used ;		N/A
	b) the requirements for an AOPD used as a tripping and presence-sensing device (see IEC 61496) are satisfied -in particular, location, minimum distance (see ISO 13855),detection capability, reliability and monitoring of control and braking systems;		N/A
	c) the cycle time of machine is short and the facility to re-initiate the machine upon clearing of the sensing field is limited to a period commensurate with a single normal cycle;		N/A
	d) entering the sensing field of the AOPD(s) or opening interlocking guards is the only way to enter the hazard zone;		N/A
	e) if there is more than one AOPD safeguarding the machine, only one of the AOPD(s) is capable of cycle re-initiation;		N/A
	f) with regard to the higher risk resulting from automatic cycle initiation, the AOPD and the associated control system comply with a higher safety-related performance than under normal conditions.		N/A
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;		P

	- locking devices		N/A
	- movement limiters or mechanical stops;		N/A
	- acceleration or deceleration limiters;		N/A
	- load limiters;		N/A
	- alarms warning of the approach to stability or tipping limits;		N/A
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/A
	- when the operator has insufficient visibility of the hazard zone;		N/A
	- when the operator lacks knowledge of the actual value of a safety-related parameter (e. g. a distance, a speed, the mass of a load, the angle of a slope)		N/A
	-when hazards may result form operation other then		N/A
	those controlled by the operator;		-
	The necessary devices include:		-
	- devices for limiting parameters of movement (distance, angle, velocity , acceleration)		N/A
	- overloading and moment limiting devices:		N/A
	- devices to prevent collisions or interference with other machines;		N/A
	-device for preventing hazards to pedestrian operators of mobile machinery or other pedestrians:		N/A
	- torque limiting devices, breakage points to prevent excessive stress of components and assemblies;		N/A
	- devices for limiting pressure. temperature;		N/A
	- devices for monitoring emissions;		N/A
	- devices prevent operation in the absence of the operator at the control position;		N/A
	- device to prevent lifting operations unless stabilizers are in place;		N/A
	- devices to ensure that components are in a safe position before traveling;		N/A
	Automatic protective measures triggered by such devices which take operation of the machinery out of the control of the operator (e.g. automatic stop of hazardous movement) should be preceded or accompanied by a warning signal to enable the operator to take appropriate action (see 6.4.3)		N/A
6.3.3	Requirements for the design of guards and protective devices		-

6.3.3.1	General requirements		-
	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
	Guards and protective devices shall :		-
	- be of robust construction.	This requirement has been taken into account during design.	P
	- not give rise to any additional hazard;	This requirement has been taken into account during design.	P
	-not be easy to by-P or render non-operational;	This requirement has been taken into account during design.	P
	-be located at an adequate distance from the danger zone (see ISO 13857 and ISO 13855).	This requirement has been taken into account during design.	P
	-cause minimum obstruction to the view of the production process:	This requirement has been taken into account during design.	P
	-enable essential work to be carried out on installation and/or replacement of tools and also for maintenance by allowing access only to the area where the work has to be done, if possible without the guard or protective device having to be moved;	This requirement has been taken into account during design.	P
	For openings in the guards see ISO 13857	This requirement has been taken into account during design.	P
6.3.3.2	Requirements for fixed guards		-
6.3.3.2.1	Functions of guards		-
	The functions that guards can achieve are:	These functions are achieved by fixed guards.	P
	-prevention of access to the space enclosed by guard and/or . -containment/capture of materials, workpieces, chips, liquids which may be ejected or dropped by the machine and reduction of emissions(noise, radiation, hazardous	These functions are achieved by fixed guards.	P

	substances such as dust, fumes, gases)which may be generated by the machine.		
	Additionally, they may need to have particular propertied relating to electricity, temperature, fire, explosion, vibration. visibility(see ISO 14120) and operator position ergonomics(e.g. usability, operator's movements, posture, repetitive movements).	These functions are achieved by fixed guards.	P
6.3.3.2.2	Requirements for fixed guards		-
	Fixed guards shall be securely held in place:		-
	- either permanently (e.g. by welding) -or by means of fasteners (screws, nuts) making removal/opening impossible without using tools; they should not remain closed without their fasteners (see ISO 14120)	All the fixed guards are securely held in place by appropriate fasteners.	P
6.3.3.2.3	Requirements for movable guards		-
	a)movable guards which provide protection against hazards generated by moving transmission parts shall:		-
	-as far as possible remain fixed to the machinery or other structure (generally by means of hinges or guides) when open;	Gemels are used for the movable guards.	P
	-be interlocking guards (with guard locking when necessary) (see ISO 14119)		N/A
	b) movable guards against hazards generated by non-transmission moving parts shall be designed and associated with the machine control system so that;		-
	- moving parts cannot start up while they are within the operator’s reach and the operator cannot reach moving parts once they have start up; this can be achieved by interlocking guards, with guard locking when necessary.	Interlocking guards are provided to comply with these requirements.	P
	- they can be adjusted only by an intentional action, such as the use of tool or a key;	This requirement is complied with.	P
	-they absence or failure of one of their components prevents starting of the moving parts or stops them; this can be achieved by automatic monitoring (see 4.11.6)	This requirement is complied with.	P
6.3.3.2.4	Requirements for adjustable guards		-
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed;		N/A
	They shall:		-
	-be designed so that the adjustment remains fixed during a given operation		N/A
	-be readily adjustable without the use of tools;		N/A
6.3.3.2.5	Requirements for interlocking guards with a start function		N/A

	(control guards)		
	An interlocking guard with a start function may be used provided that		N/A
	- all requirements for interlocking guards are satisfied (see ISO 14119)		N/A
	- the cycle time of the machine is short		N/A
	-the maximum opening time of the guard is present to a low value (e.g. equal to the cycle time). When this time is exceeded, the hazardous function(s) cannot be initiated by the closing of the interlocking guard with a tart function and resetting is necessary before restarting the machine.		N/A
	- the dimensions or shape of the machine do not allow a person, or part of a person, to stay in the hazard zone or between the hazard zone and the guard while the guard is closed (see ISO 14120)		N/A
	- all other guards whether fixed (removable type) or movable are interlocking guards;		N/A
	-the interlocking device associated with the interlocking guard with a start function is designed in such a way – e.g. by duplication of position detectors and use of automatic monitoring (see 4.11.6)- that its failure cannot lead to an unintended/unexpected start-up;		N/A
	-the guard is securely held open(e.g. by a spring or counterweight)such that it cannot initiate a start while falling by its own weight;		N/A
6.3.3.2.6	Hazards from guards		-
	Care shall be taken to prevent hazards which might be generated by:		-
	- the guard construction (e.g. sharp edges or corners, material);	This requirement has been taken into account during design.	-
	- the movements of the guards (shearing or crushing zones generated by power-operated guards and by heavy guards which are liable to fall)	This requirement has been taken into account during design.	-
6.3.3.3	Technical characteristics of protective devices		-
	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.	This requirement has been taken into account during design.	-
	Protective devices shall be selected on the basis of their having met the appropriate product standard (for example, IEC 61496 for active optoelectronic protective devices) or shall be designed according to one or several of the principles formulated in ISO 13849-1 or IEC62061.	This requirement has been taken into account during design.	-
	Protective devices shall be installed and connected to the	This requirement has	-

	control system so that they cannot be easily defeated.	been taken into account during design.	
6.3.3.4	Provisions for alternative types of safeguards.		-
	Provisions should be made to facilitate the fitting of alternative types of safeguards on machinery where it is known that this fitting will be necessary because the work to be done on it will vary.		N/A
6.3.4	Safeguarding for reducing emissions		-
6.3.4.1	General		-
	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).	No such hazard exists.	P
6.3.4.	Noise		-
	Additional protective measures include, for example: -enclosures (see ISO 15667) -screens fitted to the machine; -silencers (see ISO 14163)	No such hazard exists.	P
6.3.4.3	Vibration		-
	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.	No such hazard exists.	P
	For measures for vibration isolation of stationary industrial machinery see EN 1299	No such hazard exists.	P
6.3.4.4	Hazardous substances		-
	Additional protective measures include, for example:		-
	-encapsulation of the machine (enclosure with negative pressure);		N/A
	- local exhaust ventilation with filtration.		N/A
	- wetting with liquids;		N/A
	- special ventilation in the area of the machine (air curtains , cabins for operators)		N/A
6.3.4.5	Radiation		-
	Additional protective measures include, for example:		-
	- use of filtering and absorption;		N/A
	- use of attenuating screens or guards		N/A
6.3.5	Complementary protective measures		-
6.3.5.1	General		-
	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	It meets the requirement.	P

	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		
6.3.5.2	Components and elements to achieve the emergency stop function		-
	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:		-
	-the actuators shall be clearly identifiable, clearly visible and readily accessible	The actuators can be clearly identifiable, clearly visible and readily accessible	P
	-the hazardous process shall be stopped as quickly as possible without creating additional hazards. If this is not possible or the risk cannot be reduced, it should be questioned whether implementation of an emergency stop function is the best solution;	The hazardous process can be topped as quickly as possible without creating additional hazards	P
	-the emergency stop control shall trigger or permit the triggering of certain safeguard movements where necessary.	No this situation exists	P
	Once active operation of the emergency stop device has ceased following an emergency stop command, the effect of this command shall be sustained until it is rest.	Reset is necessary before re-start.	P
	This reset shall be possible only at that location where the emergency stop command has been initiated. The reset of the device shall not restart the machinery, but only permit restarting.	This requirement is complied with by appropriate design of the emergency stop	P
	More details for the design and selection of electrical components and elements to achieve the emergency stop function are provided in EN 60204 series.	Please see the related clauses.	P
6.3.5.3	Measures for the escape and rescue of trapped persons-		-
	Measures for the escape and rescue of trapped persons may consist e.g. of:		-
	-escape routes and shelters in installations generating operator-trapping hazards		N/A
	-arrangements for moving some elements by hand, after an emergency stop		N/A
	-arrangements for reversing the movement of some elements		N/A
	- anchorage points for descender devices;		N/A
	-means of communication to enable trapped operators to call for help		N/A
6.3.5.4	Measures for isolation and energy dissipation		-

	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:		-
	a) isolating(disconnecting,separating)the machine(or defined parts of the machine) from all power supplies;	A main switch with lock is provided.	P
	b) locking (or otherwise securing) all the isolating units in the isolating position;	Please see the report for EN 60204	P
	dissipating or , if this is not possible or practicable, restraining (containing) any stored energy which may give rise to a hazard;	Please see the report for EN 60204	P
	verifying, by means of a safe working procedure, that the actions taken according to a), b) and c) above have produced the desired effect.	Please see the report for EN 60204	P
	See ISO 14118, clause 5 and EN 60204-1: 5.5 and 5.6		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.	Appropriate attachments are provided.	P
	These attachments may be, among others,		P
	standardized lifting appliances with slings, hooks,eyebolts, or tapped holes for appliance fixing;		P
	appliances for automatic grabbing with a lifting hook when attachment is not possible from the ground.	Such devices are used.	P
	guiding grooves for machines to be transported by a fork truck;		N/A
	lifting gear and appliances integrated into the machine.		N/A
	Parts of machinery which can be removed manually in operation shall be provided with means for their safe removal and replacement; (See also 6.4.4c item 3).		P
6.3.5.6	Measures for safe access to machinery		-
	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.	These requirements have been taken into account during design.	P
	Where this is not possible, machines shall have built-in platforms, stairs or other facilities to provide safe access for those tasks ,but care should be taken to ensure that such		N/A

	platforms or stairs do not give access to danger zones of machinery.		
	The walking areas shall be made from materials which remain as slip resistant as practicable under working conditions and, depending on the height from the ground , suitable guard-rails(see ISO14122-3)shall be provided.		N/A
	In large automated installations, particular attention shall be given to safe means of access such as walkways, conveyor bridges or crossover points.		N/A
	Means of access to parts of machinery located at a height shall be provided with collective means of protection against falls(e.g. guard-rails for stairways, stepladders and platforms and/or safety cages for ladders)		N/A
	As necessary, anchorage points for personal protective equipment against falls from a height shall also be provided(e.g. in carriers of machinery for lifting persons or with elevating control stations)		N/A
	Openings shall whenever possible open towards a safe position, They shall be designed to prevent hazards due to unintended opening.		N/A
	The necessary aids for access shall be provided(e.g. steps, handholds).Control devices shall be designed and located to prevent their being used as aids for access.		N/A
	When machinery for lifting goods and/or persons includes landings at fixed levels, these shall be equipped with inter locking guards preventing falls when the platform is not present at the level.		N/A
	Movement of the lifting platform shall be prevented while the guards are open.		N/A
	For detailed provisions see ISO 14122.		N/A
	Information for use		-
6.4	General requirements		-
6.4.1	Drafting information for use is an integral part of the design of a machine(see figure2).	Please see the related clause.	P
6.4.1.1	Information of use consists of communication links, such as texts, words, signs, signals, symbols or diagrams, used separately or in combination to convey information to the user. It is directed to professional and/or non-professional users.	All the information is stated in the appropriate place.	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.		-
	The information shall contain all directions required to ensure safe and correct use of the machine. With this in	All the information is stated in the	P

	view, it shall inform and warn the user about residual risk.	appropriate place.	
	The information shall indicate, as appropriate,		-
	- the need for training,	All the information is stated in the appropriate place.	P
	- the need for personal protective equipment,	All the information is stated in the appropriate place.	P
	- the possible need for additional guards devices (see Figure 2, Footnote d).	All the information is stated in the appropriate place.	P
	It shall not exclude uses of the machine that can reasonably be expected from its designation and description and shall also warn about the risk which would result from using the machine in other ways than the ones described in the information, especially considering its reasonably foreseeable misuse.	All the information is stated in the appropriate place.	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.	All the information is stated in the appropriate place.	P
6.4.2	Location and nature of the information for use		-
	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:	All the information is stated in the appropriate place.	P
	- in /on the machine itself (see 6.3 and 6.4.4)	Adequate information stated in the machine itself.	P
	-in accompanying documents (in particular instruction handbook , see 6.4.5)	Adequate information is stated in the accompanying documents	P
	- on the packaging	Adequate information is stated on the packaging	P
	- by other means such as signals and warnings outside the machine.	Adequate information is stated	P
	Standardized phrases shall be considered where important messages such as warnings need to be given (see also IEC 62079)	This requirement is considered.	P
6.4.3	Signals and warning devices		-

	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.	Signals and warning devices are provided.	P
	Such signals may also be used to warn the operator before the triggering of automatic protective measures (see last paragraph of 5.2.7)	Please see the related clause.	P
	It is essential that these signals:		-
	- be emitted before the occurrence of the hazardous event;	This requirement is taken into account during design and selection of the warning devices.	P
	- be unambiguous;	This requirement is taken into account during design and selection of the warning devices.	P
	be clearly perceived and differentiated from all other signals used; be clearly recognized by the operator and other persons.	This requirement is taken into account during design and selection of the warning devices.	P
	The warning devices shall be designed and located such that checking is easy.	This requirement is taken into account during design and selection of the warning devices.	P
	The information for use shall prescribe regular checking of warning devices.	This requirement is taken into account during design and selection of the warning devices.	P
	The attention of designers is drawn to the risks from “sensorial saturation” which results from too many visual and/or acoustic signals, which may also lead to defeating the warning devices.	This requirement is taken into account during design and selection of the warning devices.	P
6.4.4	Markings, signs (pictograms), written warnings		-
	Machinery shall bear all markings which are necessary:		-
	a) for its unambiguous identification, at least name and address of the manufacturer; designation of series or type; serial number, if any.	Adequate information is provided.	P
	b) in order to indicate its compliance with mandatory		-

	requirements;		
	- marking; -written indications (e.g. for machines intended for use in potentially explosive atmosphere)	Adequate information is provided.	P
	c) for its safe use, e.g. :		-
	maximum speed of rotating parts; maximum diameter of tools; - mass (expressed in kilograms) of the machine itself and/or of removable parts maximum working load; necessity of wearing personal protective equipment; guard adjustment data; frequency of inspection.	Adequate information is provided.	P
	Information printed directly on the machine should be permanent and remain legible throughout the expected life of the machine.	This requirement is complied with.	P
	Signs or written warnings only saying “danger” shall not be used.	This requirement is complied with.	P
	Readily understandable signs (pictograms) should be used in preference to written warnings.	This requirement is complied with.	P
	Signs and pictograms should only be used if the are understood in the culture in which the machinery is to be used.	This requirement is complied with.	P
	Markings shall comply with recognized standards (see ISO 2972, ISO 7000, particularly for pictograms, symbols, colours) See EN 60204 series as regards marking of electrical equipment.	This requirement is complied with.	P
6.4.5	Accompanying documents (in particular, instruction handbook)		-
6.4.5.1	Contents		-
	The instruction handbook or other written instructions (e.g. on the packaging) shall contain among others:		-
	a) information relating to transport, handling and storage of the machine e.g. :	All the related information is stated in the instruction handbook	P
	- storage conditions for the machine;	All the related information is stated in the instruction handbook	P
	-dimensions , mass value(s), position of the centre (s) of gravity;	All the related information is stated in the instruction handbook	P

	-indications for handling (e.g. drawings indicating application points for lifting equipment)	All the related information is stated in the instruction handbook	P
	b) information relating to installation and commissioning of the machine, e.g.		-
	- fixing/anchoring and vibration dampening requirements	All the related information is stated in the instruction handbook	P
	- assembly and mounting conditions;	All the related information is stated in the instruction handbook	P
	- space needed for use and maintenance;	All the related information is stated in the instruction handbook	P
	- permissible environmental conditions (e.g. temperature, moisture, vibration, electromagnetic radiation);	All the related information is stated in the instruction handbook	P
	-instructions for connecting the machine to power supply (particularly about protection against electrical overloading);	All the related information is stated in the instruction handbook	P
	- advice about waste removal /disposal;	All the related information is stated in the instruction handbook	P
	-if necessary, recommendations about protective measures which have to be taken by the user; e.g. additional safeguards, safety distances, safety signs and signals.	All the related information is stated in the instruction handbook	P
	c) information relating to the machine itself, e.g. :		-
	-detailed description of the machine, its fittings, its guards and/or protective devices;	All the related information is stated in the instruction handbook	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.	All the related information is stated in the instruction handbook	P
	-diagrams (especially schematic representation of safety	All the related	P

	functions);	information is stated in the instruction handbook	
	- data about noise and vibration generated by the machine, about radiation, gases, vapours, dust emitted by it, with reference to the measuring methods used.	All the related information is stated in the instruction handbook	P
	-technical documentation about electrical equipment (see EN 60204 series)	All the related information is stated in the instruction handbook	P
	-documents attesting that the machine complies with mandatory requirements;	All the related information is stated in the instruction handbook	P
	d)information relating to the use of the machine, e.g. about:	All the related information is stated in the instruction handbook	P
	intended use; description of manual controls (actuators); setting and adjustment; modes and means for stopping (especially emergency stop) risks which could not be eliminated by the protective measures taken by the designer; 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. -reasonably foreseeable misuse and prohibited usages; fault identification and location , repair, and re-starting after an intervention; personal protective equipment which need to be usd and training required.	All the related information is stated in the instruction handbook	P
	e) information for maintenance e.g.	All the related information is stated in the instruction handbook	P
	-nature and frequency of inspections for safety functions; -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)	All the related information is stated in the instruction handbook	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) -drawings and diagrams enabling maintenance personnel to carry out their task rationally (especially fault-finding tasks) information relating to de-commissioning , dismantling and disposal; information for emergency situations , e.g. : type of fire-fighting equipment to be used. warning about possible emission or leakage of harmful substance(s), and if possible, indication of means to fight their effects.		
	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.	All the related information is stated in the instruction handbook	P
6.4.5.2	Production of the instruction handbook	All the related information is stated in the instruction handbook	P
	a) type and size of print shall ensure the best possible legibility. Safety warnings and/or cautions should be emphasized the use of colours, symbols and/or large print.	All the related information is stated in the instruction handbook	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.	All the related information is stated in the instruction handbook	P
	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.	All the related information is stated in the instruction handbook	P
	d) consideration should be given to presenting information in tabular form where this will aid understanding.Tables should be adjacent to the relevant text.	All the related information is stated in the instruction handbook	P
	e) the use of colours should be considered, particularly in relation to components requiring quick identification.	All the related information is stated in the instruction	P

		handbook	
	f) when information for use is lengthy, a table of contents and/or an index should be given.	All the related information is stated in the instruction handbook	P
	g) safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator.	All the related information is stated in the instruction handbook	P
6.4.5.3	Drafting and editing information for use		-
	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).	All the related information is stated in the instruction handbook	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.	All the related information is stated in the instruction handbook	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.	All the related information is stated in the instruction handbook	P
	d) when it is foreseen that a machine will be 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.	All the related information is stated in the instruction handbook	P
	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.	All the related information is stated in the instruction handbook	P
7	Documentation of risk assessment and risk reduction		-
	The documentation shall demonstrate the procedure that has been followed and the results that have been achieved. This includes, when relevant, documentation		-
	a)the machinery for which the risk assessment has been	See the risk	P

	made (for example, specifications, limits, intended use);	assessment report in detail.	
	b) any relevant assumptions that have been made (loads, strengths, safety factors, etc.);	See the risk assessment report in detail.	P
	c) the hazards and hazardous situations identified and the hazardous events considered in the risk assessment	See the risk assessment report in detail.	P
	d) the information on which risk assessment was based (see 5.2):	See the risk assessment report in detail.	P
	1) the data used and the sources (accident histories, experience gained from risk reduction applied to similar machinery, etc.);	See the risk assessment report in detail.	P
	2) the uncertainty associated with the data used and its impact on the risk assessment;	See the risk assessment report in detail.	P
	e) the risk reduction objectives to be achieved by protective measures;	See the risk assessment report in detail.	P
	f) the protective measures implemented to eliminate identified hazards or to reduce risk;	See the risk assessment report in detail.	P
	g) residual risks associated with the machinery;	See the risk assessment report in detail.	P
	h) the result of the risk assessment (see Figure 1);	See the risk assessment report in detail.	P
	i) any forms completed during the risk assessment.	See the risk assessment report in detail.	P

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4	General requirements		P
4.1	General		P
	This standard specifies requirements for the electrical equipment of machines. The risks associated with the hazards relevant to the electrical equipment shall be assessed as part of the overall requirements for risk assessment of the machine.This will: - identify the need for risk reduction;and - determine adequate risk reductions;and - determine the necessary protective measures for persons who can be exposed to those hazards,while still maintaining an appropriate performance of the machine and its equipment. Hazardous situations can result from,but are not limited to,the following causes: - failures or faults in the electrical equipment resulting in the possibility of electric shock, arc,or fire; - failures or faults in control circuits (or components and devices associated with those circuits)resulting in the malfunctioning of the machine; - disturbances or disruptions in power sources as well as failures or faults in the power circuits resulting in the malfunctioning of the machine; - loss of continuity of circuits that can result in a failure of a safety function,for example those that depend on sliding or rolling contacts; - electrical disturbances for example,electromagnetic,electrostatic either from outside the electrical equipment or internally generated,resulting in the malfunctioning of the machine; - release of stored energy(either electrical or mechanical)resulting in,for example,electric shock,unexpected movement that can cause injury; - acoustic noise and mechanical vibration at levels that cause health problems to persons; - surface temperatures that can cause injury. Safety measures are a combination of the measures incorporated at the design stage and those measures required to be implemented by the user. The design and development process shall identify hazards and the risks arising from them. Where the hazards cannot be removed and/or the risks cannot be sufficiently reduced by inherently safe design measures,protective measures(for example safeguarding)shall be provided to reduce the risk.Additional means (for example,awareness means)shall be provided where further risk reduction is necessary.In addition,working procedures that reduce risk can be necessary.		

	It is recommended that,where the user is known,Annex B be used to facilitate an exchange of information between the user and the supplier(s)on basic conditions and additional user specifications related to the electrical equipment. NOTE Those additional specifications can: - provide additional features that are dependent on the type of machine (or group of machines)and the application; - facilitate maintenance and repair;and - improve the reliability and ease of operation.		
4.2	Selection of equipment		P
4.2.1	General		P
	Electrical components and devices shall: - be suitable for their intended use;and - conform to relevant IEC standards where such exist;and - be applied in accordance with the supplier's instructions.		
4.2.2	Switchgear		P
	In addition to the requirements of IEC 60204-1,depending upon the machine,its intended use and its electrical equipment,the designer may select parts of the electrical equipment of the machine that are in compliance with relevant parts of the IEC61439 series (see also Annex F).		
4.3	Electrical supply		P
4.3.1	General		P
	The electrical equipment shall be designed to operate correctly with the conditions of the supply: - as specified in 4.3.2 or 4.3.3,or - as otherwise specified by the user,or - as specified by the supplier of a special source of supply(see 4.3.4)		
4.3.2	AC supplies		P
	Voltage: Steady state voltage:0,9 to 1,1 of nominal voltage. Frequency: 0,99 to 1,01 of nominal frequency continuously; 0,98 to 1,02 short time. Harmonics: Harmonic distortion not exceeding 12%of the total r.m.s.voltage between live conductors for the sum of the 2nd through to the 30th harmonic. Voltage unbalance: Neither the voltage of the negative sequence component nor the voltage of the zero sequence component in three-phase supplies exceeding 2%of the positive sequence component. Voltage interruption: Supply interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1s between successive interruptions. Voltage dips: Voltage dips not exceeding 20%of the rms voltage of the supply for more than one cycle with more than 1 s between successive dips.		
4.3.3	DC supplies		P

	From batteries: Voltage 0,85 to 1,15 of nominal voltage; 0,7 to 1,2 of nominal voltage in the case of battery-operated vehicles. Voltage interruption Not exceeding 5ms. From converting equipment: Voltage 0,9 to 1,1 of nominal voltage. Voltage interruption Not exceeding 20 ms with more than 1 s between successive interruptions. NOTE This is a variation to IEC Guide 106 to ensure proper operation of electronic equipment. Ripple(peak-to-peak) Not exceeding 0,15 of nominal voltage.		
4.3.4	Special supply systems		P
	For special supply systems(e.g.on-board generators,DC bus,etc.)the limits given in 4.3.2 and 4.3.3 may be exceeded provided that the equipment is designed to operate correctly with those conditions.		
4.4	Physical environment and operating conditions		P
4.4.1	General		P
	The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use.The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of machines covered by this part of IEC 60204.When special conditions apply or the limits specified are exceeded,an exchange of information between user and supplier(see 4.1)can be necessary.		
4.4.2	Electromagnetic compatibility (EMC)		P
	The electrical equipment shall not generate electromagnetic disturbances above levels that are appropriate for its intended operating environment.In addition,the electrical equipment shall have a sufficient level of immunity to electromagnetic disturbances so that it can function in its intended environment. NOTE The generic EMC standards IEC 61000-6-1 or IEC 61000-6-2 and IEC61000-6-3 or IEC 61000-6-4 give general EMC emission and immunity limits		
4.4.3	Ambient air temperature		P
	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature.The minimum requirement for all electrical equipment is correct operation in ambient air temperatures outside of enclosures (cabinet or box)between+5℃and+40℃.		
4.4.4	Humidity		P
	The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50%at a maximum temperature of +40℃.Higher relative humidities are permitted at lower temperatures (for example 90%at 20℃). Harmful effects of occasional condensation shall be avoided by design of the equipment or, where necessary,by additional measures(for example built-in heaters,air conditioners,drain holes).		

4.4.5	Altitude		P
	Electrical equipment shall be capable of operating correctly at altitudes up to 1000 m above mean sea level. For equipment to be used at higher altitudes,it is necessary to take into account changes in parame-ters for example,the reduction of: - the switching capability of the devices,and; - the cooling effect of the air. Other parameters of different components can also alter with altitude. It is recommended that the manufacturer is consulted regarding the correction factors to be used where the factors are not specified in product data.		
4.4.6	Contaminants		P
	Electrical equipment shall be adequately protected against the ngress of solids and liquids (see 11.3). The electrical equipment shall be adequately protected against contaminants(for example dust,acids,corrosive gases,salts)that can be present in the physical environment in which the electrical equipment is to be installed.		
4.4.7	Ionizing and non-ionizing radiation		P
	When equipment is subject to radiation (for example microwave , ultraviolet, lasers ,X-rays), additional measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation.		
4.4.8	Vibration,shock,and bump		P
	Undesirable effects of vibration,shock and bump(including those generated by the machine and its associated equipment and those created by the physical environment) shall be avoided by the selection of suitable equipment,by mounting it away from the machine,or by provision of anti-vibration mountings.		
4.5	Transportation and storage		P
	Electrical equipment shall be designed to withstand,or suitable precautions shall be taken to protect against,the effects of transportation and storage temperatures within a range of -25℃to +55℃and for short periods not exceeding 24 h at up to+70℃.Suitable means shall be provided to prevent damage from humidity, vibration, and shock. NOTE Electrical equipment susceptible to damage at low temperatures includes PVC insulated cables.		
4.6	Provisions for handling		P
	Heavy and bulky electrical equipment that has to be removed from the machine for transport, or that is independent of the machine,shall be provided with suitable means for handling, including where necessary means for handling by cranes or similar equipment.		
5	Incoming supply conductor terminations and devices for disconnecting		P

	and switching off		
5.1	Incoming supply conductor terminations		P
	It is recommended that,where practicable,the electrical equipment of a machine is connected to a single incoming supply. Where another supply is necessary for certain parts of the equipment (for example, electronic equipment that operates at a different voltage),that supply should be derived,as far as is practicable,from devices(for example,transformers, converters)forming part of the electrical equipment of the machine.For large complex machinery there can be a need for more than one incoming supply depending upon the site supply arrangements (see 5.3.1). Unless a plug is provided with the machine for the connection to the supply (see 5.3.2 e)),it is recommended that the supply conductors are terminated at the supply disconnecting device. Where a neutral conductor is used it shall be clearly indicated in the technical documentation of the machine,such as in the installation diagram and in the circuit diagram,and a separate insulated terminal,labelled N in accordance with 16.1,shall be provided for the neutral conductor.The neutral terminal may be provided as part of the supply disconnecting device. There shall be no connection between the neutral conductor and the protective bonding circuit inside the electrical equipment. Exception:a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the electrical equipment to a TN-C supply system. For machines supplied from parallel sources,the requirements of IEC 60364-1 for multiple source systems apply. Terminals for the incoming supply connection shall be clearly identified in accordance with IEC 60445.The terminal for the external protective conductor shall be identified in accordance with 5.2.		
5.2	Terminal for connection of the external protective conductor		P
	For each incoming supply,a terminal shall be provided in the same compartment as the associated line conductor terminals for connection of the machine to the external protective conductor. The terminal shall be of such a size as to enable the connection of an external protective copper conductor with a cross-sectional area determined in relation to the size of the associated line conductors in accordance with Table 1.		

	Table 1-Minimum cross-sectional area of copper protective conductors CrosS-sectional area of line conductors S mm²: Minimum crosS-sectional area of the corresponding protective conductor (PE)Sp mm² S≤16: S 16<S≤35: 16 S>35: S/2 Where an external protective conductor of a material other than copper is used,the terminal size and type shall be selected accordingly. At each incoming supply point,the terminal for connection of external protective conductor shall be marked or labelled with the letters PE (see IEC 60445)		
5.3	Supply disconnecting (isolating)device		P
5.3.1	General		P
	A supply disconnecting device shall be provided: for each incoming supply to(a)machine(s); NOTE The incoming supply can be connected directly to the supply disconnecting device of the machine or to the supply disconnecting device of a feeder system of the machine.Feeder systems of machines can include conductor wires,conductor bars,slip-ring assemblies,flexible cable systems(reeled,festooned)or inductive power supply systems. - for each on-board power supply. The supply disconnecting device shall disconnect (isolate)the electrical equipment of the machine from the supply when required (for example for work on the machine,including the electrical equipment). Where two or more supply disconnecting devices are provided,protective interlocks for their correct operation shall also be provided in order to prevent a hazardous situation,including damage to the machine or to the work in progress.		
5.3.2	Type		P
	The supply disconnecting device shall be one of the following types: switch-disconnector,with or without fuses,in accordance with IEC 60947-3,utilization category AC-23B or DC-23B; control and protective switching device suitable for isolation,in accordance with IEC 60947-6-2; a circuit-breaker suitable for isolation in accordance with IEC60947-2; any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements and the appropriate utilization category and/or specified endurance requirements defined in the product standard; a plug/socket combination for a flexible cable supply.		
5.3.3	Requirements		P

	Where the supply disconnecting device is one of the types specified in 5.3.2 a)to d)it shall fulfil all of the following requirements: - isolate the electrical equipment from the supply and have one OFF(isolated)and one ON position marked with "O"and "I"(symbols IEC 60417-5008(2002-10)and IEC 60417-5007(2002-10),see 10.2.2); - have a visible contact gap or a position indicator which cannot indicate OFF (isolated)until all contacts are actually open and the requirements for the isolating function have been satisfied; -have an operating means(see 5.3.4); - be provided with a means permitting it to be locked in the OFF (isolated)position (for example by padlocks).When so locked,remote as well as local closing shall be prevented; -disconnect all live conductors of its power supply circuit.However,for TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used)is compulsory; - have a breaking capacity sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and other loads.The calculated breaking capacity may be reduced by the use of a proven diversity factor.Where motor(s)are supplied by converter(s)or similar devices,the calculation should take into account the possible effect on the required breaking capacity. Where the supply disconnecting device is a plug/socket combination,it shall comply with the requirements of 13.4.5 and shall have the breaking capacity,or be interlocked with a switching device that has a breaking capacity,sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and other loads.The calculated breaking capacity may be reduced by the use of a proven diversity factor.Where the interlocked switching device is electrically operated (for example a contactor)it shall have an appropriate utilisation category.Where motor(s)are supplied by converter(s)or similar devices,the calculation should take into account the possible effect on the required breaking capacity. NOTE A suitably rated plug and socket-outlet,cable coupler,or appliance coupler,in accordance with IEC60309-1 can fulfi these requirements. Where the supply disconnecting device is a plug/socket combination,a switching device with an appropriate utilisation category shall be provided for switching the machine on and off. This can be achieved by the use of the interlocked switching device described above.		
5.3.4	Operating means of the supply disconnecting device		P
	The operating means (for example,a handle)of the supply		

	disconnecting device shall be external to the enclosure of the electrical equipment. Exception:power-operated switchgear need not be provided with a handle outside the enclosure where other means (e.g.pushbuttons)are provided to open the supply disconnecting device from outside the enclosure. The operating means of the supply disconnecting device shall be easily accessible and located between 0,6m and 1,9m above the servicing level.An upper limit of 1,7m is recommended. NOTE The direction of operation is given in IEC61310-3. Where the external operating means is intended for emergency operation,see 10.7.3 or 10.8.3. Where the external operating means is not intended for emergency operations: here the external operating means is intended for emergency operation,see 10.7.3 or 10.8.3. Where the external operating means is not intended for emergency operations: - it is recommended that it be coloured BLACK or GREY(see 10.2) - a supplementary cover or door that can be readily opened without the use of a key or tool may be provided,for example for protection against environmental conditions or mechanical damage.Such a cover/door shall clearly show that it provides access to the operating means.This can be achieved,for example,by use of the relevant symbol IEC60417-6169-1(2012-08)(Figure 2)or IEC 60417-6169-2 (2012-08),(Figure 3)  **Figure 2-Disconnector isolator**  **Figure 3-Disconnecting circuit breaker**		
5.3.5	Excepted circuits		P
	The following circuits need not be disconnected by the supply disconnecting device: - lighting circuits for lighting needed during maintenance or repair;		

	-socket outlets for the exclusive connection of repair or maintenance tools and equipment (for example hand drills,test equipment)(see 15.1); - undervoltage protection circuits that are only provided for automatic tripping in the event of supply failure; - circuits supplying equipment that should normally remain energized for correct operation (for example temperature controlled measuring devices,heaters,program storage devices). It is recommended,however,that such circuits be provided with their own disconnecting device. Control circuits supplied via another supply disconnecting device,regardless of whether that disconnecting device is located in the electrical equipment or in another machine or other electrical equipment,need not be disconnected by the supply disconnecting device of the electrical equipment. Where excepted circuits are not disconnected by the supply disconnecting device: -a corresponding statement shall be included in the maintenance manual,and one or more of the following shall apply: ● the conductors are identified by colour taking into account the recommendation of 13.2.4; ● excepted circuits are separated from other circuits; · excepted circuits are identified by permanent warning label(s).		
5.4	Devices for removal of power for prevention of unexpected start-up		P
	Devices for removal of power for the prevention of unexpected start-up shall be provided where a start-up of the machine or part of the machine can create a hazard (for example during maintenance).Such devices shall be appropriate and convenient for the intended use, be suitably placed,and readily identifiable as to their function and purpose.Where their function and purpose is not otherwise obvious (e.g.by their location)these devices shall be marked to indicate the extent of removal of power. NOTE 1 This part of IEC 60204 does not address all provisions for prevention of unexpected start up.Further information is provided in ISO 14118. NOTE 2 Removal of power means removal of the connection to the source of electrical energy but does not imply isolation. The supply disconnecting device or other devices in accordance with 5.3.2 may be used for prevention of unexpected start-up. Disconnectors,withdrawable fuse links and withdrawable links may be used for protection of unexpected start-up only if they are located in an enclosed electrical operating area(see 3.1.23). Devices that do not fulfil the isolation function (for example a contactor switched off by a control circuit,or Power Drive System(PDS)with a Safe Torque Off(STO)function in accordance with IEC61800-5-2)may only be used for prevention of unexpected start-up during tasks such		

	as: - inspections; - adjustments; - work on the electrical equipment where: · there is no hazard arising from electric shock (see Clause 6)and burn; ·the switching off means remains effective throughout the work; · the work is of a minor nature (for example,replacement of plug-in devices without disturbing existing wiring). The selection of a device will be dependent on the risk assessment,taking into account the intended use of the device,and the persons who are intended to operate them.		
5.5	Devices for isolating electrical equipment		P
	Devices shall be provided for isolating(disconnecting)the electrical equipment or part(s)of the electrical equipment to enable work to be carried out when it is de-energised and isolated. Such devices shallbe: - appropriate and convenient for the intended use; - suitably placed; - readily identifiable as to which part(s)or circuit(s)of the equipment is served.Where their function and purpose is not otherwise obvious(e.g.by their location)these devices shall be marked to indicate the extent of the equipment that they isolate. The supply disconnecting device (see 5.3)may,in some cases,fulfil that function.However, where it is necessary to work on individual parts of the electrical equipment of a machine,or on one of the machines fed by a common conductor bar,conductor wire or inductive power supply system,a disconnecting device shall be provided for each part,or for each machine, requiring separate isolation. In addition to the supply disconnecting device,the following devices that fulfil the isolation function may be provided for this purpose: - devices described in 5.3.2; - disconnectors,withdrawable fuse links and withdrawable links only if located in an enclosed electrical operating area (see 3.1.23)and relevant information is provided with the electrical equipment (see Clause 17).		
5.6	Protection against unauthorized,inadvertent and/or mistaken connection		P
	Where the devices described in 5.4 and 5.5 are located outside an enclosed electrical operating area they shall be equipped with means to secure them in the OFF position (disconnected state),(for example by provisions for padlocking,trapped key interlocking). When so secured,remote as well as local reconnection shall be prevented. Where the devices described in 5.4 and 5.5 are located inside an enclosed electrical operating area other means of protection against		

	reconnection (for example warning labels) can be sufficient. However,when a plug/socket combination according to 5.3.2 e)is so positioned that it can be kept under the immediate supervision of the person carrying out the work,means for securing in the disconnected state need not be provided.		
6	Protection against electric shock		P
6.1	General		P
	The electrical equipment shall provide protection of persons against electric shock by: - basic protection (see 6.2 and 6.4),and; - fault protection(see 6.3 and 6.4). The measures for protection given in 6.2,6.3,and,for PELV,in 6.4,are a selection from IEC 60364-4-41.Where those measures are not practicable,for example due to the physical or operational conditions,other measures from IEC 60364-4-41 may be used (e.g.SELV).		
6.2	Basic protection		P
6.2.1	General		P
	For each circuit or part of the electrical equipment,the measures of either 6.2.2 or 6.2.3 and, where applicable,6.2.4 shall be applied. Exception:where those measures are not appropriate,other measures for basic protection (for example by using barriers,by placing out of reach,using obstacles,using construction or installation techniques that prevent access)as defined in IEC 60364-4-41 may be applied (see also 6.2.5 and 6.2.6). Where the equipment is located in places open to all persons,which can nclude children, measures of either 6.2.2 with a minimum degree of protection against contact with live parts corresponding to IP4X or IPXXD (see IEC 60529),or 6.2.3 shall be applied.		
6.2.2	Protection by enclosures		P
	Live parts shall be located inside enclosures that provide protection against contact with live parts of at least IP2X or IPXXB(see IEC60529). Where the top surfaces of the enclosure are readily accessible,the minimum degree of protection against contact with live parts provided by the top surfaces shall be IP4X or IPXXD. under one of the following conditions: The use of a key or tool is necessary for access. NOTE 1 The useofa keyortool is intendedto restrictaccessto skilled or instructed persons(see 17.2f). All live parts,(including those on the inside of doors)that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected,shall be protected against contact to at least IP2X or IPXXB.Other live parts on the inside of doors shall be protected against unintentional direct contact to at		

	least IP1X or IPXXA. The disconnection of live parts inside the enclosure before the enclosure can be opened. This may be accomplished by interlocking the door with a disconnecting device(for example,the supply disconnecting device)so that the door can only be opened when the disconnecting device is open and so that the disconnecting device can only be closed when the door is closed. Exception:a key or tool as prescribed by the supplier can be used to defeat the interlock provided that the following conditions are met: - it is possible at all times while the interlock is defeated to open the disconnecting device and lock the disconnecting device in the OFF(isolated)position or otherwise prevent unauthorised closure of the disconnecting device; - upon closing the door,the interlock is automatically restored; -all live parts,(including those on the inside of doors)that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected,are protected against unintentional contact with live parts to at least IP2X or IPXXB and other live parts on the inside of doors are protected against unintentional contact to at least IP1X or IPXXA; - relevant information about the procedures for the defeat of the interlock is provided with the instructions for use of the electrical equipment(see Clause 17). - means are provided to restrict access to live parts behind doors that are not directly interlocked with the disconnecting means to skilled or instructed persons.(See 17.2 b)). All parts that are still live after switching off the disconnecting device(s)(see 5.3.5)shall be protected against direct contact to at least IP2X or IPXXB(see IEC 60529).Such parts shall be marked with a warning sign in accordance with 16.2.1(see also 13.2.4 for identification of conductors by colour),except for: - parts that can be live only because of connection to interlocking circuits and that are distinguished by colour as potentially live in accordance with 13.2.4; - the supply terminals of the supply disconnecting device when the latter is mounted alone in a separate enclosure. Opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against contact to at least IP2X or IPXXB (see IEC 60529).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..Where protection against contact is achieved in accordance with 6.2.2 c),and a hazard can be caused by manual actuation of devices (for example manual closing of		

	contactors or relays),such actuation should be prevented by barriers or obstacles that require a tool for their removal.		
6.2.3	Protection by insulation of live parts		P
	Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction.Such insulation shall be capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions. NOTE Paints,varnishes,lacquers,and similar products alone are generally considered to be inadequate for protection against electric shock under normal operating conditions.		
6.2.4	Protection against residual voltages		P
	Live parts having a residual voltage greater than 60V when the supply is disconnected shall be discharged to 60Vor less within a time period of 5s provided that this rate of discharge does not interfere with the proper functioning of the equipment.Exempted from this requirement are components having a stored charge of 60μC or less.Where this specified rate of discharge would interfere with the proper functioning of the equipment,a durable warning notice drawing attention to the hazard and stating the delay required before the enclosure may be opened shall be displayed at an easily visible location on or immediately adjacent to the enclosure that contains the live parts. In the case of plugs or similar devices,the withdrawal of which results in the exposure of conductors(for example pins),the discharge time to 60V shall not exceed 1 s,otherwise such conductors shall be protected to at least IP2X or IPXXB.If neither a discharge time of 1s nor a protection of at least IP2X or IPXXB can be achieved (for example in the case of removable collectors on conductor wires,conductor bars,or slip-ring assemblies,see 12.7.4), additional switching devices or an appropriate warning,for example a warning sign drawing attention to the hazard and stating the delay required shall be provided.When the equipment is located in places open to all persons,which can include children,warnings are not sufficient and therefore a minimum degree of protection against contact with live parts to IP4X or IPXXD is required. NOTE Frequencyconvertersand DCbussuppliescould havetypically a longer dischargetime than 5s.		
6.2.5	Protection by barriers		P
	For protection by barriers,the requirements of IEC 60364-4-41 shall apply.		
6.2.6	Protection by placing out of reach or protection by obstacles		P
	For protection by placing out of reach,the requirements of IEC 60364-4-41 shall apply.For protection by obstacles,the requirements of IEC60364-4-41 shall apply. For conductor wire systems or conductor bar systems with a degree of		

	protection less than IP2X or IPXXB,see 12.7.1.		
6.3	Fault protection		P
6.3.1	General		P
	Fault protection (3.31)is intended to prevent hazardous situations due to an insulation fault between live parts and exposed conductive parts. For each circuit or part of the electrical equipment,at least one of the measures in accordance with 6.3.2 to 6.3.3 shall be applied: - measures to prevent the occurrence of a touch voltage (6.3.2);or - automatic disconnection of the supply before the time of contact with a touch voltage can become hazardous (6.3.3). NOTE 1 The risk of harmful physiological effects from touch voltages depends upon a number of factors.These include but are not limited to;value of touch voltage,duration of possible exposure,environmental factors,skin condition@ NOTE 2 IEC61140 provides information about classes of equipment and protective provisions.		
6.3.2	Prevention of the occurrence of a touch voltage		P
6.3.2.1	General		P
	Measures to prevent the occurrence of a touch voltage include the following: - provision of class ll equipment or by equivalent insulation; - electrical separation.		
6.3.2.2	Protection by provision of class ll equipment or by equivalent insulation		P
	This measure is intended to prevent the occurrence of touch voltages on the accessible parts through a fault in the basic insulation. This protection is provided by one or more of the following: - class ll electrical devices or apparatus(double insulation,reinforced insulation or by equivalent insulation in accordance with IEC61140); - switchgear and controlgear assemblies having total insulation in accordance with IEC61439-1; - supplementary or reinforced insulation in accordance with IEC60364-4-41.		
6.3.2.3	Protection by electrical separation		P
	Electrical separation of an individual circuit is intended to prevent a touch voltage through contact with exposed conductive parts that can be energized by a fault in the basic insulation of the live parts of that circuit. For this type of protection,the requirements of IEC 60364-4-41 apply.		
6.3.3	Protection by automatic disconnection of supply		P
	Automatic disconnection of the supply of any circuit affected by an insulation fault is intended to prevent a hazardous situation resulting from a touch voltage. This measure consists of the interruption of one or more of the line conductors by the automatic operation of a protective device in case of		

	a fault.This interruption shall occur within a sufficiently short time to limit the duration of a touch voltage to a time within the limits specified in Annex A for TN and TT systems. This measure necessitates co-ordination between: - the type of supply system,the supply source impedance and the earthing system; current paths through the protective bonding circuit; - the characteristics of the protective devices that detect insulation fault(s) NOTE 1 Details of verification of conditions for protection by automatic disconnection of supply are provided in 18.2. This protective measure comprises both: - protective bonding of exposed conductive parts (see 8.2.3), - and one of the following: In TN systems,the following protective devices may be used: NOTE 2 The preventive maintenance can be enhanced by use of a residual current monitoring device, RCM,complying with IEC 62020. in TT systems,either: ·RCDs and associated overcurrent protective device(s)to initiate the automatic disconnection of the supply on detection of an insulation fault from a live part to exposed conductive parts or to earth,or · overcurrent protective devices may be used for fault protection provided a suitably low value of the fault loop impedance Zs(see A.2.2.3)is permanently and reliably assured; NOTE 3 The preventive maintenance can be enhanced by use of a residual current monitoring device, RCM,compying with IEC62020. In IT systems the relevant requirements of IEC 60364-4-41 shall be fulfilled.During an insulation fault,an acoustic and optical signal shall be sustained.After annunciation, the acoustic signal may then be manually muted.This can require an agreement between the supplier and user regarding the provision of insulation monitoring devices and/or insulation fault location system(s). NOTE 4 In large machines,the provision of an insulation fault location system(IFLS)in accordance with IEC61557-9 can facilitate maintenance. Where automatic disconnection is provided in accordance with a),and disconnection within the time specified in A.1.1 cannot be assured,supplementary protective bonding shall be provided as necessary to meet the requirements of A.1.3. Where a power drive system (PDS)is provided,fault protection shall be provided for those circuits of the power drive system that are supplied by the converter.Where this protection is not provided within the converter,the necessary protection measures shall be in accordance with the converter manufacturer's instructions.		
6.4	Protection by the use of PELV		P
6.4.1	General requirements		P

	The use of PELV(Protective Extra-Low Voltage)is to protect persons against electric shock from indirect contact and limited area direct contact(see 8.2.1). PELV circuits shall satisfy all of the following conditions: the nominal voltage shall not exceed: · 25V AC r.m.s.or 60 V ripple-free DC 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 · 6VAC r.m.s.or 15V ripple-free DC in all other cases; NOTE "Ripple-free"is conventionally defined for a sinusoidal ripple voltage as a ripple content of not more than 10%r.m.s. one side of the circuit or one point of the source of the supply of that circuit shall be connected to the protective bonding circuit; live parts of PELV circuits shall be electrically separated from other live circuits.Electrical separation shall be not less than that required between the primary and secondary circuits of a safety isolating transformer(see IEC61558-1 and IEC61558-2-6); conductors of each PELV circuit shall be physically separated from those of any other circuit.When this requirement is impracticable,the insulation provisions of 13.1.3 shall apply; plugs and socket-outlets for a PELV circuit shall conform to the following: · plugs shall not be able to enter socket-outlets of other voltage systems; · socket-outlets shall not admit plugs of other voltage systems.		
6.4.2	Sources for PELV		P
	The source for PELV shall be one of the following: - a safety isolating transformer in accordance with IEC61558-1 and IEC61558-2-6; -a source of current providing a degree of safety equivalent to that of the safety isolating transformer(for example a motor generator with winding providing equivalent isolation); - an electrochemical source (for example a battery)or another source independent of a higher voltage circuit (for example a diesel-driven generator); - an electronic power supply conforming to appropriate standards specifying measures to be taken to ensure that,even in the case of an internal fault,the voltage at the outgoing terminals cannot exceed the values specified in 6.4.1. This Clause 7 details the measures to be taken to protect equipment against the effects of: - overload and/or loss of cooling of motors; - abnormal temperature; - loss of or reduction in the supply voltage; - overspeed of machines/machine elements; -earth fault/residual current; -incorrect phase sequence; -overvoltage		

	due to lightning and switching surges.		
7	Protection of equipmen		P
7.1	General		P
	his Clause 7 details the measures to be taken to protect equipment against the effects of: - overcurrent arising from a short-circuit; - overload and/or loss of cooling of motors; - abnormal temperature; - loss of or reduction in the supply voltage; - overspeed of machines/machine elements; - earth fault/residual current; - incorrect phase sequence; - overvoltage due to lightning and switching surges.		
7.2	Overcurrent protection		P
7.2.1	General		P
	Overcurrent protection shall be provided where the current in any circuit can exceed either the rating of any component or the current carrying capacity of the conductors,whichever is the lesser value.The ratings or settings to be selected are detailed in 7.2.10.		
7.2.2	Supply conductors		P
	Unless otherwise specified by the user,the supplier of the electrical equipment is not responsible for providing the supply conductors and the overcurrent protective device for the supply conductors to the electrical equipment. The supplier of the electrical equipment shall state in the installation documents the data necessary for conductor dimensioning (including the maximum cross-sectional area of the supply conductor that can be connected to the terminals of the electrical equipment)and for selecting the overcurrent protective device (see 7.2.10 and 17).		
7.2.3	Power circuits		P
	Devices for detection and interruption of overcurrent,selected in accordance with 7.2.10,shall be applied to each live conductor including circuits supplying control circuit transformers. The following conductors,as applicable,shall associated live conductors: not be disconnected without disconnecting all - the neutral conductor of AC power circuits; - the earthed conductor of DC power circuits; - DC power conductors bonded to exposed conductive parts of mobile machines. Where the cross-sectional area of the neutral conductor is at least equal to or equivalent to that of the line conductors,it is not necessary to provide overcurrent detection for the neutral conductor nor a disconnecting device for that conductor.For a neutral conductor with a cross- sectional area smaller than that of the associated line		

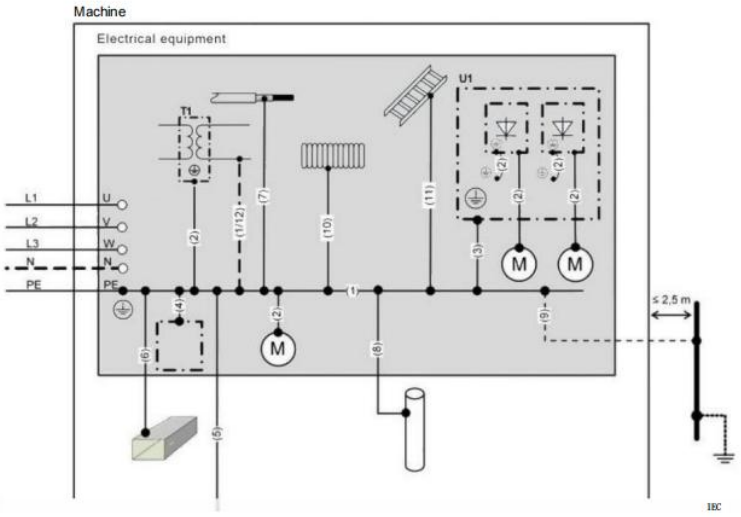
	conductors,the measures detailed in 31.2.2 of IEC 60364-4-43:2008 shall apply.		
7.2.4	Control circuits		P
	Conductors of control circuits directly connected to the supply voltage shall be protected against overcurrent in accordance with 7.2.3. Conductors of control circuits supplied by a transformer or DC supply shall be protected against overcurrent (see also 9.4.3.1.1): protective device into the switched conductor; - in control circuits not connected to the protective bonding circuit; ·where all control circuits of the equipment have the same current carrying capacity,by inserting an overcurrent protective device into the switched conductor,or; ·where different control circuits of the equipment have different current carrying capacity,by inserting an overcurrent protective device into both switched and common conductors of each control circuit. Exception: Where the supply unit provides current limiting below the current carrying capacity of the conductors in a circuit and below the current rating of connected components,no separate overcurrent protective device is required.		
7.2.5	Socket outlets and their associated conductors		P
	Overcurrent protection shall be provided for the circuits feeding the general purpose socket outlets intended primarily for supplying power to maintenance equipment.Overcurrent protective devices shall be provided in the unearthed live conductors of each circuit feeding such socket outlets.See also 15.1.		
7.2.6	Lighting circuits		P
	All unearthed conductors of circuits supplying lighting shallbe protected against the effects of short-circuits by the provision of overcurrent devices separate from those protecting other circuits.		
7.2.7	Transformers		P
	Transformers shall be protected by an overcurrent protective device having a type and setting in accordance with the transformer manufacturer's instructions.Such protection shall(see also 7.2.10): - avoid nuisance tripping due to transformer magnetizing inrush currents; - avoid a winding temperature rise in excess of the permitted value for the insulation class of transformer when it is subjected to the effects of a short-circuit at its secondary terminals.		
7.2.8	Location of overcurrent protective devices		P
	An overcurrent protective device shall be located at the point where a reduction in the cross- sectional area of the conductors or another change reduces the current-carrying capacity of the conductors,except where all the following conditions are satisfied: -the current carrying		

	capacity of the conductors is at least equal to that of the load; -the part of the conductor(s)between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is no longer than 3m; -the conductors are installed in such a manner as to reduce the possibility of a short- circuit,for example,protected by an enclosure or duct.		
7.2.9	Overcurrent protective devices		P
	The rated short-circuit breaking capacity shall be at least equal to the prospective fault current at the point of installation.Where the short-circuit current to an overcurrent protective device can include additional currents other than from the supply (for example from motors, from power factor correction capacitors),those currents shall be taken into consideration. NOTE Information on co-ordination under short-circuit conditions between a circuit-breaker and another short- circuit protective device is provided in Annex A of IEC 60947-2:2006,IEC 60947-2:2006/AMD1:2009 and IEC 60947-2:2006/AMD2:2013. 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.		
7.2.10	Rating and setting of overcurrent protective devices		P
	The rated current of fuses or the setting current of other overcurrent protective devices shall be selected as low as possible but adequate for the anticipated overcurrents(for example during starting of motors or energizing of transformers).When selecting those protective devices,consideration shall be given to the protection of switching devices against damage due to overcurrents. The rated current or setting of an overcurrent protective device for conductors is determined by the current carrying capacity of the conductors to be protected in accordance with 12.4, Clause D.3 and the maximum allowable interrupting time t in accordance with Clause D.4, taking into account the needs of co-ordination with other electrical devices in the protected circuit.		
7.3	Protection of motors against overheating		P
7.3.1	General		P
	Protection of motors against overheating shall be provided for each motor rated at more than 0,5 kW. Exception:In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps),the means of detection shall give a warning signal to which the operator can respond. Protection of motors against overheating can be achieved by: - overload protection(7.3.2), NOTE 1 Overload protective devices detect the time and current relationships(I21)in a circuit that are in excess ofther ated fullload of		

	the circuit and initiate appropriate control responses. - over-temperature protection (7.3.3),or NOTE2Temperaturedetectiondevicessenseover-temperatureand initiateappropriate control responses. Automatic restarting of any motor after the operation of protection against overheating shall be prevented where this can cause a hazardous situation or damage to the machine or to the work in progress.		
7.3.2	Overload protection		P
	Where overload protection is provided,detection of overload(s)shall be provided in each live conductor except for the neutral conductor. However,where the motor overload detection is not used for cable overload protection(see also Clause D.2),detection of overload may be omitted in one of the live conductors.For motors having single-phase or DC power supplies,detection in only one unearthed live conductor is permitted. Where overload protection is achieved by switching off,the switching device shall switch off all live conductors.The switching of the neutral conductor is not necessary for overload protection. Where motors with special duty ratings are required to start or to brake frequently(for example,motors for rapid traverse,locking,rapid reversal,sensitive drilling)it can be difficult to provide overload protection with a time constant comparable with that of the winding to be protected.Appropriate protective devices designed to accommodate special duty motors or over-temperature protection (see 7.3.3)can be necessary. For motors that cannot be overloaded (for example torque motors,motion drives that either are protected by mechanical overload protection devices or are adequately dimensioned), overload protection is not required.		
7.3.3	Over-temperature protection		P
	The provision of motors with over-temperature protection in accordance with IEC 60034-11 is recommended in situations where the cooling can be impaired (for example dusty environments).Depending upon the type of motor,protection under stalled rotor or loss of phase conditions is not always ensured by over-temperature protection,and additional protection should then be provided. Over-temperature protection is also recommended for motors that cannot be overloaded(for example torque motors,motion drives that are either protected by mechanical overload protection devices or are adequately dimensioned),where the possibility of over-temperature exists (for example due to reduced cooling)		
7.4	Protection against abnormal temperature		P
	Equipment shall be protected against abnormal temperatures that can result in a hazardous situation.		

7.5	Protection against the effects of supply interruption or voltage reduction and subsequent restoration		P
	Where a supply interruption or a voltage reduction can cause a hazardous situation,damage to the machine,or to the work in progress,undervoltage protection shall be provided by,for example,switching off the machine at a predetermined voltage level. Where the operation of the machine can allow for an interruption or a reduction of the voltage for a short time period,delayed undervoltage protection may be provided.The operation of the undervoltage device shall not impair the operation of any stopping control of the machine. Upon restoration of the voltage or upon switching on the incoming supply,automatic or unexpected restarting of the machine shall be prevented where such a restart can cause a hazardous situation. Where only a part of the machine or of the group of machines working together in a co- ordinated manner is affected by the voltage reduction or supply interruption,the undervoltage protection shall initiate appropriate control commands to ensure co-ordination.		
7.6	Motor overspeed protection		P
	Overspeed protection shall be provided where overspeeding can occur and could possibly cause a hazardous situation taking into account measures in accordance with 9.3.2. Overspeed protection shall initiate appropriate control responses and shall prevent automatic restarting. The overspeed protection should operate in such a manner that the mechanical speed limit of the motor or its load is not exceeded. NOTE This protection can consist,for example,of a centrifugal switch or speed limit monitor.		
7.7	Additional earth fault/residual current protection		P
	In addition to providing overcurrent protection for automatic disconnection as described in 6.3, earth fault/residual current protection can be provided to reduce damage to equipment due to earth fault currents less than the detection level of the overcurrent protection. The setting of the devices shall be as low as possible consistent with correct operation of the equipment. If fault currents with DC components are possible,an RCD of type B in accordance with IEC TR 60755 can be required.		
7.8	Phase sequence protection		P
	Where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine,protection shall be provided. NOTE Conditions of use that can lead to an incorrect phase sequence include: - a machine transferred from one supply to another; - a mobile machine with a facility for connection to an external power supply.		

7.9	Protection against overvoltages due to lightning and to switching surge		P
	Surge protective devices(SPDs) can be provided to protect against the effects of overvoltages due to lightning or to switching surges. - SPDs for the suppression of overvoltages due to lightning shall be connected to the incoming terminals of the supply disconnecting device. - SPDs for the suppression of overvoltages due to switching surges shall be connected as necessary for equipment requiring such protection. NOTE 1 Information about the correct selection and installation of SPDs is given for example in IEC 60364-4-44, IEC60364-5-53,IEC61643-12,IEC 62305-1 and IEC62305-4. NOTE 2 Equipotential bonding of the machine,its electrical equipment and extraneous-conductive-parts to a common bonding network of the building/site can help mitigate electromagnetic interference,including the effects of lightning,on the equipment.		
7.10	Short-circuit current rating		P
	The short-circuit current rating of the electrical equipment shall be determined.This can be done by the application of design rules or by calculation or by test.		
8	Equipotential bonding		P
8.1	General		P
	This Clause 8 provides requirements for protective bonding and functional bonding.Figure 4 illustrates those concepts. Protective bonding is a basic provision for fault protection to enable protection of persons against electric shock(see 6.3.3 and 8.2). The objective of functional bonding (see 8.4)is to reduce: - the consequence of an insulation failure which could affect the operation of the machine; - electrical disturbances to sensitive electrical equipment which could affect the operation of the machine; - induced currents from lightning which could damage the electric equipment. Functional bonding s achieved by connection to the protective bonding circuit,but where the level of electrical disturbances on the protective bonding circuit is not sufficiently low for proper functioning of electrical equipment,it can be necessary to use separate conductors for protective bonding .		



Protective bonding circuit:	
(1)	Interconnection of protective conductor(s)and the PE terminal
(2)	Connection of exposed conductive parts
(3)	Protective conductor connected to an electrical equipment mounting plate used as a protective conductor
(4)	Connection of conductive structural parts of the electrical equipment
(5)	Conductive structural parts of the machine
Parts connected to the protective bonding circuit which are not to be used as protective conductor:	
(6)	Metal ducts of flexible or rigid construction
(7)	Metalic cable sheaths or armouring
(8)	Metalic pipes containing flammable materials
(9)	Extraneous-conductive-parts, if earthed independently from the power supply of the machine and liable to introduce a potential, generally the earth potential, (see 17.2 d)), e.g.: metallic pipes, fences, ladders, handrails.
(10)	Flexible or pliable metal conduits
(11)	Protective bonding of support wires, cables tray and cable ladders
Connections to the protective bonding circuit for functional reasons:	
(12)	Functional bonding
Legend to reference designations:	
T1	Auxiliary transformer
U1	Mounting plate of electrical equipment

Figure 4-Example of equipotential bonding for electrical equipment of a machine

8.2	Protective bonding circuit		P
8.2.1	General		P
	The protective bonding circuit consists of the interconnection of: · PE terminal(s)(see 5.2); · the protective conductors (see 3.1.51)in the equipment of the machine including sliding contacts where they are part of the circuit; · the conductive structural parts and exposed conductive parts of the electrical equipment; Exception:see 8.2.5. · conductive structural parts of the machine. All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses that can be caused by earth fault currents that could flow in that part of the protective bonding circuit. The cross-sectional area of every protective conductor which does not form part of a cable or which is not in a common enclosure with the line conductor shall be not less than -2,5 mm²Cu or 16 mm²Al if protection against mechanical		

	damage is provided, -4mm²Cu or 16 mm²Al if protection against mechanical damage is not provided. NOTE The use of steel for a protective conductor is not excluded. A protective conductor not forming part of a cable is considered to be mechanically protected if it is installed in a conduit,trunking or protected in a similar way.Conductive structural parts of equipment in accordance with 6.3.2.2 need not be connected to the protective bonding circuit.Conductive structural parts of the machine need not be connected to the protective bonding circuit where all the equipment provided is in accordance with 6.3.2.2. Exposed conductive parts of equipment in accordance with 6.3.2.3 shall not be connected to the protective bonding circuit. It is not necessary to connect exposed conductive parts to the protective bonding circuit where those parts are mounted so that they do not constitute a hazard because: - they cannot be touched on large surfaces or grasped with the hand and they are small in size (less than approximately 50 mm×50 mm);or - they are located so that either contact with live parts,or an insulation failure,is unlikely. This applies to small parts such as screws,rivets,and nameplates and to parts inside an enclosure,irrespective of their size (for example electromagnets of contactors or relays and mechanical parts of devices).		
8.2.2	Protective conductors		P
	Protective conductors shall be identified in accordance with 13.2.2. Copper conductors are preferred.Where a conductor material other than copper is used,its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm²in cross-sectional area for reasons of mechanical durability. Metal enclosures or frames or mounting plates of electrical equipment,connected to the protective bonding circuit,may be used as protective conductors if they satisfy the following three requirements: · their electrical continuity shall be assured by construction or by suitable connection so as to ensure protection against mechanical,chemical or electrochemical deterioration; · they comply with the requirements of 543.1 of IEC 60364-5-54:2011; · they shall permit the connection of other protective conductors at every predetermined tap-off point. The cross-sectional area of protective conductors shall either be calculated in accordance with 543.1.2 of IEC 60364-5-54:2011,or selected in accordance with Table 1(see 5.2).See also 8.2.6.and 17.2(d)of this document. Each protective conductor shall: · be part of a multicore cable,or;		

	· be in a common enclosure with the line conductor,or; · have a cross-sectional area of at least; · 2,5 mm²Cu or 16 mm²Al if protection against mechanical damage is provided; ·4 mm²Cu or 16 mm²Al if protection against mechanical damage is not provided. NOTE 1 The use of steel for a protective conductor is not excluded. A protective conductor not forming part of a cable is considered to be mechanically protected if it is installed in a conduit,trunking or protected in a similar way. The following parts of the machine and its electrical equipment shall be connected to the protective bonding circuit but shall not be used as protective conductors: · conductive structural parts of the machine; ·metal ducts of flexible or rigid construction; · metallic cable sheaths or armouring; · metallic pipes containing flammable materials such as gases,liquids,powder. · flexible or pliable metal conduits; · constructional parts subject to mechanical stress in normal service; · flexible metal parts;support wires;cable trays and cable ladders. NOTE 2 Information on cathodic protection is provided in 542.2.5 and 542.2.6 of IEC 60364-5-54:2011.		
8.2.3	Continuity of the protective bonding circuit		P
	Where a part is removed for any reason(for example routine maintenance),the protective bonding circuit for the remaining parts shall not be interrupted. Connection and bonding points shall be so designed that their current-carrying capacity is not impaired by mechanical,chemical,or electrochemical influences.Where enclosures and conductors of aluminium or aluminium alloys are used,particular consideration should be given to the possibility of electrolytic corrosion . Where the electrical equipment is mounted on lids,doors,or cover plates,continuity of the protective bonding circuit shall be ensured and a protective conductor (see 8.2.2)is recommended.Where a protective conductor is not provided,fastenings,hinges or sliding contacts designed to have a low resistance shall be used (see 18.2.2,Test 1). The continuity of conductors in cables that are exposed to damage (for example flexible trailing cables)shall be ensured by appropriate measures (for example monitoring) For requirements for the continuity of conductors using conductor wires,conductor bars and slip-ring assemblies,see 12.7.2. Exception:links that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area may be provided for test or measurement purposes. Where the continuity of the protective bonding circuit can be interrupted by means of removable current collectors or plug/socket combinations,the protective bonding circuit shall be interrupted by a		

	first make last break contact.This also applies to removable or withdrawable plug-in units (see also 13.4.5).		
8.2.4	Protective conductor connecting points		P
	All protective conductors shall be terminated in accordance with 13.1.1.The protective conductor connecting points are not intended,for example,to attach appliances or parts. Each protective conductor connecting point shall be marked or labelled as such using the symbol IEC60417-5019:2006-08 as illustrated in Figure 5:  **Figure 5-Symbol IEC 60417-5019:Protective earth** or with the letters PE,the graphical symbol being preferred,or by use of the bicolour combination GREEN-AND-YELLOW,or by any combination of these.		
8.2.5	Mobile machines		P
	On mobile machines with on-board power supplies,the protective conductors,the conductive structural parts of the electrical equipment,and those extraneous-conductive-parts which form the structure of the machine shall all be connected to a protective bonding terminal to provide protection against electric shock.Where a mobile machine is also capable of being connected to an external incoming power supply,this protective bonding terminal shall be the connection point for the external protective conductor. NOTE When the supply of electrical energy is self-contained within stationary,mobile,or movable items of equipment,and when there is no external supply connected (for example when an on-board battery charger is not connected),there is no need to connect such equipment to an external protective conductor. Where electrical equipment has an earth leakage current that is greater than 10 mA AC or DC in any protective conductor,one or more of the following conditions for the integrity of each section of the associated protective bonding circuit that carries the earth leakage current shall be satisfied: the protective conductor is completely enclosed within electrical equipment enclosures or otherwise protected throughout its length against mechanical damage; the protective conductor has a cross-sectional area of at least 10 mm²Cu or 16 mm²Al; c) where the protective conductor has a cross-sectional area of less than 10 mm²Cu or 16 mm²Al,a second protective conductor of at least the same cross-sectional area is provided up to a point where the		

	protective conductor has a cross-sectional area not less than 10 mm²Cu or 16 mm²Al.This can require that the electrical equipment has a separate terminal for a second protective conductor. d) the supply is automatically disconnected in case of loss of continuity of the protective conductor; e)where a plug-socket combination is used,an industrial connector in accordance with IEC 60309 series,with adequate strain relief and a minimum protective earthing conductor cross-section of 2,5 mm²as part of a multi-conductor power cable is provided. A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6. NOTE A warning label may also be provided adjacent to the PE terminal to state that the protective conductor current exceeds 10mA.		
8.3	Measures to restrict the effects of high leakage current		P
	The effects of high leakage current can be restricted to the equipment having high leakage current by connection of that equipment to a dedicated supply transformer having separate windings.The protective bonding circuit shall be connected to exposed conductive parts of the equipment and,in addition,to the secondary winding of the transformer.The protective conductor(s)between the equipment and the secondary winding of the transformer shall comply with one or more of the arrangements described in 8.2.6.		
8.4	Functional bonding		P
	Protection against maloperation as a result of insulation failures can be achieved by connecting to a common conductor in accordance with 9.4.3.1.1. For recommendations regarding functional bonding to avoid maloperation due to electromagnetic disturbances,see 4.4.2 and Annex H. Functional bonding connecting points should be marked or labelled as such using the symbol IEC60417-5020:2002-10(see Figure 6).  **Figure6-Symbol IEC60417-5020:Frame or chassis**		
9	Control circuits and control function		P
9.1	Control circuit		P
9.1.1	Control circuit supply		
	Where control circuits are supplied from an AC source,transformers having separate windings shall be used to separate the power supply		

	from the control supply. Examples include: · low voltage power supplies in accordance with IEC61204-7 fitted with transformers having separate windings. Where several transformers are used,it is recommended that the windings of those transformers be connected in such a manner that the secondary voltages are in phase. Exception:Transformers or switch mode power supply units fitted with transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices (for example,interlock device,start/stop control station). Where DC control circuits derived from an AC supply are connected to the protective bonding circuit(see 8.2.1),they shall be supplied from a separate winding of the AC control circuit transformer or by another control circuit transformer.		
9.1.2	Control circuit voltages		P
	The nominal value of the control voltage shall be consistent with the correct operation of the control circuit. The nominal voltage of AC control circuits should preferably not exceed -230V for circuits with 50 Hz nominal frequency, - 277 V for circuits with 60 Hz nominal frequency. The nominal voltage of DC control circuits should preferably not exceed 220V. and 7.2.10.		
9.1.3	Protection		P
	Control circuits shall be provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		
9.2	Control functions		P
9.2.1	General		P
	NOTE Subclause 9.2 does not specify requirements for the devices used to implement control functions. Examples of requirements fordevices are givenin Clause 10.		
9.2.2	Categories of stop functions		P
	There are three categories of stop functions as follows: - stop category 0: stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop-see 3.1.64); - stop category 1: a controlled stop(see 3.1.14)with power available to the machine actuators to achieve the stop and then removal of power when the stop is achieved; - stop category 2: a controlled stop with power remaining available to the machine actuators. NOTE Forremovalofpoweritcan besufficient to remove the power needed to generate a torque orforce.This can be achieved by declutching,disconnecting,switching off,or by electronic means (e.g.a PDSin accordance with IEC61800 series)etc.		
9.2.3	Operation		P
9.2.3.1	General		P
	Safety functions and/or protective measures (for example		

	interlocks(see 9.3))shall be provided where required to reduce the possibility of hazardous situations. Where a machine has more than one control station,measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.		
9.2.3.2	Start		P
	Start functions shall operate by energizing the relevant circuit. The start of an operation shall be possible only when all relevant safety functions and/or protective measures are in place and are operational,except for conditions as described in 9.3.6. For those machines (for example mobile machines)where safety functions and/or protective measures cannot be applied for certain operations,starting of such operations shall be by hold-to-run controls,together with enabling devices,as appropriate. The provision of acoustic and/or visual warning signals before the starting of hazardous machine operation shall be considered during the risk assessment.Where the risk assessment determines that either or both are required the emission level of noise/light shall be suitable for the intended environment. Suitable interlocks shall be provided where necessary for correct sequential starting. In the case of machines requiring the use of more than one control station to initiate a start, each of these control stations shall have a separate manually actuated start control device. The conditions to initiate a start shall be: · all required conditions for machine operation shall be met,and · all start control devices shall be in the released (off)position,then · all start control devices shall be actuated concurrently (see 3.1.7)		
9.2.3.3	Stop		P
	Stop category 0 and/or stop category 1 and/or stop category 2 stop functions shall be provided as indicated by the risk assessment and the functional requirements of the machine (see 4.1). NOTE1 Thesupplydisconnectingdevice(see 5.3)when operated achieves a stop category 0. Stop functions shall override related start functions. Where more than one control station is provided,stop commands from any control station shall be effective when required by the risk assessment of the machine. NOTE 2 When stop functions are initiated,it can be necessary to discontinue machine functions other than motion.		
9.2.3.4	Emergency operations(emergency stop,emergency switching off)		P
9.2.3.4.1	General		P
	Emergency stop and emergency switching off are complementary protective measures that are not primary means of risk reduction for hazards(for example trapping,entanglement, electric shock or burn)at		

	a machine (see ISO 12100). This part of IEC 60204 specifies the requirements for the emergency stop and the emergency switching off functions of the emergency operations listed in Annex E,both of which are intended to be initiated by a single human action. Once active operation of an emergency stop (see 10.7)or emergency switching off (see 10.8) actuator has ceased following a stop or switching off command,the effect of this command shall be sustained until it is reset.This reset shall be possible only by a manual action at the IEC 60204-1:device where the command has been initiated.The reset of the command shall not restart the machinery but only permit restarting. It shall not be possible to restart the machinery until all emergency stop commands have been reset.It shall not be possible to reenergize the machinery until all emergency switching off commands have been reset.		
9.2.3.4.2	Emergency stop		P
	Requirements for functional aspects of emergency stop equipment are given in ISO 13850. The emergency stop shall function either as a stop category 0 or as a stop category 1.The choice of the stop category of the emergency stop depends on the results of a risk assessment of the machine. Exception:In some cases,to avoid creating additional risks,it can be necessary to perform a controlled stop and maintain the power to machine actuators even after stopping is achieved. The stopped condition shall be monitored and upon detection of failure of the stopped condition,power shall be removed without creating a hazardous situation. In addition to the requirements for stop given in 9.2.3.3,the emergency stop function has the following requirements: · it shall override all other functions and operations in all modes; ·it shall stop the hazardous motion as quickly as practicable without creating other hazards; · reset shall not initiate a restart.		
9.2.3.4.3	Emergency switching off		P
	The functional aspects of emergency switching off are given in 536.4 of IEC 60364-5-53:2001. Emergency switching off should be provided where: · basic protection(for example for conductor wires,conductor bars,slip-ring assemblies, controlgear in electrical operating areas)is achieved only by placing out of reach or by obstacles (see 6.2.6);or · there is the possibility of other hazards or damage caused by electricity. Emergency switching off is accomplished by switching off the relevant supply by electromechanical switching devices,effecting a stop category 0 of machine actuators connected to this incoming		

	supply.When a machine cannot tolerate this category 0 stop,it may be necessary to provide other measures,for example basic protection,so that emergency switching off is not necessary.		
9.2.3.5	Operating modes		P
	Each machine can have one or more operating modes(for example manual mode,automatic mode,setting mode,maintenance mode)determined by the type of machine and its application. Where machinery has been designed and constructed to allow its use in several control or operating modes requiring different protective measures and having a different impact on safety,it shall be fitted with a mode selector which can be locked in each position(for example key operated switch).Each position of the selector shall be clearly identifiable and shall correspond to a single operating or control mode. The selector may be replaced by another selection method which restricts the use of certain functions of the machinery to certain categories of operator(for example access code). Mode selection by itself shall not initiate machine operation.A separate actuation of the start control shall be required. For each specific operating mode,the relevant safety functions and/or protective measures shall be implemented. Indication of the selected operating mode shall be provided (for example the position of a mode selector,the provision of an indicating light,a visual display indication).		
9.2.3.6	Monitoring of command actions		P
	Movement or action of a machine or part of a machine that can result in a hazardous situation shall be monitored by providing,for example,overtravel limiters,motor overspeed detection, mechanical overload detection or anti-collision devices. NOTE On some manually controlled machines(for example,manual driling machine),operators provide monitoring.		
9.2.3.7	Hold-to-run controls		P
	Hold-to-run controls shall require continuous actuation of the control device(s)to achieve operation.		
9.2.3.8	Two-hand control		P
	Three types of two-hand control are defined in ISO 13851,the selection of which is determined by the risk assessment.These shall have the following features: Type I:this type requires: A Type I two-hand control device is not considered to be suitable for the initiation of hazardous operation. Type II:a Type I control requiring the release of both control devices before machine operation can be reinitiated. Type III:a Type II control requiring concurrent actuation of the control devices as follows: · it shall be necessary to actuate the control devices within a certain		

	time limit of each other,not exceeding 0,5 s; · where this time limit is exceeded,both control devices shall be released before machine operation can be initiated.		
9.2.3.9	Enabling control		P
	Enabling control (see also 10.9)is a manually activated control function interlock that: a)when activated allows a machine operation to be initiated by a separate start control,and b)when de-activated · initiates a stop function,and · prevents initiation of machine operation. Enabling control shall be so arranged as to minimize the possibility of defeating,for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated.		
9.2.3.10	Combined start and stop controls		P
	Push-buttons and similar control devices that,when operated, alternately initiate and stop motion shall only be provided for functions which cannot result in a hazardous situation.		
9.2.4	Cableless control system(CCS)		P
9.2.4.1	General requirements		P
	Subclause 9.2.4 deals with the functional requirements of control systems employing cableless (for example radio,infra-red)techniques for transmitting control signals and data between operator control station(s)and other parts of the control system(s). NOTE 1 Reference to a machine in 9.2.4 is intendedto be readas "machine or part(s)ofa machine". Where a safety function of a cCS relies on data transmission the transmission reliability shall be considered. The CCS shall have functionality and a response time suitable for the application based on the risk assessment. NOTE 2 IEC 61784-3 describes communication failures of communication networks and requirements for safety- related data transmission. NOTE 3 Further requirements for cableless control systems are under development by IEC TC 44 in draft IEC627451.		
9.2.4.2	Monitoring the ability of a cableless control system to control a machine		P
	The ability of a cableless control system (CCS) to control a machine shall be automatically monitored,either continuously or at suitable intervals.The status of this ability shall be clearly indicated (for example,by an indicating light,a visual display indication,etc.) If the communication signal is degraded in a manner that might lead to the loss of the ability of a CCS to control a machine (e.g.,reduced signal level,low battery power)a warning to the operator shall be provided before the ability of the CCS to control a machine is lost. When the ability of a CCS to control a machine has been lost for a time		

	that is determined from a risk assessment of the application,an automatic stop of the machine shall be initiated. NOTE In some cases,for example,in order to avoid this automatic stop generating an unexpected hazardous condition,it can be necessary for the machine to go to a predetermined state before stopping. Restoration of the ability of a CCS to control a machine shall not restart the machine.Restart shall require a deliberate action,for example manual actuation of a start button.		
9.2.4.3	Control limitation		P
	Measures shall be taken(e.g.coded transmission)to prevent the machine from responding to signals other than those from the intended cableless operator control station(s). Cableless operator control station(s)shall only control the intended machine(s)and shall affect only the intended machine functions.		
9.2.4.4	Use of multiple cableless operator control stations		P
	When more than one cableless operator control station is used to control a machine,then: · only one cableless operator control station shall be enabled at a time except as necessary for the operation of the machine; · transfer of control from one cableless operator control station to another shall require a deliberate manual action at the control station that has control; · during machine operation,transfer of control shall only be possible when both cableless operator control stations are set to the same mode of machine operation and/or function(s) of the machine; · transfer of control shall not change the selected mode of machine operation and/or function(s)of the machine; · each cableless operator control station that has control of the machine shall be provided with an indication that it has control(by for example,the provision of an indicating light,a visual display indication). NOTE Indications at other locations can be necessary as determined by the risk assessment.		
9.2.4.5	Portable cableless operator control stations		P
	Portable cableless operator control stations shall be provided with means(for example key operated switch,access code)to prevent unauthorized use. Each machine under cableless control should have an indication when it is under cableless control. When a portable cableless operator control station can be connected to one or more of several machines,means shall be provided on the portable cableless operator control station to select which machine(s)is to be connected.Selecting a machine to be connected shall not initiate control commands.		

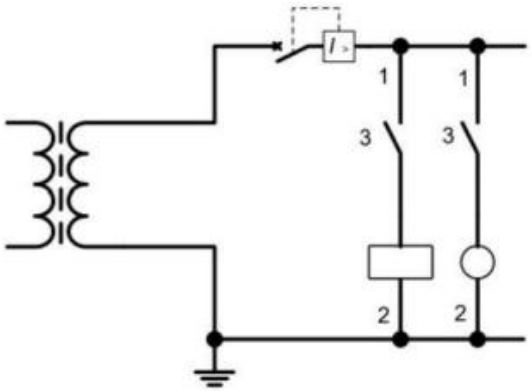
9.2.4.6	Deliberate disabling of cableless operator control stations		P
	Where a cableless operator control station is disabled when under control,the associated machine shall meet the requirements for loss of ability of a cCS to control a machine in 9.2.4.2. Where it is necessary to disable a cableless operator control station without interrupting machine operation,means shall be provided(for example on the cableless operator control station)to transfer control to another fixed or portable control station.		
9.2.4.7	Emergency stop devices on portable cableless operator control stations		P
	Emergency stop devices on portable cableless operator control stations shall not be the sole means of initiating the emergency stop function of a machine. Confusion between active and inactive emergency stop devices shall be avoided by appropriate design and information for use.See also ISO 13850.		
9.2.4.8	Emergency stop reset		P
	Restarting of cableless control after power loss,disabling and re-enabling,loss of communication,or failure of parts of the CCS shall not result in a reset of an emergency stop condition. The instructions for use shall state that the reset of an emergency stop condition initiated by a portable cableless operator control station shall only be performed when it can be seen that the reason for initiation has been cleared. Where the risk assessment show that resetting of an emergency stop actuator on the portable cableless operator control station is not adequate then one or more supplementary fixed resets shall be provided.		
9.3	Protective interlocks		P
9.3.1	Reclosing or resetting of an interlocking safeguard		P
	The reclosing or resetting of an interlocking safeguard shall not initiate hazardous machine operation. NOTE Requirements for interlocking guards with a start function(control guards)are specified in 6.3.3.2.5 of ISO 12100:2010.		
9.3.2	Exceeding operating limits		P
	Where an operating limit(for example speed,pressure,position)can be exceeded leading to a hazardous situation,means shall be provided to detect when a predetermined limit(s)is exceeded and initiate an appropriate control action.		
9.3.3	Operation of auxiliary functions		P
	The correct operation of auxiliary functions shall be checked by appropriate devices(for example pressure sensors). Where the non-operation of a motor or device for an auxiliary function(for example lubrication,supply of coolant,swarf removal)can cause a hazardous situation,or cause damage to the machine or to the work in		

	progress,appropriate interlocking shall be provided.		
9.3.4	Interlocks between different operations and for contrary motions		P
	All contactors,relays,and other control devices that control elements of the machine and that can cause a hazardous situation when actuated at the same time(for example those which initiate contrary motion),shall be interlocked against incorrect operation. Reversing contactors (for example those controlling the direction of rotation of a motor)shall be interlocked in such a way that in normal service no short-circuit can occur when switching. Where,for safety or for continuous operation,certain functions on the machine are required to be interrelated,proper co-ordination shall be ensured by suitable nterlocks.For a group of machines working together in a co-ordinated manner and having more than one controller, provision shall be made to co-ordinate the operations of the controllers as necessary. Where a failure of a mechanical brake actuator can result in the brake being applied when the associated machine actuator is energized and a hazardous situation can result,interlocks shall be provided to switch off the machine actuator.		
9.3.5	Reverse current braking		P
	Where braking of a motor is accomplished by current reversal,measures shall be provided to prevent the motor starting in the opposite direction at the end of braking where that reversal can cause a hazardous situation or damage to the machine or to the work in progress.For this purpose,a device operating exclusively as a function of time is not permitted. Control circuits shall be so arranged that rotation of a motor shaft,for example by applying a manual force or any other force causing the shaft to rotate after it has stopped,shall not result in a hazardous situation.		
9.3.6	Suspension of safety functions and/or protective measures		P
	Where it is necessary to suspend safety functions and/or protective measures (for example for setting or maintenance purposes),the control or operating mode selector shall simultaneously: · disable all other operating (control)modes; · permit operation only by the use of a hold-to-run device or by a similar control device positioned so as to permit sight of the hazardous elements; · permit operation of the hazardous elements only in reduced risk conditions(e.g.reduced speed,reduced power /force,step-by-step operation,e.g.with a limited movement control device); · prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. If these four conditions cannot be fulfilled simultaneously,the control or operating mode selector shall activate other protective measures		

	designed and constructed to ensure a safe intervention zone.In addition,the operator shall be able to control operation of the parts he is working on from the adjustment point.		
9.4	Control functions in the event of failure		P
9.4.1	General requirements		P
	Where failures or disturbances in the electrical equipment can cause a hazardous situation or damage to the machine or to the work in progress,appropriate measures shall be taken to minimize the probability of the occurrence of such failures or disturbances.The required measures and the extent to which they are implemented,either individually or in combination, depend on the level of risk associated with the respective application(see 4.1). Examples of such measures that can be appropriate include but are not limited to: · protective interlocking of the electrical circuit; · use of proven circuit techniques and components (see 9.4.2.2); · provision of partial or complete redundancy(see 9.4.2.3)or diversity (see 9.4.2.4); · provision for functional tests(see 9.4.2.5). The electrical control system(s)shall have an appropriate performance that has been determined from the risk assessment of the machine. The requirements for safety-related control functions of IEC 62061 and/or ISO 13849-1, ISO 13849-2 shall apply. Where functions performed by the electrical control system(s)have safety implications but application of IEC 62061 leads to a required safety integrity less than that required by SIL 1, compliance with the requirements of this part of IEC 60204 can lead to an adequate performance of the electrical control system(s). Where memory retention is achieved for example,by battery power,measures shall be taken to prevent hazardous situations arising from failure,undervoltage or removal of the battery. Means shall be provided to prevent unauthorized or inadvertent memory alteration by,for example,requiring the use of a key,access code or tool.		
9.4.2	Measures to minimize risk in the event of failure		P
9.4.2.1	General		P
	Measures to minimize risk in the event of failure include but are not limited to: · use of proven circuit techniques and components; · provisions of partial or complete redundancy; · provision of diversity; · provision for functional tests.		
9.4.2.2	Use of proven circuit techniques and components		P
	These measures include but are not limited to:		

	·bonding of control circuits to the protective bonding circuit for functional purposes (see 9.4.3.1.1 and Figure 4); · connection of control devices in accordance with 9.4.3.1.1; · stopping by de-energizing; ·the switching of all control circuit conductors(for example both sides of a coil)of the device being controlled; · switching devices having direct opening action(see IEC 60947-5-1); · monitoring by: - use of mechanically linked contacts (see IEC 60947-5-1); - use of mirror contacts (see IEC 60947-4-1); · circuit design to reduce the possibility of failures causing undesirable operations.		
9.4.2.3	Provisions of partial or complete redundancy		P
	By providing partial or complete redundancy,it is possible to minimize the probability that one single failure in the electrical circuit can result in a hazardous situation.Redundancy can be effective in normal operation(on-line redundancy)or designed as special circuits that take over the protective function (off-line redundancy)only where the operating function fails. Where off-line redundancy which is not active during normal operation is provided,suitable measures shall be taken to ensure that those control circuits are available when required.		
9.4.2.4	Provision of diversity		P
	The use of control circuits having different principles of operation,or using different types of components or devices can reduce the probability of hazards resulting from faults and/or failures.Examples include: - the use of a combination of normally open and normally closed contacts; - the use of different types of control devices in the circuit(s); - the combination of electromechanical and electronic equipment in redundant configurations. The combination of electrical and non-electrical systems(for example mechanical,hydraulic, pneumatic)may perform the redundant function and provide the diversity.		
9.4.2.5	Provision for functional tests		P
	Functional tests may be carried out automatically by the control system,or manually by inspection or tests at start-up and at predetermined intervals,or a combination as appropriate (see also 17.2 and 18.6).		
9.4.3	Protection against malfunction of control circuits		P
9.4.3.1	Insulation faults		P
9.4.3.1.1	General		P
	Measures shall be provided to reduce the probability that insulation		

	faults on any control circuit can cause malfunction such as unintentional starting,potentially hazardous motions,or prevent stopping of the machine. The measures to meet the requirements include but are not limited to the following methods: - method a)Earthed control circuits fed by transformers; - method b)Non-earthed control circuits fed by transformers; - method c)Control circuits fed by transformer with an earthed centre-tap winding; -method d)Control circuits not fed by a transformer.		
9.4.3.1.2	Method a)-Earthed control circuits fed by transformers		P
	The common conductor shall be connected to the protective bonding circuit at the point of supply.All contacts,solid state elements,etc.,which are intended to operate an electromagnetic or other device (for example,a relay,indicator light)are to be inserted between the switched conductor of the control circuit supply and one terminal of the coil or device.The other terminal of the coil or device is connected directly to the common conductor of the control circuit supply without any switching elements(see Figure 7)		

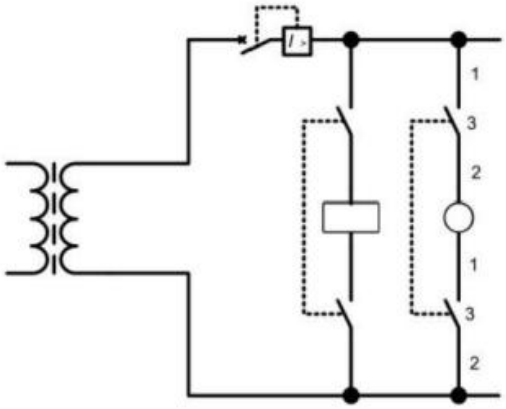


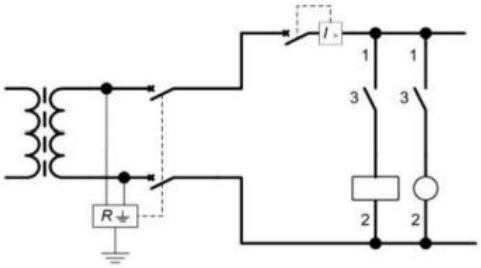
1	Switched conductors
2	Common conductors
3	Control switches

Figure 7-Method a)Earthed control circuit fed by a transformer

NOTE Method a)can be used also for DC control circuits.In this case the transformer shown in Figure 7 is substituted by a DC power supply unit.

Exception:Contacts of protective devices may be connected between the common conductor and the coils,provided that the connection is

	very short (for example in the same enclosure) so that an earth fault is unlikely(for example overload relays directly fitted to contactors).		
9.4.3.1.3	Method b)-Non-earthed control circuits fed by transformers		P
	Control circuits fed from a control transformer that is not connected to the protective bonding have 2-pole control switches that operate on both conductors,see Figure 8;or be provided with a device,for example an insulation monitoring device,that interrupts the circuit automatically in the event of an earth fault,see Figure 9;or where an interruption as per item 2 above would increase the risk,for example when continued operation is required during the first fault to earth,it can be sufficient to provide an insulation monitoring device (e.g.in accordance with IEC61557-8)that will initiate an acoustic and optical signal at the machine,see Figure 10.Requirements for the procedure to be performed by the machine user in response to this alarm shall be described in the information for use.  IEC 1 Switched conductors 2 Common conductors 3 Control switches **Figure8-Method b1)Non-earthed control circuit fed by transformer** NOTE 1 Method b1)can be used also for DC control circuits.In this case the transformer shown in Figure 8 is substitutedbya DC powersupply.		



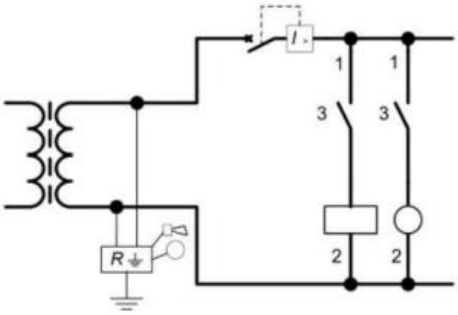
IEC

1	Switched conductors
2	Common conductors
3	Control switches

Figure 9-Method b2)Non-earthed control circuit fed by transformer

NOTE 2 Method b2)can be used also for DC control circuits.In this case the transformer shown in Figure 9 is substituted by a DC power supply.

NOTE 3 Figure 9 does not show the overcurrent protective devices in the measurement circuits for protection of the insulation monitoring device.



IEC

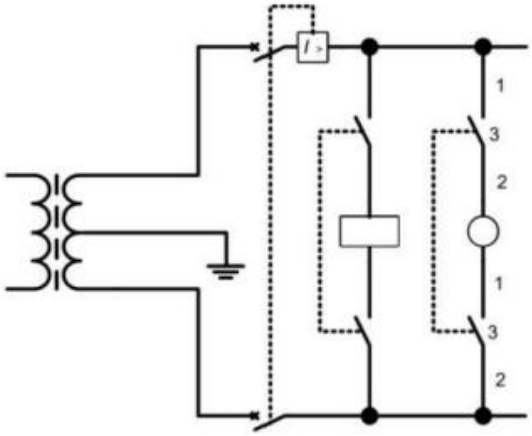
1	Switched conductors
2	Common conductors
3	Control switches

Figure 10-Method b3)Non-earthed control circuit fed by transformer

NOTE 4 Method b3)can be used also for DC control circuits.In this case the transformer shown in Figure 10 is substituted by a DC power supply.When a transformer and rectifier combination is used,the insulation monitoring device is connected to the protective bonding circuit in the DC part of the control circuit,so after the rectifier.

NOTE5 Figure 10 does not showthe overcurrent protective devices in the measurement circuits for protection of theinsulationmonitoring device.

9.4.3.1.4	windingMethod c)-Control circuits fed by transformer with an earthed		P

	centre-tap		
	Control circuits fed from a control transformer with its centre-tap winding connected to the protective bonding circuit shall have overcurrent protective devices that break both the conductors. The control switches shall be 2-pole types that operate on both conductors.  IEC 1 Switched conductors 2 Common conductors 3 Control switches **Figure 11-Method c)Control circuits fed by transformer with an earthed centre-tap winding**		
9.4.3.1.5	Method d)-Control circuits not fed by a transformer		P
	Control circuits that are not fed by a control transformer or switch mode power supply units fitted with transformers having separate windings in accordance with IEC61558-2-16 are only allowed for machines with a maximum of one motor starter and/or maximum of two control devices,in accordance with 9.1.1. Depending on the earthing of the supply system the possible cases are: 1)directly connected to an earthed supply system(TN-or TT-system)and: a)being powered between a line conductor and the neutral conductor,see Figure 12;or b)being powered between two line conductors,see Figure 13;or 2)directly connected to a supply system that is not earthed or is earthed through a high impedance (IT-system)and: a)being powered between a line conductor and the neutral conductor,see Figure 14;or b)being powered between two line conductors,see Figure 15. avoid an unintentional start in case of an earth fault.		

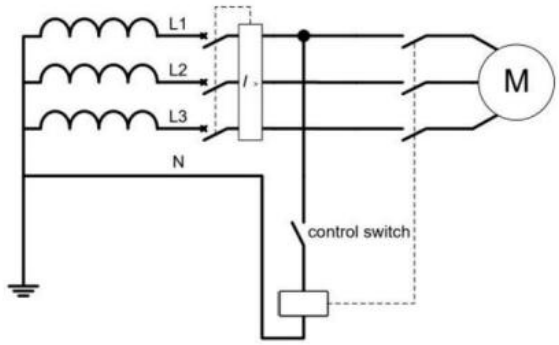


Figure 12-Method d1a)Control circuit without transformer connected between a phase and the neutral of an earthed supply system

NOTE 1 Figure 12 shows the case where the supply system is a TN system.The control circuit is the same in the caseofa TT system.

NOTE 2 Figure 12 does not show any protective devices for the power circuit and control circuit,provisions for which are stated in 6.3 and 7.2.

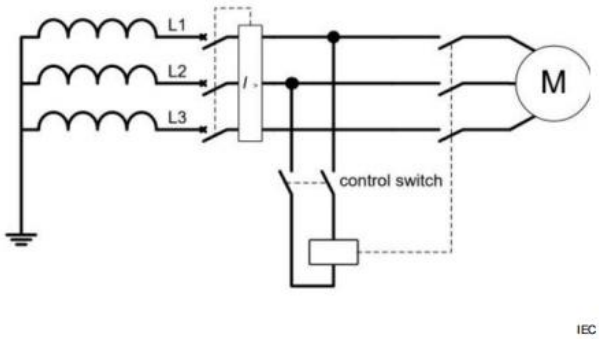


Figure 13-Method d1b)Control circuit without transformer connected between two phases of an earthed supply system

NOTE 3 Figure 13 shows the case where the supply system is a TN system.The control circuit is the same in caseofa TT system.

NOTE 4 Figure 13 does not show any necessary protective devices for power circuit and control circuit,provisions for which are stated in 6.3 and 7.2.

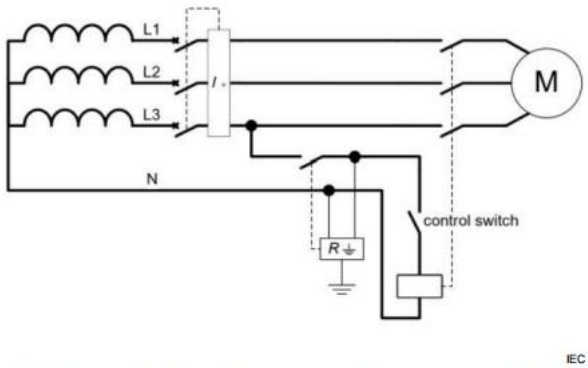
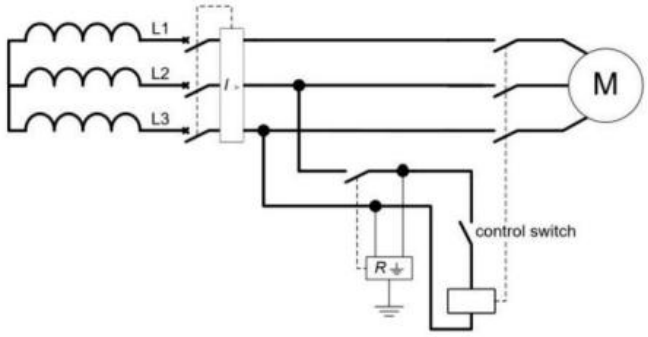


Figure 14-Method d2a)Control circuit without transformer connected between phase and neutral of a non-earthed supply system

	NOTE 5 Figure 14 does not show any necessary protective devices for the power circuit and control circuit, provisions for which are stated in 6.3 and 7.2.  IEC **Figure 15-Method d2b)control circuit without transformer connected between two phases of a non-earthed supply system** NOTE6 Figure 15 does not show any necessary protective devices for power circuit and control circuit,provisions for which are stated in 6.3 and 7.2.		
9.4.3.2	Voltage interruptions		P
	See also 7.5. Where the control system uses a memory device(s),proper functioning in the event of power failure shall be ensured (for example by using a non-volatile memory)to prevent any loss of memory that can result in a hazardous situation.		
9.4.3.3	Loss of circuit continuity		P
	Where the loss of continuity of control circuits depending upon sliding contacts can result in a hazardous situation,appropriate measures shall be taken (for example by duplication of the sliding contacts).		
10	Operator interface and machine-mounted control devices		P
10.1	General		P
10.1.1	General requirements		P
	Control devices for operator interface shall,as far as is practicable,be selected,mounted, and identified or coded in accordance with IEC61310 series. The possibility of inadvertent operation shall be minimized by,for example,positioning of devices,suitable design,provision of additional protective measures.Particular consideration shall be given to the selection,arrangement,programming and use of operator input devices such as touchscreens,keypads and keyboards for the control of hazardous machine operations,and of sensors(for example position sensors)that can initiate machine operation. Further information can be found in IEC 60447. Ergonomic principles shall be taken into account in the location of operator interface devices.		

10.1.2	Location and mounting		P
	As far as is practicable,machine-mounted control devices shall be: The actuators of hand-operated control devices shall be selected and installed so that: The actuators of foot-operated control devices shall be selected and installed so that: · they are within easy reach of the normal working position of the operator; · the operator is not placed in a hazardous situation when operating them.		
10.1.3	Protection		P
	The degree of protection(IP rating in accordance with IEC 60529)together with other appropriate measures shall provide protection against: · the effects of liquids,vapours,or gases found in the physical environment or used on the machine; · the ingress of contaminants (for example swarf,dust,particulate matter). In addition,the operator interface control devices shall have a minimum degree of protection against contact with live parts of IPXXD in accordance with IEC 60529.		
10.1.4	Position sensors		P
	Position sensors(for example position switches,proximity switches)shall be so arranged that they will not be damaged in the event of overtravel. Position sensors in circuits with safety-related control functions(for example,to maintain the safe condition of the machine or prevent hazardous situations arising at the machine)shall have direct opening action (see IEC 60947-5-1)or shall provide similar reliability (see 9.4.2).		
10.1.5	Portable and pendant control stations		P
	Portable and pendant operator control stations and their control devices shall be so selected and arranged as to minimize the possibility of machine operations caused by inadvertent actuation,shocks and vibrations(for example if the operator control station is dropped or strikes an obstruction)(see also 4.4.8).		
10.2	Actuators		P
10.2.1	Colours		P
	Actuators(see 3.1.1)shall be colour-coded as follows. The colours for START/ON actuators should preference for WHITE.RED shall not be used. be WHITE,GREY,BLACK or GREEN with a The colour RED shall be used for emergency stop and emergency switching off actuators (including supply disconnecting devices where it is foreseen that they are for use in an emergency).If a		

	background exists immediately around the actuator,then this background shall be coloured YELLOW.The combination of a RED actuator with a YELLOW background shall only be used for emergency operation devices. The colours for STOP/OFF actuators should be BLACK,GREY,or WHITE with a preference for BLACK.GREEN shall not be used.RED is permitted,but it is recommended that RED is not used near an emergency operation device. WHITE,GREY,or BLACK are the preferred colours for actuators that alternately act as START/ON and STOP/OFF actuators.The colours RED,YELLOW,or GREEN shall not be used. WHITE,GREY,or BLACK are the preferred colours for actuators that cause operation while they are actuated and cease the operation when they are released(for example hold-to-run). The colours RED,YELLOW,or GREEN shall not be used. The colour YELLOW is reserved for use in abnormal conditions,for example,in the event of an abnormal condition of the process,or to interrupt an automatic cycle. Where the same colour WHITE,GREY,or BLACK is used for various functions (for example WHITE for START/ON and for STOP/OFF actuators)a supplementary means of coding(for example shape,position,symbol)shall be used for the identification of actuators.		
10.2.2	Markings		P
	In addition to the functional identification as described in 16.3,recommended symbols to be placed near to or preferably directly on certain actuators are given in Table 2 or 3.		

Table 2-Symbols for actuators (Power)

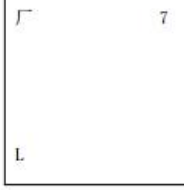
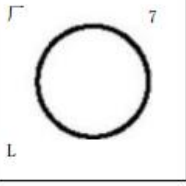
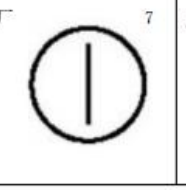
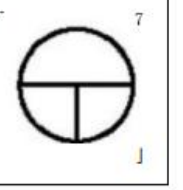
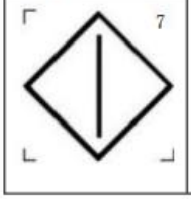
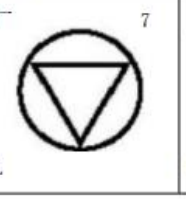
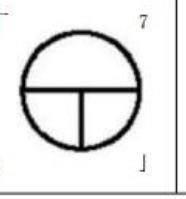
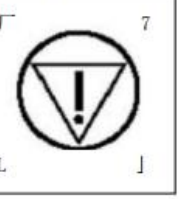
Power			
ON	OFF	ON/OFF (push on-push off)	ON (hold-to-run)
IEC 60417-5007 (2002-10)	IEC 60417-5008 (2002-10)	IEC 60417-5010 (2002-10)	IEC 60417-5011 (2002-10)
			

Table 3-Symbols for actuators (Machine operation)

Machine operation			
START	STOP	HOLD-TO-RUN	EMERGENCY STOP
IEC 60417-5104 (2006-08)	IEC 60417-5110A (2004-06)	IEC 60417-5011 (2002-10)	IEC 60417-5638 (2002-10)
			

10.3	Indicator lights and displays		P
10.3.1	General		
	Indicator lights and displays serve to give the following types of information: -indication:to attract the operator's attention or to indicate that a certain task should be performed.The colours RED,YELLOW,BLUE,and GREEN are normally used in this mode;for flashing indicator lights and displays,see 10.3.3. -confirmation:to confirm a command,or a condition,or to confirm the termination of a change or transition period.The colours BLUE and WHITE are normally used in this mode and GREEN may be used in some cases. Indicator lights and displays shall be selected and installed in such a manner as to be visible from the normal position of the operator(see also IEC61310-1). Circuits used for visual or audible devices used to warn persons of an impending hazardous event shall be fitted with facilities to check the operability of these devices.		
10.3.2	Colours		P
	Indicator lights should be colour-coded with respect to the condition (status)of the machine in accordance with Table 4.		

Table 4-Colours for indicator lights and their meanings with respect to the condition of the machine

Colour	Meaning	Explanation	Action by operator
RED	Emergency	Hazardous condition	Immediate action to deal with hazardous condition (for example switching off the machine supply,being alert to the hazardous condition and staying clear of the machine)
YELLOW	Abnormal	Abnormal condition Impending critical condition	Monitoring and/or intervention (for example by re-establishing the intended function)
BLUE	Mandatory	Indication of a condition that requires action by the operator	Mandatory action
GREEN	Normal	Normal condition	Optional
WHITE	Neutral	Other conditions;may be used whenever doubt exists about the application of RED, YELLOW, GREEN, BLUE	Monitoring

Indicating towers on machines should have the applicable colours in the following order from the top down;RED,YELLOW,BLUE,GREEN and WHITE.

10.3.3	Flashing lights and displays		P
	For further distinction or information and especially to give additional emphasis,flashing lights and displays can be provided for the following purposes: - to attract attention; - to request immediate action; -to indicate a discrepancy between the command and actual state; - to indicate a change in process (flashing during transition). It is recommended that higher flashing frequencies are used for higher priority information (see IEC 60073 for recommended flashing rates and pulse/pause ratios). Where flashing lights or displays are used to provide higher priority information,additional acoustic warnings should be considered.		
10.4	Illuminated push-buttons		P
	Iluminated push-button actuators shall be colour-coded in accordance with 10.2.1.Where there is difficulty in assigning an appropriate colour,WHITE shall be used. The colour of active emergency stop actuators shall remain RED regardless of the state of the illumination.		
10.5	Rotary control devices		P
	Devices having a rotational member,such as potentiometers and selector switches,shall have means of prevention of rotation of the stationary member.Friction alone shall not be considered sufficient.		
10.6	Start devices		P
	Actuators used to initiate a start function or the movement of machine elements (for example slides,spindles,carriers)shall be constructed and mounted so as to minimize inadvertent operation.		
10.7	Emergency stop devices		P
10.7.1	Location of emergency stop devices		P
	Devices for emergency stop shall be readily accessible.		

	Emergency stop devices shall be provided at each location where the initiation of an emergency stop can be required. There can be circumstances where confusion can occur between active and inactive shall be provided to minimise confusion.		
10.7.2	Types of emergency stop device		P
	The types of device for emergency stop include,but are not limited to: · a push-button device for actuation by the palm or the fist(e.g.mushroom head type); · a pull-cord operated switch; · a pedal-operated switch without a mechanical guard. The devices shall be in accordance with IEC 60947-5-5.		
10.7.3	Operation of the supply disconnecting device to effect emergency stop		P
	Where a stop category 0 is suitable,the supply disconnecting device may serve the function of emergency stop where: · it is readily accessible to the operator;and · it is of the type described in 5.3.2 a),b),c),or d). Where intended for emergency use,the supply disconnecting device shall meet the colour requirements of 10.2.1.		
10.8	Emergency switching off devices		P
10.8.1	Location of emergency switching off devices		P
	Emergency switching off devices shall be located as necessary for the given application. Normally,those devices will be located separate from operator control stations.Where confusion can occur between emergency stop and emergency switching off devices,means shall be provided to minimise confusion. NOTE This can be achieved by,for example,the provision of a break-glass enclosure for the emergency switching off device.		
10.8.2	Types of emergency switching off device		P
	The types of device for initiation of emergency switching off include: · a push-button operated switch with a palm or mushroom head type of actuator; · a pull-cord operated switch. The devices shall have direct opening action(see Annex K of IEC 60947-5-1:2003 and IEC 60947-5-1:2003/AMD1:2009).		
10.8.3	Local operation of the supply disconnecting device to effect emergency switching off		P
	Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and shall meet the colour requirements of 10.2.1.		
10.9	Enabling control device		P
	The enabling control function is described in 9.2.3.9. Enabling control devices shall be selected and arranged so as to minimize the possibility of defeating. Enabling control devices shall be selected that have the following features:		

	- designed in accordance with ergonomic principles; - for a two-position type: · position 1:off-function of the switch (actuator is not operated); · position 2:enabling function (actuator is operated). - for a three-position type: · position 1:off-function of the switch (actuator is not operated); · position 2:enabling function (actuator is operated in its mid position); · position 3:off-function(actuator is operated past its mid position); · when returning from position 3 to position 2,the enabling function is not activated. NOTE IEC60947-5-8 specifies requirements for three-position enabling switches.		
11	Controlgear: location, mounting, and enclosures		
11.1	General requirements		
	All controlgear shall be located and mounted so as to facilitate: - its accessibility and maintenance; - its protection against the external influences or conditions under which it is intended to operate; - operation and maintenance of the machine and its associated equipment.		
11.2	Location and mounting		P
11.2.1	Accessibility and maintenance		P
	All items of controlgear shall be placed and oriented so that they can be identified without moving them or the wiring.For items that require checking for correct operation or that are liable to need replacement,those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers,barriers or obstacles).Terminals not part of controlgear components or devices shall also conform to these requirements. All controlgear shall be mounted so as to facilitate its operation and maintenance.Where a special tool is necessary to adjust,maintain,or remove a device,such a tool shall be supplied.Where access is required for regular maintenance or adjustment,the relevant devices shall be located between 0,4 m and 2,0m above the servicing level.It is recommended that terminals be at least 0,2m above the servicing level and be so placed that conductors and cables can be easily connected to them. No devices except devices for operating,indicating,measuring,and cooling shall be mounted on doors or on access covers of enclosures that are expected to be removed. Where control devices are connected through plug-in arrangements,their association shall be made clear by type (shape),marking or reference designation,singly or in combination (see		

	13.4.5). Plug-in devices that are handled during normal operation shall be provided with non- interchangeable features where the lack of such a facility can result in malfunctioning. Plug/socket combinations that are handled during normal operation shall be located and mounted so as to provide unobstructed access. Test points for connection of test equipment,where provided,shall be: - mounted so as to provide unobstructed access; - clearly identified to correspond with the documentation; - adequately insulated; - sufficiently spaced.		
11.2.2	Physical separation or grouping		P
	Non-electrical parts and devices,not directly associated with the electrical equipment,shall not be located within enclosures containing controlgear.Devices such as solenoid valves should be separated from the other electrical equipment (for example in a separate compartment). Control devices mounted in the same location and connected to the power circuits,or to both power and control circuits,should be grouped separately from those connected only to the control circuits. Terminals shall be separated into groups for: - power circuits; -control circuits of the machine; - other control circuits,fed from external sources (for example for interlocking). The groups may be mounted adjacently,provided that each group can be readily identified (for example by markings,by use of different sizes,by use of barriers or by colours). When arranging the location of devices (including interconnections),the clearances and creepage distances specified for them by the supplier shall be maintained,taking into account the external influences or conditions of the physical environment.		
11.2.3	Heating effects		P
	The temperature rise inside electrical equipment enclosures shall not exceed the ambient temperature specified by the component manufacturers. NOTE 1 IEC TR 60890can be used for the calculation oftemperature rise inside enclosures. Heat generating components (for example heat sinks,power resistors)shall be so located that the temperature of each component in the vicinity remains within the permitted limit. NOTE 2 Information on the selection of insulating materials to resist thermal stresses is given in IEC 60216 and IEC60085.		
11.3	Degrees of protection		P
	The protection of controlgear against ingress of solid foreign objects		

	and of liquids shall be adequate taking into account the external influences under which the machine is intended to operate (i.e.the location and the physical environmental conditions)and shall be sufficient against dust,coolants,lubricants and swarf. NOTE 1 The degrees of protection against ingress of water are covered by IEC 60529.Additional protective measures can be necessary against other liquids. Exception:an enclosure providing a minimum degree of protection IP22 is not required where: an electrical operating area provides an appropriate degree of protection against ingress of solids and liquids,or: removable collectors on conductor wire or conductor bar systems are used and the measures of 12.7.1 are applied.		
11.4	Enclosures,doors and openings		P
	Enclosures shall be constructed using materials capable of withstanding the mechanical, electrical and thermal stresses as well as the effects of humidity and other environmental factors that are likely to be encountered in normal service. Fasteners used to secure doors and covers should be of the captive type. Windows of enclosures shall be of a material suitable to withstand expected mechanical stress and chemical attack. It is recommended that enclosure doors having vertical hinges be not wider than 0,9m,with an angle of opening of at least 95°. The joints or gaskets of doors,lids,covers and enclosures shall withstand the chemical effects of the aggressive liquids,vapours,or gases used on the machine.The means provided to maintain the degree of protection of an enclosure on doors,lids and covers that require opening or removal for operation or maintenance shall: · be securely attached to either the door/cover or the enclosure; · not deteriorate due to removal or replacement of the door or the cover,and so impair the degree of protection. Where openings in enclosures are provided (for example,for cable access),including those towards the floor or foundation or to other parts of the machine,means shall be provided to ensure the degree of protection specified for the equipment.Openings for cable entries shall be easy to re-open on site.A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away. There shall be no opening between enclosures containing electrical equipment and compartments containing coolant,lubricating or hydraulic fluids,or those into which oil,other liquids,or dust can penetrate.This requirement does not apply to electrical devices specifically designed to operate in oil(for example electromagnetic		

	clutches)nor to electrical equipment in which coolants are used. Where there are holes in an enclosure for mounting purposes,means may be necessary to ensure that after mounting,the holes do not impair the required protection. Equipment that,in normal or abnormal operation,can attain a surface temperature sufficient to cause a risk of fire or C detrimentalC effect to an enclosure material shall: - be located within an enclosure that will withstand,without risk of fire or harmful effect, such temperatures as can be generated;and - be mounted and located at a sufficient distance from adjacent equipment so as to allow safe dissipation of heat (see also 11.2.3);or - be otherwise screened by material that can withstand,without risk of fire or harmful effect, the heat emitted by the equipment. NOTE A warning label in accordance with 16.2.2 can be necessary.		
11.5	Access to electrical equipment		P
	Doors in gangways and for access to electrical operating areas shall: - be at least 0,7m wide and 2,0m high; - open outwards; - have a means (for example panic bolts)to allow opening from the inside without the use of a key or tool. NOTE Further information is given in IEC 60364-7-729.		
12	Conductors and cables		P
12.1	General requirements		P
	Conductors and cables shall be selected so as to be suitable for the operating conditions(for example voltage,current,protection against electric shock,grouping of cables)and external influences (for example ambient temperature,presence of water or corrosive substances, mechanical stresses(including stresses during installation),fire hazards)that can exist. These requirements do not apply to the integral wiring of assemblies,subassemblies,and devices that are manufactured and tested in accordance with their relevant IEC standard(for example IEC61800 series).		
12.2	Conductors		P
	Conductors should be of copper.Where aluminium conductors are used,the cross-sectional area shall be at least 16 mm2. To ensure adequate mechanical strength,the cross-sectional area of conductors should not be less than as shown in Table 5.However,conductors with smaller cross-sectional areas or other constructions than shown n Table 5 may be used in equipment provided adequate mechanical strength is achieved by other means and proper functioning is not impaired. Classification ofconductorsisgiven inTable D.4.		

Table 5-Minimum cross-sectional areas of copper conductors

Location	Application	Type of conductor, cable				
		Single core		Multicore		
		Flexible Class 5 or 6	Solid (class 1)or stranded (class 2)	Two core, shielded	Two core not shielded	Three or more cores, shielded or not
Wiring outside (protecting) enclosures	Power circuits, fixed	1,0	1,5	0,75	0,75	0,75
	Power circuits, subjected to frequent movements	1,0	-	0,75	0,75	0,75
	Control circuits	1,0	1,0	0,2	0,5	0,2
	Data communication	-	-	-	-	0,08
Wiring inside enclosures a)	Power circuits (connections not moved)	0,75	0,75	0,75	0,75	0,75
	Control circuits	0,2	0,2	0,2	0,2	0,2
	Data communication	-	-	-	-	0,08

NOTE All cross-sections in mm².
a)Except special requirements of individual standards, see also 12.1.

Class 1 and class 2 conductors are primarily intended for use between rigid,non-moving parts where vibration is not considered to be likely to cause damage.
All conductors that are subject to frequent movement(for example one movement per hour of machine operation)should have flexible stranding of class 5or class 6.

12.3	Insulation		P
	Where the insulation of conductors and cables can constitute hazards due for example to the propagation of a fire or the emission of toxic or corrosive fumes,guidance from the cable supplier Dshall@be sought.It is important to give special attention to the integrity of acircuit having a safety-related function. The insulation of cables and conductors used,shall be suitable for a test voltage: - not less than 2000 V AC for a duration of 5 min for operation at voltages higher than 50VAC or 120 VDC,or - not less than 500 V AC for a duration of 5 min for PELV circuits(see IEC 60364-4-41, class III equipment). The mechanical strength and thickness of the insulation shall be such that the insulation cannot be damaged in operation or during laying, especially for cables pulled into ducts.		
12.4	Current-carrying capacity in normal service		P
	The current-carrying capacity depends on several factors,for example insulation material, number of conductors in a cable,design(sheath),methods of installation,grouping and ambient temperature. NOTE 1 Detailed information and further guidance can be found in IEC 60364-5-52,in some national standards or given by the manufacturer. NOTE 2 For specific applications where the correct cable dimensioning can depend on the relationship between the period of		

	the duty cycle and the thermal time constant of the cable(for example starting against high-inertia oad,intermittent duty),the cable manufacturer can provide information.		

Table 6-Examples of current-carrying capacity(Iz)of PVC insulated copper conductors or cables under steady-state conditions in an ambient air temperature of+40℃ for different methods of installation

	Installation method (see D.2.2)			
	B1	B2	C	E
Cross-sectional area mm²	Current-carrying capacity I_z for three phase circuits A			
0,75	8,6	8,5	9,8	10,4
1,0	10,3	10,1	11,7	12,4
1,5	13,5	13,1	15,2	16,1
2,5	18,3	17,4	21	22
4	24	23	28	30
6	31	30	36	37
10	44	40	50	52
16	59	54	56	70
25	77	70	84	88
35	96	86	104	110
50	117	103	125	133
70	149	130	160	171
95	180	156	194	207
120	208	179	225	240
		Control circuit pairs		
0,20	4,5	4,3	4,4	4,4
0,5	7,9	7,5	7,5	7,8
0,75	9,5	9,0	9,5	10

NOTE 1 The values of the current-carrying capacity of Table 6 are based on:

- one symmetrical three-phase circuit for cross-sectional areas 0,75mm² and greater;
- one control circuit pair for cross-sectional areas between 0,2 mm² and 0,75 mm²

Where more oaded cables/pairs are installed, derating factors for the values of Table 6 can be found in Tables D.2 or D.3.

NOTE 2 For ambient temperatures other than 40℃, correction factors for current-carrying capacities are provided in Table D.1.

NOTE 3 These values are not applicable to flexible cables wound on drums(see 12.6.3)

NOTE 4 Current-carrying capacities of other cables are provided in IEC 60364-5-52.

12.5	Conductor and cable voltage drop		P
	The voltage drop from the point of supply to the load in any power circuit cable shall not exceed 5%of the nominal voltage under normal operating conditions.In order to conform to this requirement,it can be necessary to use conductors having a larger cross-sectional area than that derived from Table 6. See also 4.3. The voltage drop in components,for example overcurrent protective devices and switching devices,should be considered.		
12.6	Flexible cable		P
12.6.1	General		P
	Flexible cables shall have Class 5 or Class 6 conductors. NOTE 1 Class 6 conductors have smaller diameter strands and are more flexible than Class 5 conductors(see Table D.4). drums. NOTE 2 Cables for such conditions are specified in some national standards. NOTE 3 The operational life of the cable will be reduced where		

	unfavourable operating conditions such as high tensile stress,small radii,bending into another plane and/or where frequent duty cycles coincide.		
12.6.2	Mechanical rating		P
	The cable handling system of the machine shall be so designed to keep the tensile stress of the conductors as low as is practicable during machine operations.Where copper conductors are used,the tensile stress applied to the conductors shall not exceed 15 N/mm²of the copper cross-sectional area.Where the demands of the application exceed the tensile stress limit of 15 N/mm²,cables with special construction features should be used and the allowed maximal tensile stress should be agreed with the cable manufacturer. The maximum stress applied to the conductors of flexible cables with material other than copper shall be within the cable manufacturer's specification. NOTE The following conditions affect the tensile stress on the conductors: acceleration forces; - speed of motion; - dead (hanging)weight of the cables; - method of guiding; - design of cable drum system.		
12.6.3	Current-carrying capacity of cables wound on drums		P
	Cables to be wound on drums shall be selected with conductors having a cross-sectional area such that,when fully wound on the drum and carrying the normal service load,the maximum allowable conductor temperature is not exceeded. For cables of circular cross-sectional area installed on drums,the maximum current-carrying capacity in free air should be derated in accordance with Table 7		
12.7	Conductor wires,conductor bars and slip-ring assemblies		P
12.7.1	Basic protection		P
	Conductor wires,conductor bars and slip-ring assemblies shall be		

Table 7-Derating factors for cables wound on drums

Drum type	Number of layers of cable				
	Any number	1	2	3	4
Cylindrical ventilated	–	0,85	0,65	0,45	0,35
Radial ventilated	0,85	–	–		–
Radial non-ventilated	0,75	–	–		–

It is recommended that the use of derating factors be discussed with the cable and the cable drum manufacturers. This may result in other factors being used.

NOTE 1 A radial type drum is one where spiral layers of cable are accommodated between closely spaced flanges;if fitted with solid flanges, the drum is described as non-ventilated and if the flanges have suitable apertures,as ventilated

NOTE 2 A ventilated cylinder drum is one where the layers of cable are accommodated between widely spaced flanges and the drum and end flanges have ventilating apertures.

	installed or enclosed in such a way that,during normal access to the machine,basic protection is achieved by the application of one of the following protective measures: - protection by partial insulation of live parts,or where this is not practicable; - protection by enclosures or barriers of at least IP2X or IPXXB. Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X or IPXXD. 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 9.2.3.4.3 shall be applied. Conductor wires and conductor bars shall be so placed and/or protected as to: - prevent contact,especially for unprotected conductor wires and conductor bars,with conductive items such as the cords of pull-cord switches,strain-relief devices and drive chains; - prevent damage from a swinging load. See also 6.2.6.		
12.7.2	Protective conductors		P
	Where conductor wires,conductor bars and slip-ring assemblies are installed as part of the protective bonding circuit,they shall not carry current in normal operation.Therefore,the protective conductor(PE) and the neutral conductor (N)shall each use a separate conductor wire,conductor bar or slip-ring. The continuity of protective conductors using sliding contacts shall be ensured by taking appropriate measures(for example,duplication of the current collector,continuity monitoring).		
12.7.3	Protective conductor current collectors		P
	Protective conductor current collectors shall have a shape or construction so that they are not interchangeable with the other current collectors.Such current collectors shall be of the sliding contact type.		
12.7.4	Removable current collectors with a disconnector function		P
	Removable current collectors having a disconnector function shall be so designed that the protective conductor circuit is interrupted only after the live conductors have been disconnected,and the continuity of the protective conductor circuit is re-established before any live conductor is reconnected (see also 8.2.3).		
12.7.5	Clearances in air		P
	Clearances between the respective conductors,and between adjacent systems,of conductor wires,conductor bars,slip-ring assemblies and		

	their current collectors shall be suitable for at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1.		
12.7.6	Creepage distances		P
	Creepage distances between the respective conductors,between adjacent systems of conductor wires,conductor bars and slip-ring assemblies,and their current collectors shall be suitable for operation in the intended environment,for example open air,inside buildings, protected by enclosures. In abnormally dusty,moist or corrosive environments,the following creepage distance requirements apply: - unprotected conductor wires,conductor bars,and slip-ring assemblies shall be equipped with insulators with a minimum creepage distance of 60 mm; - enclosed conductor wires,insulated multipole conductor bars and insulated individual conductor bars shall have a minimum creepage distance of 30 mm. The manufacturer's recommendations shall be followed regarding special measures to prevent a gradual reduction in the insulation values due to unfavourable ambient conditions (for example deposits of conductive dust,chemical attack).		
12.7.7	Conductor system sectioning		P
	Where conductor wires or conductor bars are arranged so that they can be divided into isolated sections,suitable design measures shall be employed to prevent the energization of adjacent sections by the current collectors themselves.		
12.7.8	Construction and installation of conductor wire,conductor bar systems and slip-ring assemblies		P
	Conductor wires,conductor bars and slip-ring assemblies in power circuits shall be grouped separately from those in control circuits. Conductor wires,conductor bars and slip-ring assemblies,including their current collectors, shall be capable of withstanding,without damage,the mechanical forces and thermal effects of short-circuit currents. Removable covers for conductor wire and conductor bar systems laid underground or underfloor shall be so designed that they cannot be opened by one person without the aid of a tool. Where conductor bars are installed in a common metal enclosure,the individual sections of the enclosure shall be bonded together and connected to the protective bonding circuit.Metal covers of conductor bars aid underground or underfloor shall also be bonded together and connected to the protective bonding circuit. The protective bonding circuit shall include the covers or cover plates of metal enclosures or underfloor ducts.Where metal hinges form a part of the protective bonding circuit,their continuity shall be verified (see Clause 18).		

	Conductor bar ducts that can be subject to accumulation of liquid such as oil or water shall have drainage facilities.		
13	Wiring practices		P
13.1	Connections and routing		P
13.1.1	General requirements		
	All connections,especially those of the protective bonding circuit,shall be secured against accidental loosening. The means of connection shall be suitable for the cross-sectional areas and nature of the conductors being terminated. The connection of two or more conductors to one terminal is permitted only in those cases where the terminal is designed for that purpose.However,only one protective conductor shall be connected to one terminal connecting point. Soldered connections shall only be permitted where terminals are provided that are suitable for soldering. NOTE IEC61666providesrulesthatcan be usedforthe designation ofterminalswithin the electrical equipment. Where an incorrect electrical connection (for example,arising from replacement of devices)is identified as a source of risk that needs to be reduced and it is not practicable to reduce the possibility of incorrect connection by design measures,the conductors and/or terminations shall be identified. The installation of flexible conduits and cables shall be such that liquids shall drain away from the fittings. Means of retaining conductor strands shall be provided when terminating conductors at devices or terminals that are not equipped with this facility.Solder shall not be used for that purpose. Shielded conductors shall be so terminated as to prevent fraying of strands and to permit easy disconnection. Identification tags shall be legible,permanent,and appropriate for the physical environment. Terminal blocks shall be mounted and wired so that the wiring does not cross over the terminals.		
13.1.2	Conductor and cable runs		P
	Conductors and cables shall be run from terminal to terminal without splices or joints. Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be splices or joints for the purpose of 13.1.2. Exception:Where it is impracticable to provide terminals in a junction box(for example on mobile machines,on machines having long flexible cables;cable connections exceeding a length which is not practical to be supplied by the cable manufacturer on one cable drum), splices or joints may be used. Where it is necessary to connect and disconnect cables and cable assemblies,sufficient extra length shall be provided for that purpose. the terminations of the conductors. Wherever practicable,the protective conductor shall be placed close to the		

	associated live conductors in order to decrease the impedance of the loop.		
13.1.3	Conductors of different circuits		P
	Conductors of different circuits may be laid side by side,may occupy the same duct (for example conduit,cable trunking system),or may be in the same multi conductor cable or in the same plug/socket combination provided that the arrangement does not impair the proper functioning of the respective circuits and: · where those circuits operate at different voltages,the conductors are separated by suitable barriers or; · the conductors are insulated for the highest voltage to which any of the conductors can be subjected,for example line to line voltage for unearthed systems and phase to earth voltage for earthed systems.		
13.1.4	AC circuits-Electromagnetic effects(prevention of eddy currents)		P
	Conductors of AC circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit,including the protective conductor of each circuit,are contained in the same enclosure.Where such conductors enter a ferrous enclosure,they shall be arranged such that the conductors are not individually surrounded by ferromagnetic material. Single-core cables armoured with steel wire or steel tape should not be used for AC circuits. NOTE 1 The steel wire or steel tape armour of a single-core cable is regarded as a ferromagnetic enclosure.For single-core wire armoured cables,the use of aluminium armour is recommended. NOTE 2 Derived from IEC 60364-5-52.		
13.1.5	Connection between pick-up and pick-up converter of an inductive power supply system		P
	The cable between the pick-up and the pick-up converter shall be: NOTE The output of the pick-up can be a current source,therefore damage to the cable can result in a high voltage hazard. documentation. identification. NOTE 2 IEC 62491 provides rules and guidelines for the labelling of cables and cores/conductors used in industrial installations,equipment and products.		
13.2	Identification of conductor		P
13.2.1	General requirement		
	Each conductor shall be identifiable at each termination in accordance with the technical documentation. It is recommended (for example to facilitate maintenance)that conductors be identified by number,alphanumeric,colour (either solid or with one or more stripes),or a combination of colour and numbers or alphanumeric.When numbers are used,they shall be Arabic;letters		

	shall be Roman(either upper or lower case). NOTE 1 Annex B can be used for agreement between supplier and user regarding a preferred method of identification. NOTE 2 IEC 62491 provides rules and guidelines for the labelling of cables and cores/conductors used in industrial installations,equipment and products		
13.2.2	Identification of the protective conductor /protective bonding conductor		P
	The protective conductor /protective bonding conductor shall be readily distinguishable from other conductors by shape,location,marking,or colour.When identification is by colour alone,the bicolour combination GREEN-AND-YELLOW shall be used throughout the length of the conductor. This colour identification is strictly reserved for protective conductors/protective bonding conductors. For insulated conductors,the bicolour combination GREEN-AND-YELLOW shall be such that on any 15 mm length,one of the colours covers at least 30%and not more than 70%of the surface of the conductor,the other colour covering the remainder of the surface. Where the protective conductor(s)can be easily identified by its shape,position,or construction(for example a braided conductor,uninsulated stranded conductor),or where the insulated conductor is not readily accessible or is part of a multicore cable,colour coding throughout its length is not necessary.However,where the conductor is not clearly visible throughout its length,the ends or accessible locations shall be clearly dentified by the graphical symbol IEC 60417-5019:2006-08(see Figure 16)or with the letters PE or by the bicolour combination GREEN-AND-YELLOW.  **Figure 16-Symbol IEC60417-5019** Exception:Protective bonding conductors may be marked with the letters PB and/or the symbol IEC60417-5021 (2002-10)(see Figure 17)		

	 Figure 17-Symbol IEC60417-5021		
13.2.3	Identification of the neutral conductor		P
	Where a circuit includes a neutral conductor that is identified by colour alone,the colour used for this conductor shall be BLUE.In order to avoid confusion with other colours,it is recommended that an unsaturated blue be used,called here "light blue"(see 6.2.2 of IEC 60445:2010).Where the selected colour is the sole identification of the neutral conductor, that colour shall not be used for identifying any other conductor where confusion is possible.Where identification by colour is used,bare conductors used as neutral conductors shall be either coloured by a stripe,15mm to 100 mm wide in each compartment or unit and at each accessible location,or coloured throughout their length.		
13.2.4	Identification by colour		P
	Where colour-coding is used for identification of conductors(other than the protective conductor (see 13.2.2)and the neutral conductor(see 13.2.3)),the following colours may be used: BLACK,BROWN,RED,ORANGE,YELLOw,GREEN,BLUE(including LIGHT BLUE), VIOLET,GREY,WHITE,PINK,TURQUOISE. NOTE This listof colours is derivedfrom IEC 60757. It is recommended that,where colour is used for identification,the colour be used throughout the length of the conductor either by the colour of the insulation or by colour markers at regular intervals and at the ends or accessible location. For safety reasons,the colour GREEN or the colour YELLOW should not be used where there is a possibility of confusion with the bicolour combination GREEN-AND-YELLOW(see 13.2.2). Colour identification using combinations of those colours listed above may be used provided there can be no confusion and that GREEN or YELLOW is not used except in the bicolour combination GREEN-AND-YELLOW. Where colour-coding is used for identification of conductors,it is recommended that they be colour-coded as follows: - BLACK: AC and DC power circuits; - RED: AC control circuits; -BLUE: DC control circuits; - ORANGE:excepted circuits in accordance with 5.3.5. Exceptions to		

	the above are permitted where insulation is not available in the colours recommended(for example in multiconductor cables).		
13.3	Wiring inside enclosures		P
	Conductors inside enclosures shall be supported where necessary to keep them in place. Non-metallic ducts shall be permitted only when they are made with a flame-retardant insulating material (see the IEC 60332 series). It is recommended that electrical equipment mounted inside enclosures be designed and constructed in such a way as to permit modification of the wiring from the front of the enclosure (see also 11.2.1).Where that is not practicable and control devices are connected from the rear of the enclosure,access doors or swingout panels shall be provided. Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors in accordance with 12.2 and 12.6 to allow for the frequent movement of the part.The conductors shall be anchored to the fixed part and to the movable part independently of the electrical connection(see also 8.2.3 and 11.2.1). Conductors and cables that do not run in ducts shall be adequately supported. Terminal blocks or plug/socket combinations shall be used for control wiring that extends beyond the enclosure.For plug/socket combinations,see also 13.4.5 and 13.4.6. Power cables and cables of measuring circuits may be directly connected to the terminals of the devices for which the connections were intended.		
13.4	Wiring outside enclosures		P
13.4.1	General requirements		P
	The means of introduction of cables or ducts with their individual glands,bushings,etc.,into an enclosure shall ensure that the degree of protection is not reduced (see 11.3). Conductors of a circuit shall not be distributed over different multi-core cables,conduits,cable ducting systems or cable trunking systems.This is not required where a number of multi-core cables,forming one circuit,are installed in parallel.Where multi-core cables are installed in parallel,each cable shall contain one conductor of each phase and the neutral if any.		
13.4.2	External ducts		P
	Conductors and their connections external to the electrical equipment enclosure(s)shall be enclosed in suitable ducts(i.e.conduit or cable trunking systems)as described in 13.5 except for suitably protected cables that may be installed without ducts and with or without the use of cable trays or cable support means.Where devices such as position switches or proximity switches are supplied with a dedicated cable,their cable need not be enclosed in a duct when the cable is suitable for the purpose,sufficiently short,and so located or		

	protected,that the risk of damage is minimized. Fittings used with ducts or cables shall be suitable for the physical environment. Flexible conduit or flexible multiconductor cable shall be used where it is necessary to employ flexible connections to pendant push-button stations.The weight of the pendant stations shall be supported by means other than the flexible conduit or the flexible multiconductor cable, except where the conduit or cable is specifically designed for that purpose.		
13.4.3	Connection to moving elements of the machine		P
	The design of connections to moving parts shall take into account the foreseeable frequency of movement and shall be made using conductors in accordance with 12.2 and 12.6.Flexible cable and flexible conduit shall be so installed as to avoid excessive flexing and straining, particularly at the fittings. Cables subject to movement shall be supported in such a way that there is no mechanical strain on the connection points nor any sharp flexing.When this is achieved by the provision of a loop,it shall have sufficient length to provide for a bending radius of the cable as specified by the cable manufacturer or if no such specification is given,at least 10 times the diameter of the cable. Flexible cables of machines shall be so installed or protected as to minimize the possibility of external damage due to factors that include the following cable use or potential abuse: - being run over by the machine itself; - being run over by vehicles or other machines; - coming into contact with the machine structure during movements; - running in and out of cable baskets,or on or off cable drums; -acceleration forces and wind forces on festoon systems or suspended cables; -excessive rubbing by cable collector; - exposure to excessive radiated heat. The cable sheath shall be resistant to the normal wear that can be expected from movement and to the effects of environmental contaminants (for example oil,water,coolants,dust). Where cables subject to movement are close to moving parts,precautions shall be taken to maintain a space of at least 25 mm between the moving parts and the cables.Where that distance is not practicable,fixed barriers shall be provided between the cables and the moving parts. The cable handling system shall be so designed that lateral cable angles do not exceed 5°, avoiding torsion in the cable when: - being wound on and off cable drums;and - approaching and leaving cable guidance devices. Measures shall be taken to ensure that at least two turns of flexible cables always remain on a drum.		

<table>
<tr><td></td><td>Devices serving to guide and carry a flexible cable shall be so designed that the inner bending radius at all points where the cable is bent is not less than the values given in Table 8,unless otherwise agreed with the cable manufacturer,taking into account the permissible tension and the expected fatigue life.

Table 8-Minimum permitted bending radii for the forced guiding of flexible cables
<table><tr><td rowspan="2">Application</td><td colspan="3">Cable diameter or thickness of flat cable(d) mm</td></tr><tr><td>d≤8</td><td>8<d≤20</td><td>d>20</td></tr><tr><td>Cable drums</td><td>6d</td><td>6d</td><td>8 d</td></tr><tr><td>Guide rollers</td><td>6d</td><td>8 d</td><td>8 d</td></tr><tr><td>Festoon systems</td><td>6d</td><td>6d</td><td>8d</td></tr><tr><td>All others</td><td>6d</td><td>6d</td><td>8d</td></tr></table>The straight section between two bends shall be at least 20 times the diameter of the cable.
Where flexible conduit is adjacent to moving parts,the construction and supporting means shall prevent damage to the flexible conduit under all conditions of operation.
Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically designed for that purpose.</td><td></td><td></td></tr>
<tr><td>13.4.4</td><td>Interconnection of devices on the machine</td><td></td><td>P</td></tr>
<tr><td></td><td>Where several machine-mounted devices(for example position sensors,push-buttons)are connected in series or in parallel,it is recommended that the connections between those devices be made through terminals forming intermediate test points.Such terminals shall be conveniently placed,adequately protected,and shown on the relevant diagrams.</td><td></td><td></td></tr>
<tr><td>13.4.5</td><td>Plug/socket combinations</td><td></td><td>P</td></tr>
<tr><td></td><td>Components or devices inside an enclosure,terminated by fixed plug/socket combinations(no flexible cable),or components connected to a bus system by a plug/socket combination,are not considered to be plug/socket combinations for the purpose of this 13.4.5.
After installation in accordance with item a)below,plug/socket combinations shall be of such a type as to prevent unintentional contact with live parts at any time,including during insertion or removal of the connectors.
The degree of protection shallbe at least IP2X or IPXXB.PELV circuits are excepted from this requirement.
Where the plug/socket contains a contact for the protective bonding circuit,it shall have a first make last break contact (see also 8.2.4).
Plug/socket combinations intended to be connected or disconnected during load conditions shall have sufficient load-breaking capacity .
Where the plug/socket combination is rated at 30 A,or greater,it shall</td><td></td><td></td></tr>
</table>

	be interlocked with a switching device so that the connection and disconnection is possible only when the switching device is in the OFF position. Plug/socket combinations that are rated at more than 16A shall have a retaining means to prevent unintended or accidental disconnection. Where an unintended or accidental disconnection of plug/socket combinations can cause a hazardous situation,they shall have a retaining means. The installation of plug/socket combinations shall fulfil the following requirements as applicable: The component which remains live after disconnection shall have a degree of protection of at least IP2X or IPXXB,taking into account the required clearance and creepage distances.PELV circuits are excepted from this requirement. Metallic housings of plug/socket combinations shall be connected to the protective bonding circuit. Plug/socket combinations intended to carry power loads but not to be disconnected during load conditions shall have a retaining means to prevent unintended or accidental disconnection and shall be clearly marked that they are not intended to be disconnected under load. Where more than one plug/socket combination is provided in the same electrical equipment,the associated combinations shall be clearly identifiable.It is recommended that mechanical coding be used to prevent incorrect insertion. Plug/socket combinations used in control circuits shall fulfil the applicable requirements of IEC61984. Exception: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.This exception does not apply to control circuits using high frequency signals superimposed on the power circuits.		
13.4.6	Dismantling for shipment		P
	Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points.Such terminals shall be suitably enclosed and plug/socket combinations shall be protected from the physical environment during transportation and storage.		
13.4.7	Additional conductors		P
	Consideration should be given to providing additional conductors for maintenance or repair. When spare conductors are provided,they shall be connected to spare terminals or isolated in such a manner as to prevent contact with live parts.		
13.5	Ducts,connection boxes and other boxes		P
13.5.1	General requirements		P
	Ducts shall provide a degree of protection (see IEC 60529)suitable for		

	the application. All sharp edges,flash,burrs,rough surfaces,or threads with which the insulation of the conductors can come in contact shall be removed from ducts and fittings.Where necessary, additional protection consisting of a flame-retardant,oil-resistant insulating material shall be provided to protect conductor insulation. Drain holes of 6mm diameter are permitted in cable trunking systems,connection boxes,and other boxes used for wiring purposes that can be subject to accumulations of oil or moisture. In order to prevent confusion of conduits with oil,air,or water piping,it is recommended that the conduits be either physically separated or suitably identified. Ducts and cable trays shall be rigidly supported and positioned at a sufficient distance from moving parts and in such a manner so as to minimize the possibility of damage or wear. In areas where human passage is required,the ducts and cable trays shall be mounted at least 2m above the working surface. Cable trays that are partially covered should not be considered to be ducts or cable trunking systems (see 13.5.6),and the cables used shall be of a type suitable for installation on open cable trays. It is recommended that the dimensions and arrangement of ducts be such as to facilitate the insertion of the conductors and cables.		
13.5.2	Rigid metal conduit and fittings		P
	Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material suitable for the conditions.CWhere galvanic action is possible between dissimilar metals metal these combinations shall not be used.C Conduits shall be securely held in place and supported at each end. Fittings shall be compatible with the conduit and appropriate for the application. Fittings should be threaded unless structural difficulties prevent assembly.Where threadless fittings are used,the conduit shall be securely fastened to the equipment. Conduit bends shall be made in such a manner that the conduit shall not be damaged and the internal diameter of the conduit shall not be effectively reduced.		
13.5.3	Flexible metal conduit and fittings		P
	A flexible metal conduit shall consist of a flexible metal tubing or woven wire armour.It shall be suitable for the expected physical environment. Fittings shall be compatible with the conduit and appropriate for the application.		
13.5.4	Flexible non-metallic conduit and fitting		P
	F lexible non-metallic conduit shall be resistant to kinking and shall have physical characteristics similar to those of the sheath of		

	multiconductor cables. The conduit shall be suitable for use in the expected physical environment . Fittings shall be compatible with the conduit and appropriate for the application		
13.5.5	Cable trunking systems		P
	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving parts of the machine and of sources of contamination. Covers shall be shaped to overlap the sides;gaskets shall be permitted.Covers shall be attached to cable trunking systems by suitable means.On horizontal cable trunking systems, the cover shall not be on the bottom unless specifically designed for such installation. NOTE Requirementsforcabletrunkingandductingsystemsforelectrical installationsare given in the IEC 61084 series. Where the cable trunking system is furnished in sections,the joints between sections shall fit tightly but need not be gasketed. The only openings permitted shall be those required for wiring or for drainage.Cable trunking systems shall not have opened but unused knockouts.		
13.5.6	Machine compartments and cable trunking systems		P
	The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided the compartments or cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed.Conductors run in enclosed compartments and cable trunking systems shall be so secured and arranged that they are not subject to damage.		
13.5.7	Connection boxes and other boxes		P
	Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance.Those boxes shall provide protection against the ingress of solid bodies and liquids,taking into account the external influences under which the machine is intended to operate(see 11.3). Those boxes shall not have opened but unused knockouts nor any other openings and shall be so constructed as to exclude materials such as dust,flyings,oil,and coolant.		
13.5.8	Motor connection boxes		P
	Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (for example brakes, temperature sensors, plugging switches, tachometer generators).		
14	Electric motors and associated equipment		P
14.1	General requirements		P
	Electric motors should conform to the relevant parts of IEC 60034 series. The protection requirements for motors and associated equipment are given in 7.2 for overcurrent protection,in 7.3 for protection of motors		

	against overheating,and in 7.6 for overspeed protection. As many controllers do not switch off the supply to a motor when it is at rest,care shall be taken to ensure compliance with the requirements of 5.3,5.4,5.5,7.5,7.6 and 9.4.Motor control equipment shall be located and mounted in accordance with Clause 11.		
14.2	Motor enclosures		P
	Enclosures for motors should be in accordance with IEC 60034-5. The degree of protection shall be dependent on the application and the physical environment (see 4.4).All motors shall be adequately protected from mechanical damage.		
14.3	Motor dimensions		P
	As far as is practicable,the dimensions of motors shall conform to those given in the IEC 60072 series.		
14.4	Motor mounting and compartments		P
	Each motor and its associated couplings,belts,pulleys,or chains,shall be so mounted that they are adequately protected and are easily accessible for inspection,maintenance, adjustment and alignment,lubrication,and replacement.The motor mounting arrangement shall be such that all motor mounting means can be removed and all terminal boxes are accessible. Motors shall be so mounted that proper cooling is ensured and the temperature rise remains within the limits of the insulation class (see IEC 60034-1). Where practicable,motor compartments should be clean and dry,and when required,shall be ventilated directly to the exterior of the machine.The vents shall be such that ingress of swarf,dust,or water spray is at an acceptable level. There shall be no opening between the motor compartment and any other compartment that does not meet the motor compartment requirements. Where a conduit or pipe is run into the motor compartment from another compartment not meeting the motor compartment requirements,any clearance around the conduit or pipe shall be sealed.		
14.5	Criteria for motor selection		P
	The characteristics of motors and associated equipment shall be selected in accordance with the anticipated service and physical environmental conditions (see 4.4).In this respect,the points that shall be considered include: - type of motor; - type of duty cycle (see IEC 60034-1); ventilation); - mechanical vibration; -type of motor control; - temperature rise and other effects of the frequency spectrum of the voltage and/or current feeding the motor(particularly when it is		

	supplied from a converter); - method of starting and the possible influence of the inrush current on the operation of other users of the same power supply,taking also into account possible special considerations stipulated by the supply authority; - variation of counter-torque load with time and speed; -influence of loads with large inertia; - influence of constant torque or constant power operation; - possible need of inductive reactors between motor and converter.		
14.6	Protective devices for mechanical brakes		P
	Operation of the overload and overcurrent protective devices for mechanical brake actuators shall initiate the simultaneous de-energization (release)of the associated machine actuators. NOTE Associated machine actuators are those associatedwith the same motion,for example cable drums and long-traveldrives.		
15	Socket-outlets and lighting		P
15.1	Socket-outlets for accessories		P
	Where the machine or its associated equipment is provided with socket-outlets that are intended to be used for accessory equipment(for example hand-held power tools,test equipment),the following apply: - the socket-outlets should conform to IEC 60309-1.Where that is not practicable,they should be clearly marked with the voltage and current ratings; - the continuity of the protective bonding circuit to the socket-outlet shall be ensured; - all unearthed conductors connected to the socket-outlet shall be protected against overcurrent and,when required,against overload in accordance with 7.2 and 7.3 separately from the protection of other circuits; - where the power supply to the socket-outlet is not disconnected by the supply discon- necting device for the machine or the section of the machine,the requirements of 5.3.5 apply; -where fault protection is provided by automatic disconnection of supply,the disconnection time shall be in accordance with Table A.1 for TN systems or Table A.2 for TT systems; - circuits supplying socket-outlets with a current rating not exceeding 20 A shall be provided with residual current protection(RCDs)with a rated operating current not exceeding 30 mA.		
15.2	Local lighting of the machine and of the equipment		P
15.2.1	General		P
	The ON/OFF switch shall not be incorporated in the lampholder or in the flexible connecting cord. Stroboscopic effects from lights shall be avoided by the selection of		

	appropriate luminaires. Where fixed lighting is provided in an enclosure,electromagnetic compatibility should be taken into account using the principles outlined in 4.4.2.		
15.2.2	Supply		P
	The nominal voltage of the local lighting circuit shall not exceed 250 V between conductors. A voltage not exceeding 50V between conductors is recommended. Lighting circuits shall be supplied from one of the following sources (see also 7.2.6): - a dedicated solating transformer connected to the load side of the supply disconnecting device.Overcurrent protection shall be provided in the secondary circuit; - a dedicated isolating transformer connected to the line side of the supply disconnecting device.That source shall be permitted for maintenance lighting circuits in control enclosures only.Overcurrent protection shall be provided in the secondary circuit (see also 5.3.5); - a circuit of the electrical equipment of the machine for lighting,with dedicated overcurrent protection; - an isolating transformer connected to the line side of the supply disconnecting device, provided with a dedicated primary disconnecting means (see 5.3.5)and secondary overcurrent protection,and mounted within the control enclosure adjacent to the supply disconnecting device; -an externally supplied ighting 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; - power supply units,for DC supply to LED light sources,fitted with isolating transformers (for example,in accordance with IEC61558-2-6). Exception:where fixed lighting is out of reach of operators during normal operations,the provisions of 15.2.2 do not apply.		
15.2.3	Protection		P
	Local lighting circuits shall be protected in accordance with 7.2.6.		
15.2.4	Fittings		P
	Adjustable lighting fittings shall be suitable for the physical environment. The lampholders shall be: - in accordance with the relevant IEC standard; - constructed with an insulating material protecting the lamp cap so as to prevent unintentional contact. Reflectors shall be supported by a bracket and not by the lampholder. Exception:where fixed lighting is out of reach of operators during normal operation,the provisions of 15.2.4 do not apply.		
16	Marking,warning signs and reference designations		P

16.1	General		P
	Warning signs,nameplates,markings,abels and dentification plates shall be of sufficient durability to withstand the physical environment involved. The markings shall be sufficiently durable to remain legible for the foreseen lifetime of the machine.		
16.2	Warning signs		P
16.2.1	Electric shock hazard		P
	Enclosures that do not otherwise clearly show that they contain electrical equipment that can give rise to a risk of electric shock shall be marked with the graphical symbol ISO 7010-W012 (see Figure 18).  **Figure 18-Symbol ISO 7010-W012** The warning sign shall be plainly visible on the enclosure door or cover. The warning sign may be omitted (see also 6.2.2 b))for: - an enclosure equipped with a supply disconnecting device; - an operator-machine interface or control station; - a single device with its own enclosure (for example position sensor).		
16.2.2	Hot surfaces hazard		P
	Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures of the electrical equipment,the graphical symbol ISO 7010-W017 shall be used (see Figure 19).  **Figure 19-Symbol ISO 7010-W017** NOTE ISO 13732-1 gives guidance for the assessment of the risks of burns when humans might touch hot surfaces with their unprotected skin.		
16.3	Functional identification		P
	Control devices and visual indicators shall be clearly and durably marked with regard to their functions either on or adjacent to the item.It is recommended that such markings are made in accordance with IEC		

	60417 and ISO 7000.		
16.4	Marking of enclosures of electrical equipment		P
	The following information shall be legibly and durably marked in a way that is plainly visible after the equipment is installed on enclosures that receive incoming power supplies: ·name or trade mark of supplier; · type designation or model,where applicable; · serial number where applicable; · main document number (see IEC 62023)where applicable; · rated voltage,number of phases and frequency (if AC),and full-load current for each incoming supply It is recommended that this information is provided adjacent to the main incoming supply(ies).		
16.5	Reference designations		
	All enclosures,assemblies,control devices,and components shall be plainly identified with the same reference designation as shown in the technical documentation.		
17	Technical documentation		P
17.1	General		P
	The information necessary for identification, transport, installation, use, maintenance, decommissioning and disposal of the electrical equipment shall be supplied. NOTE 1 Documentation is sometimes supplied in paper form,since it cannot be assumed that the user has acess to the means of reading instructions supplied in electronic form or made available on an Internet site. However,it is often useful for the documentation to be made available in electronic form and on the Internet as well as in paper form,since this enables the user to download the electronic file if he so wishes and to recover the documentation if the paper copy has been lost.This practice also facilitates the updating of the documentation when this is necessary. NOTE 2 In some countries,the requirement to use specific language(s)is covered by legal requirements. Annex I should be considered as guidance for the preparation of information and documents.		
17.2	Information related to the electrical equipment		P
	The following shall be supplied: where more than one document is provided,a main document for the electrical equipment as a whole,listing the complementary documents associated with the electrical equipment; identification of the electrical equipment (see 16.4); information on installation and mounting including: · a description of the electrical equipment's installation and mounting,and its connection to the electrical supplies and where		

	relevant other supplies; · short-circuit current rating of the electrical equipment for each incoming power supply; · rated voltage,number of phases and frequency (if AC.),type of distribution system (TT,TN,IT)and full-load current for each incoming supply; · any additional electrical supply(ies)requirements (for example maximum supply source impedance,leakage current)for each incoming supply; · space required for the removal or servicing of the electrical equipment; · installation requirements where needed to ensure that the arrangements for cooling are not impaired; · environmental limitations (for example lighting, vibration, EMC environment, atmospheric contaminants)where appropriate; · functional limitations(for example peak starting currents and permitted voltage drop(s))as applicable; · precautions to be taken for the installation of the electrical equipment relevant to the electromagnetic compatibility; an instruction for the connection of simultaneously accessible extraneous-conductive- parts in the vicinity of the machine (for example,within 2,5 metres)such as the following to the protective bonding circuit: · metallic pipes; · fences; · ladders; ·handrails. information on the functioning and operation,including as applicable: · an overview of the structure of the electrical equipment (for example by structure diagram or overview diagram); ·procedures for programming or configuring,as necessary for the intended use; · procedures for restarting after an unexpected stop; · a sequence of operation; information on maintenance of the electrical equipment,as appropriate,including: · frequency and method of functional testing; ·instructions on the procedures for safe maintenance and where it is necessary to suspend a safety function and/or protective measure (see 9.3.6); ·guidance on the adjustment,repair,and frequency and method of preventive maintenance; · details of the interconnections of the electrical components subject to replacement (for example by circuit diagrams and/or connection tables); · information on required special devices or tools; ·information on		

	spare parts; · information on possible residual risks,indication of whether any particular training is required and specification of any necessary personal protective equipment; ·where applicable,instructions to restrict availability of key(s)or tool(s)to skilled or instructed persons only; · settings (DIP-switches,programmable parameter values,etc); · information for validation of safety related control functions after repair or modification, and for periodic testing where necessary; information on handling,transportation and storage as appropriate(for example dimensions,weight,environmental conditions,possible ageing constraints); information for proper disassembly and handling of components(for example for recycling or disposal).		
18	Verification		P
18.1	General		P
	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),c)and h)and may include one or more of the items d)to g): verification that the electrical equipment complies with its technical documentation; verification of continuity of the protective bonding circuit(Test 1 of 18.2.2); in case of fault protection by automatic disconnection of supply,conditions for protection by automatic disconnection shall be verified according to 18.2; insulation resistance test (see 18.3); voltage test (see 18.4); protection against residual voltage(see 18.5); verification that the relevant requirements of 8.2.6 are met; functional tests (see 18.6). When these tests are performed,it is recommended that they follow the sequence listed above.C Where the sequence cannot be followed verification a)and b)shall be conducted first.@ When the electrical equipment is modified,the requirements stated in 18.7 shall apply. IEC 61557 series is recommended. The results of the verification shall be documented.		
18.2	Verification of conditions for protection by automatic disconnection of supply		P
18.2.1	General		P
	The conditions for automatic disconnection of supply (see 6.3.3)shall be verified by tests. Test 1 verifies the continuity of the protective bonding circuit.		

	Test 2 verifies the conditions for protection by automatic disconnection of the supply in TN systems. For TN-systems,those test methods are described in 18.2.2 and 18.2.3;their application for different conditions of supply are specified in 18.2.4. For TT systems,see Clause A.2 For IT systems,see IEC 60364-6. Where RCDs are used in the electrical equipment,their function shall be verified in accordance with the manufacturer's instructions.The test procedure and test interval shall be specified in the maintenance instructions.		
18.2.2	Test 1-Verification of the continuity of the protective bonding circuit		P
	The resistance between the PE terminal(see 5.2 and Figure 4)and relevant points that are part of the protective bonding circuit shall be measured with a current between at least 0,2 A and approximately 10A derived from an electrically separated supply source(for example SELV,see 414 of IEC 60364-4-41:2005)having a maximum no-load voltage of 24 V AC or DC. The resistance measured shall be in the expected range according to the length,the cross sectional area and the material of the related protective conductors and protective bonding conductor(s). Earthed PELV supplies can produce misleading results in this test and therefore shall not be used. NOTE Larger currents used for the continuity test increases the accuracy of the test result,especially with low resistance values,i.e.larger cross sectional areas and/or lower conductor lengths.		
18.2.3	Test 2-Fault loop impedance verification and suitability of the associated overcurrent protective device		
	The connections of each power supply ncluding the connection of the associated protective conductor to the PE terminal of the machine,shall be verified by inspection. The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A shall be verified by both: verification of the fault loop impedance by: - calculation,or - measurement in accordance with A.1.4,and confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A,and where a power drive system(PDS)is used, confirmation that the setting and characteristics of the protective device(s)associated with a PDS are in accordance with the converter manufacturer's and protective device manufacturer's instructions.		
18.2.4	Application of the test methods for TN-systems		P
	When Test 2 of 18.2.3 is carried out by measurement,it shall always be preceded by Test 1 of 18.2.2. NOTE A discontinuity of the protective		

bonding circuit can cause a hazardous situation for the tester or other persons, or damage to the electrical equipment during the loop impedance test. The tests that are necessary for machines of different status are specified in Table 9.

Table 9-Application of the test methods for TN-systems

Procedure	Machine status	Verification on site
A	Electrical equipment of machines, erected and connected on site, where the continuity of the protective bonding circuits has not been confirmed following erection and connection on site.	Test 1(see 18.2.2)and test 2(see 18.2.3) Exception:Test 2 is not required where: test 1 is performed on the protective bonding conductors of the machine that are connected on site, and; - the connections of each incoming power supply and of the associated protective conductor(PE) to the PE-terminal of the machine, are verified by inspection, and previous calculations of the fault loop impedance (or resistance) by the manufacturer of the electrical equipment are available, and: the arrangement of the installations permits the verification of the length and cross-sectional area of the conductors used for the calculation, and; it can be confirmed through calculation or measurement, or by information supplied by the customer, that the supply source impedance on site does not exceed the value specified by the manufacturer of the electrical equipment.See 17.2 c), fourth bullet).
B	Machine supplied with confirmation of the verification(see 18.1)of continuity of the protective bonding circuits by test 1 or with the results of a test 2 by measurement, having protective bonding circuits exceeding the cable length for which examples are given in Table 10. Case B1)supplied fully assembled and not dismantled for shipment Case B2)supplied dismantled for shipment, where the continuity of protective conductors is ensured after dismantling, transportation and reassembly (for example by the use of plug/socket connections).	Test 2(see 18.2.3) Exception: Where it can be confirmed through calculation or measurement, or by information supplied by the customer, that the supply source impedance on site does not exceed the value specified by the manufacturer of the electrical equipment, or that of the test supply during a test 2 by measurement, no test is required on site apart from verification of the connections: in case B1)of each incoming power supply and of the associated protective conductor to the PE terminal of the machine; ● in case B2)of each incoming power supply and of the associated protective conductor to the PE terminal of the machine and of all connections of the protective conductor(s) that were disconnected for shipment
C	Machine having protective bonding circuits not exceeding the cable length for which examples are given in Table 10, supplied with confirmation of the verification(see 18.1)of continuity of the protective bonding circuits by test 1. Case C1)supplied fully assembled and not dismantled for shipment. Case C2)supplied dismantled for shipment, where the continuity of protective conductors is ensured after dismantling, transportation and reassembly (for example by the use of plug/socket combination(s)).	For case C1 or C2, no test is required on site. For a machine not connected to the power supply by a plug/socket combination, the correct connection of the external protective conductor to the PE-terminal of the machine shall be verified by visual inspection. In case C2), the installation documents (see 17.2)shall require that all connections of the protective conductor(s)that were disconnected for shipment are verified, for example by visual inspection.

Table 10-Examples of maximum cable lengths from protective devices to their loads for TN-systems

1 Maximum source impedance of the supply to the protective device	2 Minimum cross-sectional area	3 Maximum nominal rating or setting of the protective device IN	4 Fuse disconnect time 5s	5 Fuse disconnect time 0,4 s	6 Miniature circuit-breaker char.B Ia=5×IN	7 Miniature circuit-breaker char.C Ia=10×IN	8 Miniature circuit-breaker char.D =20×	9 Adjustable circuit-breaker =8
mΩ	mm²	A	Maximum cable length in m from each protective device to its load					
500	1,5	16	97	53	76	30	7	31
500	2,5	20	115	57	94	34	3	36
500	4,0	25	135	66	114	35		38
400	6,0	32	145	59	133	40		42
300	10	50	125	41	132	33		37
200	16	63	175	73	179	55		61
200	25(line)/16 (PE)	80	133					38
100	35(line)/16 (PE)	100	136					73
100	50 (line)/25 (PE)	125	141					66
100	70 (line)/35 (PE)	160	138					46
50	95(line)/50 (PE)	200	152					98
50	120 (line)/70 (PE)	250	157					79

The values of the maximum cable length in Table 10 are based on the following assumptions:
PVC cable with copper conductors, conductor temperature under short-circuit conditions 160 (see Table D.5);
cables with line conductors up to 16 mm² provide a protective conductor of equal cross sectional area to that of the line conductors;
- cables above 16 mm² provide a reduced size protective conductor as shown;

3-phase system, nominal voltage of the power supply 400V(U_0=230 V);
- column 3 values are correlated with Table 6(see 12.4).
- disconnection time for circuit-breakers is≤0,4 s(columns 6-9)

A deviation from these assumptions can require a complete calculation or measurement of the fault loop impedance. Further information is available from IEC 60228 and IEC TR 61200-53.

18.3	Insulation resistance tests		P
	When insulation resistance tests are performed,the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ.The test may be made on individual sections of the complete electrical installation. Exception:for certain parts of electrical equipment,incorporating for example bus bars, conductor wire or conductor bar systems or slip-ring assemblies,a lower minimum value is permitted,but that value shall not be less than 50 kΩ. If the electrical equipment of the machine contains surge protection devices which are likely to operate during the test,it is permitted to either - disconnect these devices,or - reduce the test voltage to a value lower than the voltage protection level of the surge protection devices,but not lower than the peak value of the upper limit of the supply (phase to neutral)voltage.		
18.4	Voltage tests		P

	When voltage tests are performed,tests and test equipment shall be in accordance with EN61180. The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz. The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1000 V,whichever is the greater.The maximum test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s.The requirements are satisfied if no disruptive discharge occurs. Components and devices that are not rated to withstand the test voltage and surge protection devices which are likely to operate during the test shall be disconnected during testing. Components and devices that have been voltage tested standards may be disconnected during testing		
18.5	Protection against residual voltages		P
	Where appropriate,tests shall be performed to ensure compliance with 6.2.4.		
18.6	Functional tests		P
	The functions of electrical equipment shall be tested.		
18.7	Retesting		P
	Where a portion of the machine or its associated equipment is changed or modified,the need for re-verification and testing of the electrical equipment shall be considered. Particular attention should be given to the possible adverse effects that retesting can have on the equipment(for example overstressing of insulation,disconnection/ reconnection of devices).		

EN ISO 11553-1:2008

Safety of machinery — Laser processing machines

Part 1:General safety requirements

Clause	Requirements - Test	Result - Remark	Verdict
1	Scope		P
	This part of ISO 11553 describes hazards generated by laser processing machines, as defined in 3.2, and specifies the safety requirements relating to radiation hazards and hazards generated by materials and substances. It also spec 巾 es the information to be supplied by the manufacturers of such equipment.		P
2	Normative references		P
3	Terms and definitions		P
4	Hazards		P
4.1	General		P
4.2	Inherent hazards		P
4.3	Hazards created by external effects (interferences)		P
4.4	Hazards covered by this part of ISO 11553		P
5	Safety requirements and measures		P
5.1	General requirements		P
	The extent to which hazards are covered is indicated in the Scope. Machinery shall comply as appropriate with ISO 12100-1 and ISO 12100-2 for hazards which are not covered by this part of ISO 11553.		P
5.2	Risk assessment		P
	A risk assessment shall be performed		P
5.3	Implementation of corrective measures		P
5.3.1	General		P
	Safety measures shall be incorporated in the machine by design and manufacture as specified in 5.3.2 to 5.3.4.		P
5.3.2	Protection against laser radiation hazards		P
5.3.3	Control means and circuits		P
5.3.4	Protection against hazards generated by materials and substances		P
6	Verification of safety requirements and measures		P
	General conformance with the requirements of this part of ISO 11553, particularly those relating to the presence and positioning of guards and control devices, shall be confirmed by visual inspection. Correct functioning of control devices shall be verified according to functional tests specified by the manufacturer.		P

	Verification procedures relating to laser radiation levels shall conform to IEC 60825-1.		
7	Information for user		P
8	Labelling		P

EN 60825-1 report			
4	ENGINEERING SPECIFICATIONS		P
4.1	General remarks		P
	Modification		P
4.2	Protective housing		P
4.2.1	General		P
4.2.2	Service		P
4.2.3	Removable laser system		P
4.3	Access panels and safety interlocks		P
4.3.1	Access panels of protective housing		P
	Product Class		P
	Accessible emission during removal of access panel		P
	The removal of the panelgives access to laser radiation levels designated by“X”in the table		P
	Accessible emissions after removal		P
4.3.2	Deliberate override mechanism		P
4.4	Remote interlock connector		P
4.5	Manual reset		P
4.6	Key control		P
4.7	Laser radiation emission warning		P
4.7.1	Class 3R (λ<400 nm;λ>700 nm),3B and 4		P
4.7.2	Audible or visible warning		P
4.7.3	Operational control and laser aperture		P
4.7.4	Laser emission distributed through more than one output		P
4.8	Beam stop or attenuation		P
4.9	Controls		P
4.10	Viewing optics		P
	a)Human access to laser radiation in excess of Class 1M prevented when the shutter is opened or attenuation varied		P
	b)Opening of the shutter or variation of the attenuation prevented when exposure to laser radiation in excess of Class 1M is possible		P
4.11	Scanning safeguard		P
4.12	Walk-in access		P
	a)Means provided so that any person inside the housing can prevent activation of a Class 3B or 4 laser hazard		P
	b)A warning device provides adequate warning of emission to any person within the housing		P
	c)Where “walk-in”access during operation is intended or reasonably foreseeable,emission of laser radiation that is equivalent to Class 3B or Class 4 while someone is present inside the enclosure of Class 1,Class 2 or Class 3R product shall be prevented by engineering means		P
4.13	Environmental conditions		P
	-climatic conditions		P

	-vibration and shock		P
4.14	Protection against other hazards		P
4.14.1	Non-optical hazards (product safety standard)		P
	-electrical hazards;		P
	-excessive temperature;		P
	-spread of fire from the equipment;		P
	-sound and ultrasonic;		P
	-harmful substances		P
	-explosion;		P
4.14.2	Collateral radiation		P
5	LABELLING		P
5.1	General		P
	LASER PRODUCT CLASS	Class 1	P
	Labelling location (Product/User instruction/ Package)		P
	Warning label-Hazard symbol (Figure 1)		P
	Explanatory label (Figure 2)		P
5.2-5.6	Text on explanatory label	CLASS 1 LASER PRODUCT	P
5.7	Aperture label		P
5.8	Radiation output and standards information		P
	Max output of laser radiation		P
	Pulse duration		P
	Emitted wavelength(s)		P
	The name and publication date of the standard		P
5.9	Labels for access panels		P
5.9.1	Warning wording used		P
5.9.2	Labels for safety interlocked panels		P
	Warning wording used		P
5.10	Warning for invisible laser radiation		P
5.11	Warning for visible laser radiation		P
6	OTHER INFORMATIONAL REQUIREMENTS		P
6.1	Information for the user		P
	a)adequate instructions for proper assembly, maintenance and safe use and description of the classification limitations,if appropriate		P
	b)warning for Class 1M and 2M		P
	c)laser beam parameters for radiation above the AEL of Class 1		P
	·Wavelength		P
	·Beam divergence		P
	·Pulse duration		P
	·Maximum power or energy output		P
	d)embedded laser products and other incorporated laser products		P
	e)MPE and NOHD for Class 3B and Class 4 laser products For collimated beam Class 1M and 2M lasers the extended		P

	NOHD(ENOHD)		
	f)information for the selection of eye protection		P
	g)reproduction of labels		P
	h)location of laser apertures		P
	i)listing of controls,adjustment of procedures and warning statement		P
	j)information about laser energy source if not incorporated in the manual		P
6.2	Purchasing and service information		P
	a)safety classification of each laser product stated in descriptive material		P
	b)adequate instructions for servicing available		P
7	ADDITIONAL REQUIREMENTS FOR SPECIFIC LASER PRODUCTS		P
7.1	Applicable other parts of the standard series IEC/EN 60825		P
	IEC 60825-2 (Safety of optical communication systems)		P
	IEC 60825-2 (Safety of optical communication systems)		P
	IEC 60825-12(Safety of free space optical communication systems used for transmission of information)		P
	Further information may be found in:		P
	IEC/TR 60825-3 (Guidance for laser displays and shows)		P
	IEC/TR 60825-5(Manufacturer's checklist for IEC 60825-1)		P
	IEC/TR 60825-8 (Guidelines for the safe use of laser beams on humans)		P
	IEC/TR 60825-9 (Compilation of maximum permissible exposure to incoherent optical radiation)		P
	IEC/TR 60825-10(Application guidelines and explanatory notes to IEC 60825-1)		P
	IEC/TR 60825-13(Measurements for classification of laser products)		P
	IEC/TR 60825-14(A user's guide)		P
	IEC 62471 (CIE S 009)(Photobiological safety of lamps and lamp system)		P
7.2	Medical laser products		P
	Class 3B and Class 4 medical laser products comply with IEC 60601-2-22		P
7.3	Laser processing machines		P
	Comply with IEC/ISO 11553-1		P
7.4	Electric toys		P
	Comply with IEC 62115		P
7.5	Consumer electronic products		P
	Complying with IEC 60950 or IEC 60065		P
8	CLASSIFICATION		P
8.2	Classification responsibilities		P
8.3	Classification rules		P
8.3a	Radiation of a single wavelength		P
8.3b	Radiation of multiple wavelengths		P
	1)Laser product emission two or more wavelengths in spectral regions shown as additive in Table 5...		P
	2)Laser product emission two or more wavelengths in spectral regions not shown as additive in Table 5		P

8.3c	Radiation from extended sources		P
	Value of angular subtense α(mrad)	Assume small source (C6=1)	P
8.3d	Non-uniform retinal image radiance profile,non- circular and multiple sources		P
8.3e	Time basis		P
	1)0.25s		P
	2)100s		P
	3)30000s		P
8.3f	Repetitively pulsed or modulated lasers		P
	1)Exposure from any single pulse not exceeding the AEL for a single pulse		P
	2)Average power for a pulse train		P
	3a)Constant pulse energy and pulse duration		P
	3b)Varying pulse widths or varying pulse durations		P
9	DETERMINATION OF ACCESSIBLE EMISSION LEVELS		P
9.1	Tests		P
	Single fault eliminated		P
	Housing material withstanding degradation		P
	Fault detection		P
9.2	Measurement conditions	a,b,c,d,e,f,g	P
	Measured laser radiation		P
9.3	Measurement geometry		P
9.3.1	General,evaluation scheme		P
	a)Simplified (default)method		P
	b)Increased AEL by parameter C_6		P
9.3.2	Default (simplified)evaluation		P
	Condition applied	Condition 3	P
	Aperture stop diameter (mm)	7mm	P
	Measurement distance (mm)	100mm	P
9.3.3	Extended sources		P
	C_6		P
9.3.3a	Aperture diameters		P
	Condition applied		P
	Aperture stop diameter (mm)		P
	Angular subtense of the apparent source a		P
9.3.3b	Angle of acceptance		P
	Condition applied		P
	1)Photochemical retinal limits		P
	Angel of acceptance		P
	2)All other retinal limits		P
	Angel of acceptance		P

Annex

Photo of Product

/Photo/

Nameplate

Cutting machine

Model(s): T3

CE

Manufacturer: Chaohan Intelligent Equipment Co., Ltd

Address: 7 Qianshan Road, Anxi Industrial Park, Yuhang District, Hangzhou City, Zhejiang Province