Technical Construction File

File No:JS-TL202506011079

Date:2025-06-11

According to

2006/42/EC/Machinery Directive
2014/35/EU/Low Voltage Directive

related to the

Product Name: Cut-Off Machine

Test Model: Table CUT-200

Trade Mark: TROJAN

Model: CT-2300, CT-250, CT-300, CT-200, Table CUT-200, Beta-250, Beta-300, Beta-400, Beta-500, DS-180

its variants and modifications,

presented by

Trooly (Suzhou) Technology Co., Ltd.
Room 1079, Building 6, No.2 Luoxiang Road,
Gusu District, Suzhou,China

Part I:General

1.1. General description of the product.

The detail descriptions of these machines please see instruction manual.

Basically, this kind of machine belongs to simple machine and with low risk when using it.All possible risks have been analysis in the risk assessment report and been prevent by suitable ways.

The main risk of this kind of Cut-Off Machine could be:
- The risk of access to the power transmission elements.
- The risk of access to the area between moving parts and fixed parts which with entanglement hazards.
- The risk of access to the in-running nips .

In order to prevent the main risks mentioned above, the protection guarding system is provided, and all the detail safety provision are constructed in accordance with the requirement of EN ISO 12100.

In order to ensure the conformity for CE marking for these Cut-Off Machine,
some main European and/or International standards have been used to made assessment of conformity, they are:
－EN ISO 12100 for carrying out risk assessment and risk reduction；
－EN 60204-1 Safety of machinery - Electrical equipment of machines -- Part 1: General requirements

The test reports for these applicable standards in detail have been included in the relevant sub-clauses of this technical construction file.

1.2. Quality control system

In order to ensure the conformity of the series production, the Factory has taken the related procedures mentioned below:

（1） Carry out the inspection for parts and components according to the TCF

Before the assemblies of the series production, the QC engineers of factory has to check and inspect the technical specifications and intended functions of parts and components to ensure the correct use of them according to the contents of TCF and principle described in the related technical information.

（2） Carry out the inspection,testing for the products before packing

Before packing the products, the QC engineers of factory have to do the necessary inspection and testing to ensure the conformity of related requirements, in particularly, the testing and inspection of electrical characteristics and outer feature.

（3） Carry out the inspection for the packing

After finishing the necessary inspection and testing for the products, an inspection for the packing has to be done to ensure the necessary elements being included in this packing before shipment.

（4） Provision for the change of design

Any change of the products described in this TCF must be checked in detail and written down again in the TCF by the designer of factory if the change may effects the related electrical or mechanical characteristics.

（5） Provision for the Quality Assurance

For the provisions of internal control measures to ensure the conformity of series production of the machines, the factory has built an internal quality control system in accordance with the international standard of ISO-9001.

EN ISO 12100
Safety of machinery - General principles for design
- Risk assessment and risk reduction
EN 60204-1
Safety of machinery - Electrical equipment of machines
Part 1: General requirements

Report Number.....	JS-TL202506011079
Date of Issue.....	Jun. 11,2025
Number of pages.....	90
Applicant's Name.....	Trooly (Suzhou) Technology Co., Ltd.
Address.....	Room 1079, Building 6, No.2 Luoxiang Road, Gusu District, Suzhou,China
Manufacturer.....	Trojan(Suzhou) Material technology Co., Ltd.
Address.....	Building 26, No.228 Gongtang Road, Luzhi Town, Wuzhong Suzhou, Jiangsu, China
Factory.....	Trojan(Suzhou) Material technology Co., Ltd.
Address.....	Building 26, No.228 Gongtang Road, Luzhi Town, Wuzhong Suzhou, Jiangsu, China
Specification:	
Standard.....	EN ISO 12100:2010, EN 60204-1:2018
Test procedure.....	CE-MD+LVD Directive
Non-standard test method.....	N/A
Item description.....	Cut-Off Machine
Trade Mark.....	TROJAN
Model/Type reference.....	CT-2300, CT-250, CT-300, CT-200, Table CUT-200, Beta-250, Beta-300, Beta-400, Beta-500, DS-180
Ratings.....	See copy of marking plate

List of Attachments (including a total number of pages in each attachment):

The Europe union

Appendix I-Photo documentation-attachment 4 pages.

Copy of marking plate:

The artwork below may be only a draft.

"The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks"

Product Name		Cut-Off Machine
Model		Table CUT-200
Wheel	Speed	500-3000rpm
	Diameter	Φ200mm
	Arbor	Φ12.7/Φ22mm
Electrical	Voltage / frequency	220-240V/50Hz
	Motor Power	1.0KW
	Touch screen	5 inch
	Cut types	Manual control with joystick or automatic feeding
Cutting capacity	Maximum Cutting Diameter	Φ50mm
	Maximum Square Cross-Section	50x126mm
Workbench	Vising Table Size	465x270mm
	Travel	240mm
Cooling tank	Capacity	5L
Dimension	W×D×H	570×717×405mm (open:570×717×900mm)
Manufacturer	Trojan(Suzhou) Material technology Co., Ltd.	
Address	Building 26, No.228 Gongtang Road, Luzhi Town, Wuzhong Suzhou, Jiangsu, China	
Weight		63kg

Possible case verdicts:
- test case does not apply to the test object .....: N(.A.)
- test object does meet the requirement .....: P(ass)
- test object does not meet the requirement .....: F(ail)

Date of receipt of test item.....:	May 18, 2025
Date(s) of performance of test.....:	May 19, 2025 to Jun. 10,2025
Sample appearance and function are in normal condition, yes or no.....:	Yes
Ambient temperature.....:	24-26℃
Ambient humidity.....:	60-65%

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing testing laboratory.
"(See Enclosure #)" refers to additional information appended to the report.
"(See appended table)" refers to a table appended to the report.

Throughout this report a ☐ comma / ☒ point is used as the decimal separator.

General product information:

These models listed in this report, them shared the very similar construction / appearance and mostcritical components , the used motors for them were from the same manufacturer with very similar manufacturing process and shared the same working principle / internal material.

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
4.	Strategy for risk assessment and risk reduction		P
	To implement risk assessment and risk reduction the designer shall take the following actions, in the order given (see Figure 1):		P
	a) determine the limits of the machinery, which include the intended use and any reasonably foreseeable misuse thereof;		P
	b) identify the hazards and associated hazardous situations;		P
	c) estimate the risk for each identified hazard and hazardous situation;		P
	d) evaluate the risk and take decisions about the need for risk reduction;		P
	e) Eliminate the hazard or reduce the risk associated with the hazard by means of protective measures.		P
	Actions a) to d) are related to risk assessment and e) to risk reduction.		P
	Risk assessment is a series of logical steps to enable, in a systematic way, the analysis and evaluation of the risks associated with machinery.		P
	Risk assessment is followed, whenever necessary, by risk reduction. Iteration of this process can be necessary to eliminate hazards as far as practicable and to adequately reduce risks by the implementation of protective measures.		P
	It is assumed that, when present on machinery, a hazard will sooner or later lead to harm if no protective measure or measures have been implemented. Examples of hazards are given in Annex B.		P
	Protective measures are the combination of the measures implemented by the designer and the user in accordance with Figure 2. Measures which can be incorporated at the design stage are preferable to those implemented by the user and usually prove more effective.		P
	The objective to be met is the greatest practicable risk reduction, taking into account the four below factors.The strategy defined in this clause is represented by the flowchart in Figure 1. The process itself is iterative and several successive applications can be necessary to reduce the risk, making the best use of available technology. In carrying out this process, it is necessary to take into account these four factors, in the following order of preference:		P
	- the safety of the machine during all the phases of its life cycle;		P
	- the ability of the machine to perform its function;		P
	- the usability of the machine;		P
	- the manufacturing, operational and dismantling costs of the machine.		P
	NOTE 1 The ideal application of these principles requires knowledge of the use of the machine, the accident history and health records, available risk reduction techniques, and the legal framework in which the machine is to be used.		P

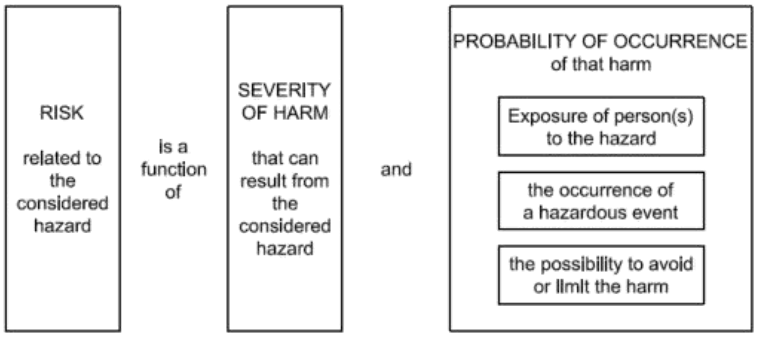
EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	NOTE 2 A machine design which is acceptable at a particular time could be no longer justifiable when technological development allows the design of an equivalent machine with lower risk.		P
5	Risk assessment		P
5.1	General		P
	Risk assessment comprises (see Figure 1)		P
	- risk analysis, comprising 1. determination of the limits of the machinery (see 5.3), 2. hazard identification (5.4 and Annex B), and 3. risk estimation (see 5.5), and		P
	- risk evaluation (see 5.6).		P
	Risk analysis provides information required for the risk evaluation, which in turn allows judgments to be made about whether or not risk reduction is required.		P
	These judgments shall be supported by a qualitative or, where appropriate, quantitative estimate of the risk associated with the hazards present on the machinery.		P
	NOTE A quantitative approach can be appropriate when useful data is available. However, a quantitative approach is restricted by the useful data that are available and/or the limited resources of those conducting the risk assessment. Therefore, in many applications only qualitative risk estimation will be possible.		P
	The risk assessment shall be documented according to Clause 7.		P
5.2	Information for risk assessment		P
	The information for risk assessment should include the following.		P
	a) Related to machinery description: 1) user specifications; 2) anticipated machinery specifications,Including i) a description of the various phases of the whole life cycle of the machinery, ii) design drawings or other means of establishing the nature of the machinery, and iii) required energy sources and how they are supplied; 3) documentation on previous designs of similar machinery, if relevant; 4) information for use of the ma chinery, as available.		P
	b) Related to regulations, standards and other applicable documents: 1) applicable regulations; 2) relevant standards; 3) relevant technical specifications; 4) relevant safety data sheets.		P
	c) Related to experience of use: 1) any accident, incident or malfunction history of the actual or similar machinery; 2) the history of damage to health resulting, for example, from emissions (noise, vibration, dust,		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	fumes, etc.), chemicals used or materials processed by the machinery; 3) the experience of users of similar machines and, whenever practicable, an exchange of information with the potential users. NOTE An incident that has occurred and resulted in harm can be referred to as an “accident”, whereas an incident that has occurred and that did not result in harm can be referred to as a “near miss” or “dangerous occurrence”.		
	d) Relevant ergonomic principles. The information shall be updated as the design develops or when modifications to the machine are required. Comparisons between similar hazardous situations associated with different types of machinery are often possible, provided that sufficient information about hazards and accident circumstances in those situations is available. NOTE The absence of an accident history, a small number of accidents or low severity of accidents ought not to be taken as a presumption of a low risk.		P
	For quantitative analysis, data from databases, handbooks, laboratories or manufacturers' specifications may be used, provided that there is confidence in the suitability of the data. Uncertainty associated with these data shall be indicated in the documentation (see Clause 7).		P
5.3	Determination of limits of machinery		P
5.3.1	General		P
	Risk assessment begins with the determination of the limits of the machinery, taking into account all the phases of the machinery life. This means that the characteristics and performances of the machine or a series of machines in an integrated process, and the related people, environment and products, should be identified in terms of the limits of machinery as given in 5.3.2 to 5.3.5.		P
5.3.2	Use limits		P
	Use limits include the intended use and the reasonably foreseeable misuse. Aspects to be taken into account include the following:		P
	a) the different machine operating modes and different intervention procedures for the users, including interventions required by malfunctions of the machine;		P
	b) the use of the machinery (for example, industrial, non-industrial and domestic) by persons identified by sex, age, dominant hand usage, or limiting physical abilities (visual or hearing impairment, size, strength, etc.);		P
	c) the anticipated levels of training, experience or ability of users including 1) operators, 2) maintenance personnel or technicians, 3) trainees and apprentices, and 4) the general public;		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	d) exposure of other persons to the hazards associated with the machinery where it can be reasonably foreseen: 1) persons likely to have a good awareness of the specific hazards, such as operators of adjacent machinery; 2) persons with little awareness of the specific hazards but likely to have a good awareness of site safety procedures, authorized routes, etc., such as administration staff; 3) persons likely to have very little awareness of the machine hazards or the site safety procedures, such as visitors or members of the general public, including children.		P
	If specific information is not available in relation to b), above, the manufacturer should take into account general information on the intended user population (for example, appropriate anthropometric data).		P
5.3.3	Space limits		P
	Aspects of space limits to be taken into account include a) the range of movement, b) space requirements for persons interacting with the machine, such as during operation and maintenance, c) human interaction such as the operator–machine interface, and d) the machine–power supply interface.		P
5.3.4	Time limits		P
	Aspects of time limits to be taken into account include a)the life limit of the machinery and/or of some of its components (tooling, parts that can wear, electromechanical components, etc.), taking into account its intended use and reasonably foreseeable misuse, and b) recommended service intervals.		P
5.3.5	Other limits		P
	Examples of other limits include a) properties of the material(s) to be processed, b) housekeeping — the level of cleanliness required, and c) environmental — the recommended minimum and maximum temperatures, whether the machine can be operated indoors or outdoors, in dry or wet weather, in direct sunlight, tolerance to dust and wet, etc.		P
5.4	Hazard identification		P
	After determination of the limits of the machinery, the essential step in any risk assessment of the machinery is the systematic identification of reasonably foreseeable hazards (permanent hazards and those which can appear unexpectedly), hazardous situations and/or hazardous events during all phases of the machine life cycle, i.e.:		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	- transport, assembly and installation; - commissioning; - use; - dismantling, disabling and scrapping.		P
	Only when hazards have been identified can steps be taken to eliminate them or to reduce risks. To accomplish this hazard identification, it is necessary to identify the operations to be performed by the machinery and the tasks to be performed by persons who interact with it, taking into account the different parts, mechanisms or functions of the machine, the materials to be processed, if any, and the environment in which the machine can be used.		P
	The designer shall identify hazards taking into account the following.		P
	a) Human interaction during the whole life cycle of the machine Task identification should consider all tasks associated with every phase of the machine life cycle as given above. Task identification should also take into account, but not be limited to, the following task categories: - setting; - testing; - teaching/programming; - process/tool changeover; - start-up; - all modes of operation; - feeding the machine; - removal of product from machine; - stopping the machine; - stopping the machine in case of emergency; - recovery of operation from jam or blockage; - restart after unscheduled stop; - fault-finding/trouble-shooting (operator intervention); - cleaning and housekeeping; - preventive maintenance; - corrective maintenance.		P
	All reasonably foreseeable hazards, hazardous situations or hazardous events associated with the various tasks shall then be identified. Annex B gives examples of hazards, hazardous situations and hazardous events to assist in this process.Several methods are available for the systematic identification of hazards. See also ISO/TR 14121-2.		P
	In addition, reasonably foreseeable hazards, hazardous situations or hazardous events not directly related to tasks shall be identified. EXAMPLE Seismic events, lightning, excessive snow loads, noise, break-up of machinery, hydraulic hose burst.		P
	b) Possible states of the machine These are as follows: 1) the machine performs the intended function (the machine operates normally); 2) the machine does not perform the intended		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	function (i.e. it malfunctions) due to a variety of reasons, including - variation of a property or of a dimension of the processed material or of the workpiece, - failure of one or more of its component parts or services, - external disturbances (for example, shocks, vibration, electromagnetic interference), - design error or deficiency (for example, software errors), - disturbance of its power supply, and - surrounding conditions (for example, damaged floor surfaces).		
	c) Unintended behaviour of the operator or reasonably foreseeable misuse of the machine Examples include - loss of control of the machine by the operator(especially for hand-held or mobile machines), - reflex behaviour of a person in case of malfunction, incident or failure during the use of the machine, - behaviour resulting from lack of concentration or carelessness, - behaviour resulting from taking the “line of least resistance” in carrying out a task, - behaviour resulting from pressures to keep the machine running in all circumstances, and - behaviour of certain persons (for example, children, disabled persons). NOTE Examination of the available design documentation can be a useful means of identifying hazards related to the machinery, particularly those associated with moving elements such as motors or hydraulic cylinders.		P
5.5	Risk estimation		P
5.5.1	General		P
	After hazard identification, risk estimation shall be carried out for each hazardous situation by determining the elements of risk given in 5.5.2. When determining these elements, it is necessary to take into account the aspects given in 5.5.3.		P
	If standardized (or other suitable) measurement methods exist for an emission, they should be used, in conjunction with existing machinery or prototypes, to determine emission values and comparative emission data. This makes it possible for the designer to		P
	- estimate the risk associated with the emissions, - evaluate the effectiveness of the protective measures implemented at the design stage, - provide potential buyers with quantitative information on emissions in the technical documentation, and - provide users with quantitative information on emissions in the information for use.		P
	Hazards other than emissions that are described by measurable parameters can be dealt with in a		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	similar manner.		
5.5.2	Elements of risk		P
5.5.2.1	General		P
	The risk associated with a particular hazardous situation depends on the following elements:		P
	a) the severity of harm;		P
	b) the probability of occurrence of that harm, which is a function of 1) the exposure of person(s) to the hazard, 2) the occurrence of a hazardous event, and 3) the technical and human possibilities to avoid or limit the harm.		P
	The elements of risk are shown in Figure 3. Additional details are given in 5.5.2.2, 5.5.2.3 and 5.5.3.		P
	 **Figure 3 — Elements of risk**		P
5.5.2.2	Severity of harm		P
	The severity can be estimated by taking into account the following:		P
	a) the severity of injuries or damage to health, for example, - slight, - serious, - death.		P
	b) the extent of harm, for example, to - one person, - several persons.		P
	When carrying out a risk assessment, the risk from the most likely severity of the harm that is likely to occur from each identified hazard shall be considered, but the highest foreseeable severity shall also be taken into account, even if the probability of such an occurrence is not high.		P
5.5.2.3	Probability of occurrence of harm		P
5.5.2.3.1	Exposure of persons to the hazard		P
	The exposure of a person to the hazard influences the probability of the occurrence of harm. Factors to be taken into account when estimating the exposure are, among others,		P
	a) the need for access to the hazard zone (for normal operation, correction of malfunction,		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	maintenance or repair, etc.),		
	b) the nature of access (for example, manual feeding of materials),		P
	c) the time spent in the hazard zone,		P
	d) the number of persons requiring access, and		P
	e) the frequency of access.		P
5.5.2.3.2	Occurrence of a hazardous event		P
	The occurrence of a hazardous event influences the probability of occurrence of harm. Factors to be taken into account when estimating the occurrence of a hazardous event are, among others		P
	a) reliability and other statistical data,		P
	b) accident history,		P
	c) history of damage to health, and		P
	d) comparison of risks (see 5.6.3). NOTE The occurrence of a hazardous event can be of a technical or human origin.		P
5.5.2.3.3	Possibility of avoiding or limiting harm		P
	The possibility of avoiding or limiting harm influences the probability of occurrence of harm. Factors to be taken into account when estimating the possibility of avoiding or limiting harm are, among others, the following:		P
	a) different persons who can be exposed to the hazard(s), for example, - skilled, - unskilled;		P
	b) how quickly the hazardous situation could lead to harm, for example, - suddenly, - quickly, - slowly;		P
	c) any awareness of risk, for example, - by general information, in particular, information for use, - by direct observation, - through warning signs and indicating devices,in particular, on the machinery;		P
	d) the human ability to avoid or limit harm (for example, reflex, agility, possibility of escape);		P
	e) practical experience and knowledge, for example - of the machinery, - of similar machinery, - no experience.		P
5.5.3	Aspects to be considered during risk estimation		P
5.5.3.1	Persons exposed		P
	Risk estimation shall take into account all persons (operators and others) for whom exposure to the hazard is reasonably foreseeable.		P
5.5.3.2	Type, frequency and duration of exposure		P
	The estimation of the exposure to the hazard		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	under consideration (including long-term damage to health) requires analysis of, and shall account for, all modes of operation of the machinery and methods of working. In particular, the analysis shall account for the needs for access during loading/ unloading, setting, teaching, process changeover or correction, cleaning, fault-finding and maintenance.		
	The risk estimation shall also take into account tasks, for which it is necessary to suspend protective measures.		P
5.5.3.3	Relationship between exposure and effects		P
	The relationship between an exposure to a hazard and its effects shall be taken into account for each hazardous situation considered. The effects of accumulated exposure and combinations of hazards shall also be considered. When considering these effects, risk estimation shall, as far as practicable, be based on appropriate recognized data. NOTE 1 Accident data can assist in establishing the probability and severity of injury associated with the use of a particular type of machinery with a particular type of protective measure. NOTE 2 Zero accident data is, however, no guarantee of the low probability and severity of an injury.		P
5.5.3.4	Human factors		P
	Human factors can affect risk and shall be taken into account in the risk estimation, including, for example,		P
	a) the interaction of person(s) with the machinery, including correction of malfunction,		N/A
	b) interaction between persons,		P
	c) stress-related aspects,		P
	d) ergonomic aspects,		P
	e) the capacity of persons to be aware of risks in a given situation depending on their training, experience and ability,		P
	f) fatigue aspects, and		P
	g) aspects of limited abilities (due to disability, age, etc.).		P
	Training, experience and ability can affect risk; nevertheless, none of these factors shall be used as a substitute for hazard elimination, risk reduction by inherently safe design measure or safeguarding, wherever these protective measures can be practicably implemented.		P
5.5.3.5	Suitability of protective measures		P
	Risk estimation shall take into account the suitability of protective measures and shall		P
	a) identify the circumstances which can result in harm,		P
	b) whenever appropriate, be carried out using quantitative methods to compare alternative protective measures (see ISO/TR 14121-2), and		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	c) provide information that can assist with the selection of appropriate protective measures.		P
	When estimating risk, those components and systems identified as immediately increasing the risk in case of failure need special attention.		P
	When protective measures include work organization, correct behavior, attention, application of personal protective equipment (PPE), skill or training, the relatively low reliability of such measures compared with proven technical protective measures shall be taken into account in the risk estimation.		P
5.5.3.6	Possibility of defeating or circumventing protective measures		P
	For the continued safe operation of a machine, it is important that the protective measures allow its easy use and do not hinder its intended use. Otherwise, there is a possibility that protective measures might be bypassed in order for maximum utility of the machine to be achieved.		P
	Risk estimation shall take account of the possibility of defeating or circumventing protective measures. It shall also take account of the incentive to defeat or circumvent protective measures when, for example,		N/A
	a) the protective measure slows down production or interferes with another activity or preference of the user,		N/A
	b) the protective measure is difficult to use,		N/A
	c) persons other than the operator are involved, or		N/A
	d) the protective measure is not recognized by the user or not accepted as being suitable for its function.		N/A
	Whether or not a protective measure can be defeated depends on both the type of protective measure, such as an adjustable guard or programmable trip device, and its design details.		N/A
	Protective measures that use programmable electronic systems introduce additional possibilities of defeat or circumvention if access to safety-related software is not appropriately restricted by design and monitoring methods. Risk estimation shall identify where safety-related functions are not separated from other machine functions and shall determine the extent to which access is possible. This is particularly important when remote access for diagnostic or process correction purposes is required.		N/A
5.5.3.7	Ability to maintain protective measures		P
	Risk estimation shall consider whether the protective measures can be maintained in the condition necessary to provide the required level of protection. NOTE If the protective measure cannot easily be maintained in correct working order, this can encourage the defeat or circumvention of the protective measure in order to allow continued		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	use of the machinery.		
5.5.3.8	Information for use		P
	Risk estimation shall take into account the information for use, as available. See also 6.4.		P
5.6	Risk evaluation		P
5.6.1	General		P
	After risk estimation has been completed, risk evaluation shall be carried out to determine if risk reduction is required. If risk reduction is required, then appropriate protective measures shall be selected and applied (see Clause 6). As shown in Figure 1, the adequacy of the risk reduction shall be determined after applying each of the three steps of risk reduction described in Clause 6. As part of this iterative process, the designer shall also check whether additional hazards are introduced or other risks increased when new protective measures are applied. If additional hazards do occur, they shall be added to the list of identified hazards and appropriate protective measures will be required to address them.		P
	Achieving the objectives of risk reduction and a favorable outcome of risk comparison applied when practicable gives confidence that risk has been adequately reduced.		P
5.6.2	Adequate risk reduction		P
	Application of the three-step method described in 6.1 is essential in achieving adequate risk reduction.		P
	Following the application of the three-step method, adequate risk reduction is achieved when		P
	- all operating conditions and all intervention procedures have been considered,		P
	- the hazards have been eliminated or risks reduced to the lowest practicable level,		P
	- any new hazards introduced by the protective measures have been properly addressed,		P
	- users are sufficiently informed and warned about the residual risks (see 6.1, step 3),		P
	- protective measures are compatible with one another,		P
	- sufficient consideration has been given to the consequences that can arise from the use in a nonprofessional / non-industrial context of a machine designed for professional/industrial use, and		P
	- the protective measures do not adversely affect the operator's working conditions or the usability of the machine.		P
5.6.3.	Comparison of risks		P
	As part of the process of risk evaluation, the risks associated with the machinery or parts of machinery can be compared with those of similar machinery or parts of machinery, provided the following criteria apply:		P

EN ISO 12100			
Clause	Requirement + Test	Result-Remark	Verdict
	- the similar machinery is in accordance with relevant type-C standard(s);		N/A
	- the intended use, reasonably foreseeable misuse and the way both machines are designed and constructed are comparable;		P
	- the hazards and the elements of risk are comparable;		P
	- the technical specifications are comparable;		P
	- the conditions for use are comparable.		P
	The use of this comparison method does not eliminate the need to follow the risk assessment process as described in this International Standard for the specific conditions of use. For example, when a band saw used for cutting meat is compared with a band saw used for cutting wood, the risks associated with the different material shall be assessed.		P
6	Risk reduction		P
6.1	General		P
	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:		P
	- severity of harm from the hazard under consideration; - probability of occurrence of that harm.		P
	All protective measures intended for reaching this objective shall be applied in the following sequence, referred to as the three-step method (see also Figures 1 and 2).		P
	Step 1: Inherently safe design measures Inherently safe design measures eliminate hazards or reduce the associated risks by a suitable choice of design features of the machine itself and/or interaction between the exposed persons and the machine. See 6.2. NOTE 1 This stage is the only one at which hazards can be eliminated, thus avoiding the need for additional protective measures such as safeguarding or complementary protective measures.		P
	Step 2: Safeguarding and/or complementary protective measures Taking into account the intended use and the reasonably foreseeable misuse, appropriately selected safeguarding and complementary protective measures can be used to reduce risk when it is not practicable to eliminate a hazard, or reduce its associated risk sufficiently, using inherently safe design measures. See 6.3.		P
	Step 3: Information for use Where risks remain despite inherently safe design measures, safeguarding and the adoption of complementary protective measures, the residual risks shall be identified in the information for use. The information for use shall include, but not be		P

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Clause	Requirement + Test	Result-Remark	Verdict
	limited to, the following: - operating procedures for the use of the machinery consistent with the expected ability of personnel who use the machinery or other persons who can be exposed to the hazards associated with the machinery; - the recommended safe working practices for the use of the machinery and the related training requirements adequately described; - sufficient information, including warning of residual risks for the different phases of the life of the machinery; - the description of any recommended personal protective equipment, including detail as to its need as well as to training needed for its use. Information for use shall not be a substitute for the correct application of inherently safe design measures, safeguarding or complementary protective measures.		
	NOTE 2 Adequate protective measures associated with each of the operating modes and intervention procedures reduce the possibility of operators being induced to use hazardous intervention techniques in case of technical difficulties.		N/A
6.2	Inherently safe design measures		P
6.2.1	General		P
	Inherently safe design measures are the first and most important step in the risk reduction process. This is because protective measures inherent to the characteristics of the machine are likely to remain effective, whereas experience has shown that even well-designed safeguarding can fail or be violated and information for use may not be followed.		P
	Inherently safe design measures are achieved by avoiding hazards or reducing risks by a suitable choice of design features for the machine itself and/or interaction between the exposed persons and the machine.		P
	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).		P
6.2.2	Consideration of geometrical factors and physical aspects		P
6.2.2.1	Geometrical factors		P
	Such factors include the following.		P
	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 human vision, particularly when safe operation requires permanent direct control by the operator, for example:		P

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Clause	Requirement + Test	Result-Remark	Verdict
	- 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 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).		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 angles, no rough surfaces, no protruding parts likely to cause injury, and no openings which can “trap” parts of the body or clothing. In particular, sheet metal edges shall be deburred, flanged or trimmed, and open ends of tubes which can cause a “ trap” shall be capped.		P
	d) The form of the machine is designed so as to achieve a suitable working position and provide accessible manual controls (actuators).		P
6.2.2.2	Physical aspects		P
	Such aspects include the following:		P
	a) limiting the actuating force to a sufficiently low value so that the actuated part does not generate a mechanical hazard;		P
	b) limiting the mass and/or velocity of the movable elements, and hence their kinetic energy;		N/A
	c) limiting the emissions by acting on the characteristics of the source using measures for reducing 1) noise emission at source (see ISO/TR 11688-1), 2) the emission of vibration at source, such as redistribution or addition of mass and changes of process parameters [for example, frequency and/or amplitude of movements (for hand-held and hand-guided machinery, see CR 1030-1)], 3) the emission of hazardous substances, including the use of less hazardous substances or dust-reducing processes (granules instead of powders, milling instead of grinding), and 4) radiation emissions, including, for example, avoiding the use of hazardous radiation sources, limiting the power of radiation to the lowest level sufficient for the proper functioning of the machine, designing the source so that the		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	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 EN12198-3)].		
6.2.3	Taking into account general technical knowledge of machine design		P
	This general technical knowledge can be derived from technical specifications for design (standards, design codes, calculation rules, etc.), which should be used to cover		P
	a) mechanical stresses such as - stress limitation by implementation of correct calculation, construction and fastening methods as regards, for example, bolted assemblies and welded assemblies, - stress limitation by overload prevention (bursting disk, pressure-limiting valves, breakage points, torque-limiting devices,etc.), - avoiding fatigue in elements under variable stresses (notably cyclic stresses), and - static and dynamic balancing of rotating elements,		P
	b) materials and their properties such as - resistance to corrosion, ageing, abrasion and wear, - hardness, ductility, brittleness, - homogeneity, - toxicity, and - flammability, and		P
	c) emission values for - noise, - vibration, - hazardous substances, and - radiation.		P
	When the reliability of particular components or assemblies is critical for safety (for example, ropes, chains, lifting accessories for lifting loads or persons), stress limits shall be multiplied by appropriate working coefficients.		P
6.2.4	Choice of appropriate technology		P
	One or more hazards can be eliminated or risks reduced by the choice of the technology to be used in certain applications such as the following:		P
	a) on machines intended for use in explosive atmospheres, using - appropriately selected pneumatic or hydraulic control system and machine actuators, - intrinsically safe electrical equipment (see IEC 60079-11);		N/A
	b) for particular products to be processed (for example, by a solvent), by using equipment that ensures the temperature will remain far below the flash point;		P
	c) the use of alternative equipment to avoid high noise levels, such as - electrical instead of pneumatic equipment, - in certain conditions, water-cutting instead of		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	mechanical equipment.		
6.2.5	Applying principle of positive mechanical action		P
	Positive mechanical action is achieved when a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements. An example of this is positive opening operation of switching devices in an electrical circuit (see IEC 60947-5-1 and ISO 14119). NOTE Where a mechanical component moves and thus allows a second component to move freely (for example, by gravity or spring force), there is no positive mechanical action of the first component on the second.		P
6.2.6	Provisions for stability		P
	Machines shall be designed so that they have sufficient stability to allow them to be used safely in their specified conditions of use. Factors to be taken into account include		P
	- the geometry of the base, - the weight distribution, including loading, - the dynamic forces due to movements of parts of the machine, of the machine itself or of elements held by the machine which can result in an overturning moment, - vibration, - oscillations of the centre of gravity, - characteristics of the supporting surface in case of travelling or installation on different sites (ground conditions, slope, etc.), and - external forces, such as wind pressure and manual forces.		P
	Stability shall be considered in all phases of the life cycle of the machine, including handling, travelling, installation, use, dismantling, disabling and scrapping.		P
	Other protective measures for stability relevant to safeguarding are given in 6.3.2.6.		P
6.2.7	Provisions for maintainability		P
	When designing a machine, the following maintainability factors shall be taken into account to enable maintenance of the machine:		P
	- accessibility, taking into account the environment and the human body measurements, including the dimensions of the working clothes and tools used; - ease of handling, taking into account human capabilities; - limitation of the number of special tools and equipment.		P
6.2.8	Observing ergonomic principles		P
	Ergonomic principles shall be taken into account in designing machinery so as to reduce the mental or physical stress of, and strain on, the operator. These principles shall be considered when allocating functions to operator and machine (degree of automation) in the basic design.		P

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	NOTE Also improved are the performance and reliability of operation and hence the reduction in the probability of errors at all stages of machine use.		
	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 ISO10075-2).		P
	All elements of the operator- machine interface, such as controls, signalling or data display elements, shall be designed to be easily understood so that clear and unambiguous interaction between the operator and the machine is possible. See EN 614-1, EN 13861 and IEC 61310-1.		P
	The designer's attention is particularly drawn to following ergonomic aspects of machine design.		P
	a) Avoid the necessity for stressful postures and movements during the use of the machine (for example, providing facilities to adjust the machine to suit the various operators).		N/A
	b) Design machines, especially hand-held and mobile machines, so as to enable them to be operated easily, taking into account human effort, actuation of controls and hand, arm and leg anatomy.		P
	c) Limit as far as possible noise, vibration and thermal effects such as extreme temperatures.		P
	d) Avoid linking the operator's working rhythm to an automatic succession of cycles.		N/A
	e) Provide 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 or 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), - they can be safely operated without hesitation or loss of time and without ambiguity (for example, 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), - their location (for push-buttons) and their movement (for levers and hand wheels) are consistent with their effect (see IEC 61310-3), and - their operation cannot cause additional risk. See also ISO 9355-3. Where a control is designed and constructed to		P

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	perform several different actions — namely, where there is no one-to-one correspondence (for example, keyboards) — the action to be performed shall be clearly displayed and subject to 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. Constraints due to the necessary or foreseeable use of personal protective equipment (such as footwear, gloves) shall be taken into account.		
	g) Select, design and locate indicators, dials and visual display units so that - they fit within the parameters and characteristics of human perception, - 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, and - the operator is able to perceive them from the control position.		N/A
6.2.9	Electrical hazards		N/A
	For the design of the electrical equipment of machines, IEC 60204-1 gives general provisions about disconnection and switching of electrical circuits and for protection against electric shock. For requirements related to specific machines, see corresponding IEC standards (for example, IEC 61029, IEC 60745 or IEC 60335).		N/A
6.2.10	Pneumatic and hydraulic hazards		N/A
	Pneumatic and hydraulic equipment of machinery shall be designed so that		N/A
	- the maximum rated pressure cannot be exceeded in the circuits (using, for example, pressure-limiting devices),		N/A
	- no hazard results from pressure fluctuations or increases, or from loss of pressure or vacuum,		N/A
	- 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 (such as in gas-loaded accumulators) comply with the applicable design standard codes or regulations for these elements,		N/A
	- all elements of the equipment, especially pipes and hoses, are protected against harmful external effects,		N/A
	- as far as possible, reservoirs and similar vessels (for example, gas-loaded accumulators) are automatically depressurized when isolating the machine from its power supply (see 6.3.5.4) and, if not possible, means are provided for their isolation, local depressurizing and pressure indication (see also ISO 14118:2000, Clause 5), and		N/A
	- all elements which remain under pressure after isolation of the machine from its power supply are		N/A

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	provided with clearly identified exhaust devices, and there is a warning label drawing attention to the necessity of depressurizing those elements before any setting or maintenance activity on the machine.		
	NOTE See also ISO 4413 and ISO 4414.		N/A
6.2.11	Applying inherently safe design measures to control systems		P
6.2.11.1	General		P
	The design measures of the control system shall be chosen so that their safety-related performance provides a sufficient amount of risk reduction (see ISO 13849-1 or IEC 62061).		P
	The correct design of machine control systems can avoid unforeseen and potentially hazardous machine behaviour.		P
	Typical causes of hazardous machine behaviour are - an unsuitable design or modification (accidental or deliberate) of the control system logic, - a temporary or permanent defect or failure of one or several components of the control system, - a variation or a failure in the power supply of the control system, and - inappropriate selection, design and location of the control devices.		N/A
	Typical examples of hazardous machine behaviour are - unexpected start-up (see ISO 14118), - uncontrolled speed change, - failure to stop moving parts, - dropping or ejection of part of the machine or of a workpiece clamped by the machine, and - machine action resulting from inhibition(defeating or failure) of protective devices.		P
	In order to prevent hazardous 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. These principles and methods shall be applied singly or in combination as appropriate to the circumstances (see ISO 13849-1, IEC 60204-1 and IEC 62061).		N/A
	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; - provision for specific operating modes (for example, 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); - clear display of the faults; - measures to prevent accidental generation of unexpected start commands (for example,shrouded start device) likely to cause dangerous machine behaviour (see ISO 14118:2000, Figure 1);		N/A

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	- maintained stop commands (for example, interlock) to prevent restarting that could result in dangerous machine behaviour (see ISO 14118:2000, Figure 1).		
	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. The different zones shall be clearly defined and it shall be obvious which parts of the machine belong to which zone. Likewise, it shall be obvious which control devices (for example, emergency stop devices, supply disconnecting devices) and/or protective devices belong to which zone. 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.		P
	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 (for example, range, speed, acceleration, deceleration, load capacity). Allowance shall be made for dynamic effects (swinging of loads, etc.).		N/A
	For example: - the travelling speed of mobile pedestrian controlled machinery other than remote-controlled shall be compatible with walking speed; - 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; - the range of movements of parts of machinery for lifting loads shall be kept within specified limits.		N/A
	When the machinery contains various elements that can be operated independently, the control system shall be designed to prevent risks arising out of a lack of coordination (for example, collision prevention system).		N/A
6.2.11.2	Starting of an internal power source/switching on an external power supply		P
	The starting of an internal power source or switching-on of an external power supply shall not result in a hazardous situation.		P
	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.		P
	See IEC 60204-1:2005, 7.5 (see also Annexes A and B).		N/A
6.2.11.3	Starting/stopping of a mechanism		N/A
	The primary action for starting or accelerating the movement of a mechanism should be performed by the application or an increase of voltage or fluid pressure, or - if binary logic elements are considered - by passage from state 0 to state 1		N/A

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	(where state 1 represents the highest energy state).		
	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 passage from state 1 to state 0 (where state 1 represents the highest energy state).		N/A
	In certain applications, such as high-voltage switchgear, this principle cannot be followed, in which case other measures should be applied to achieve the same level of confidence for the stopping or slowing down.		N/A
	When, in order for the operator to maintain permanent control of deceleration, this principle is not observed (for example, a hydraulic braking device 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.		N/A
6.2.11.4	Restart after power interruption		N/A
	If a hazard could be generated, the spontaneous restart of a machine when it is re-energized after power interruption shall be prevented (for example, by use of a self-maintained relay, contactor or valve).		N/A
6.2.11.5	Interruption of power supply		P
	Machinery shall be designed to prevent hazardous situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met: - the stopping function of the machinery shall remain; - all devices whose permanent operation is required for safety shall operate in an effective way to maintain safety (for example, 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.		P
6.2.11.6	Use of automatic monitoring		N/A
	Automatic monitoring is intended to ensure that a safety function or functions implemented by a protective measure do not fail to be performed if the ability of a component or an element to perform its function is diminished, or if the process conditions are changed such that hazards are generated.		N/A
	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. In either case, the protective measure can be initiated immediately or delayed until a specific event occurs (for example, the		N/A

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	beginning of the machine cycle).		
	The protective measure may be, for example, - the stopping of the hazardous process, - preventing the restart of this process after the first stop following the failure, or - the triggering of an alarm.		N/A
6.2.11.7	Safety functions implemented by programmable electronic control systems		N/A
6.2.11.7.1	General		N/A
	A control system that includes programmable electronic equipment (for example, programmable controllers) can, where appropriate, be used to implement safety functions at machinery. Where a programmable electronic control system is used, it is necessary to consider its performance requirements in relation to the requirements for the safety functions. 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) is sufficiently low. Where a programmable electronic control system performs a monitoring function, the system behaviour on detection of a fault shall be considered (see also the IEC 61508 series for further guidance).		N/A
	NOTE Both ISO 13849-1 and IEC 62061, specific to machinery safety, provide guidance applicable to programmable electronic control systems.		N/A
	The programmable electronic control system should be installed and validated to ensure that the specified performance [for example, safety integrity level (SIL) in IEC 61508] for each safety function has been achieved. Validation comprises testing and analysis (for example, static, dynamic or failure analysis) to show that all parts interact correctly to perform the safety function and that unintended functions do not occur.		N/A
6.2.11.7.2	Hardware aspects		N/A
	The hardware (including, for example, sensors, actuators and 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 - architectural constraints (the configuration of the system, its ability to tolerate faults, its behaviour on detection of a fault, etc.), - selection, and/or design, of equipment and devices with an appropriate probability of dangerous random hardware failure, and - the incorporation of measures and techniques within the hardware so as to avoid systematic failures and control systematic faults.		N/A
6.2.11.7.3	Software aspects		N/A
	The software, including internal operating		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	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).		
	Application software should not be reprogrammable by the user. This may be achieved by use of embedded software in a non-reprogrammable memory [for example, micro-controller, application-specific integrated circuit (ASIC)].		N/A
	When the application requires reprogramming by the user, the access to the software dealing with safety functions should be restricted (for example, by locks or passwords for the authorized persons).		N/A
6.2.11.8	Principles relating to manual control		P
	These are as follows.		P
	a) Manual control devices shall be designed and located according to the relevant ergonomic principles given in 6.2.8, item f).		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.		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.		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. 1) 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. 2) 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 by means of, among others, a portable control unit (such as a teach pendant), with which the operator can 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		N/A

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	ISO 9355-1, ISO 9355-3 and ISO 447).		
	g) For machine functions whose safe operation depends on permanent, direct control by the operator, measures shall be implemented to ensure the presence of the operator at the control position (for example, by the design and location of control devices).		N/A
	h) For cableless control, an automatic stop shall be performed when correct control signals are not received, including loss of communication (see IEC 60204-1).		N/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 be 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 into operation, the safety of the operator shall be achieved using a specific control mode which simultaneously		N/A
	a) disables all other control modes, b) permits operation of the hazardous elements only by continuous actuation of an enabling device, a two-hand control device or a hold-to-run control device, c) permits operation of the hazardous elements only in reduced risk conditions (for example, reduced speed, reduced power/force, step-by-step, for example, with a limited movement control device), and d) prevents any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. NOTE For some special machinery other protective measures can be appropriate.		N/A
	This control mode shall be associated with one or more of the following measures: - restriction of access to the danger zone as far as possible; - emergency stop control within immediate reach of the operator; - portable control unit (teach pendant) and/or local controls (allowing sight of the controlled elements). See IEC 60204-1.		N/A
6.2.11.10	Selection of control and operating modes		N/A
	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 (for example, to allow for adjustment, setting, maintenance, inspection), it shall be 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

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Clause	Requirement + Test	Result-Remark	Verdict
	The selector may be replaced by another selection means which restricts the use of certain functions of the machinery to certain categories of operators (for example, access codes for certain numerically controlled functions).		N/A
6.2.11.11	Applying measures to achieve electromagnetic compatibility (EMC)		P
	For guidance on electromagnetic compatibility, see IEC 60204-1 and IEC 61000-6.		P
6.2.11.12	Provision of diagnostic systems to aid fault- finding		N/A
	Diagnostic systems to aid fault-finding should be included in the control system so that there is no need to disable any protective measure. NOTE Such systems not only improve availability and maintainability of machinery, they also reduce the exposure of maintenance staff to hazards		N/A
6.2.12	Minimizing probability of failure of safety functions		P
6.2.12.1	General		P
	Safety of machinery is not only dependent on the reliability of the control systems but also on the reliability of all parts of the machine.		P
	The continued operation of the safety functions is essential for the safe use of the machine. This can be achieved by the measures given in 6.2.12.2 to 6.2.12.4.		P
6.2.12.2	Use of reliable components		P
	“Reliable components” means components which are capable of withstanding all disturbances and stresses associated with the usage of the equipment in the conditions of intended use (including the environmental conditions), for the period of time or the number of operations fixed for the use, with a low probability of failures generating a hazardous malfunctioning of the machine. Components shall be selected taking into account all factors mentioned above (see also 6.2.13).		P
	NOTE 1 “Reliable components” is not a synonym for “well-tried components” (see ISO 13849-1:2006, 6.2.4).		N/A
	NOTE 2 Environmental conditions for consideration include impact, vibration, cold, heat, moisture, dust, corrosive and/or abrasive substances, static electricity and magnetic and electric fields. Disturbances which can be generated by those conditions include insulation failures and temporary or permanent failures in the function of control system components.		P
6.2.12.3	Use of “oriented failure mode” components		N/A
	“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 the effect of such a failure on the machine function can be predicted.		N/A
	NOTE In some cases, it will be necessary to take additional measures to limit the negative effects of such a failure.		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	The use of such components should always be considered, particularly in cases where redundancy (see 6.2.12.4) is 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 components continue to perform the respective function(s), thereby ensuring that the safety function remains available.		N/A
	In order to allow the proper action to be initiated, component failure shall be detected by automatic monitoring (see 6.2.11.6) or in some circumstances by regular inspection, 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 (for example, from electromagnetic disturbance) or common mode failures.		N/A
6.2.13	Limiting exposure to hazards through reliability of equipment		N/A
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring intervention, thereby reducing exposure to hazards.		N/A
	This applies to power systems (operative part, see Annex A) as well as to control systems, and to safety functions as well as to other functions of machinery.		N/A
	Safety-related components (for example, certain sensors) of known reliability shall be used.		N/A
	The elements of guards and of protective devices shall be especially reliable, as their failure can expose persons to hazards, and also because poor reliability would encourage attempts to defeat them.		N/A
6.2.14	Limiting exposure to hazards through mechanization or automation of loading (feeding)/unloading (removal) operations		N/A
	Mechanization and automation of machine loading/ unloading operations and, more generally, of handling operations — of workpieces, materials or substances — limits the risk generated by these operations by reducing the exposure of persons to hazards at the operating points.		N/A
	Automation can be achieved by, for example, robots, handling devices, transfer mechanisms and air-blast equipment. Mechanization can be achieved by, for example, feeding slides, push-rods and hand-operated indexing tables.		N/A
	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 corrected. Care shall be taken to ensure that the use of these devices does not introduce further hazards, such as trapping or crushing, between the devices and parts of the machine or workpieces/materials being processed.		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	Suitable safeguards (see 6.3) shall be provided if this cannot be ensured.		
	Automatic feeding and removal devices with their own control systems and the control system of the associated machine shall be interconnected after thorough study of how all safety functions are performed in all the control and operation modes of the entire equipment.		N/A
6.2.15	Limiting exposure to hazards through location of setting and maintenance points outside danger zones		N/A
	The need for access to danger zones shall be minimized by locating maintenance, lubrication and setting points outside these zones.		N/A
6.3	Safeguarding and complementary protective measures		P
6.3.1	General		P
	Guards and protective devices shall be used to protect persons whenever an inherently safe design measure does not reasonably make it possible either to remove hazards or to sufficiently reduce risks. Complementary protective measures involving additional equipment (for example, emergency stop equipment) may have to be implemented. NOTE The different kinds of guards and protective devices are defined in 3.27 and 3.28.		P
	Certain safeguards may be used to avoid exposure to more than one hazard. EXAMPLE A fixed guard preventing access to a zone where a mechanical hazard is present used to reduce noise levels and collect toxic emissions.		P
6.3.2	Selection and implementation of guards and protective devices		P
6.3.2.1	General		P
	This subclause gives guidelines for the selection and the implementation of guards and protective devices the primary purpose of which is to protect persons against hazards 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).		P
	The exact choice of a safeguard for a particular machine shall be made on the basis of the risk assessment for that machine.		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 the access of an operator into a danger zone is not required during the normal operation (operation without malfunction) of the machinery.		P
	As the need for frequency of access increases, this inevitably leads to the fixed guard not being replaced. This requires the use of an alternative protective measure (movable interlocking guard, sensitive protective equipment).		P

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Clause	Requirement + Test	Result-Remark	Verdict
	A combination of safeguards can 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 access to the primary hazard zone, a trip device can be required to protect against the secondary drawing-in or shearing hazard between the mechanical loading (feeding) device, when reachable, and the fixed guard.		P
	Consideration shall be given to the enclosure of control positions or intervention zones to provide combined protection against several hazards including		P
	a) hazards from falling or ejected objects, using, for example, protection in the form of a falling object protection structure (FOPS),		N
	b) emission hazards (protection against noise, vibration, radiation, substances hazardous to health, etc.)		P
	c) hazards due to the environment (protection against heat, cold, foul weather, etc.)		P
	d) hazards due to tipping over or rolling over of machinery, using, for example, protection in the form of roll-over or tip-over protection structures (ROPS and TOPS).		N/A
	The design of enclosed work stations, such as cabs and cabins, shall take into account ergonomic principles concerning visibility, lighting, atmospheric conditions, access, posture.		P
6.3.2.2	Where access to the hazard zone is not required during normal operation		P
	Where access to the hazard zone is not required during normal operation of the machinery, safeguards should be selected from the following:		P
	a) fixed guards (see also ISO 14120);		P
	b) interlocking guards with or without guard locking (see also 6.3.3.2.3, ISO 14119 and ISO 14120);		N/A
	c) self-closing guards (see ISO 14120:2002,3.3.2);		N/A
	d) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496) or pressure-sensitive protective devices (see ISO 13856).		N/A

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Clause	Requirement + Test	Result-Remark	Verdict

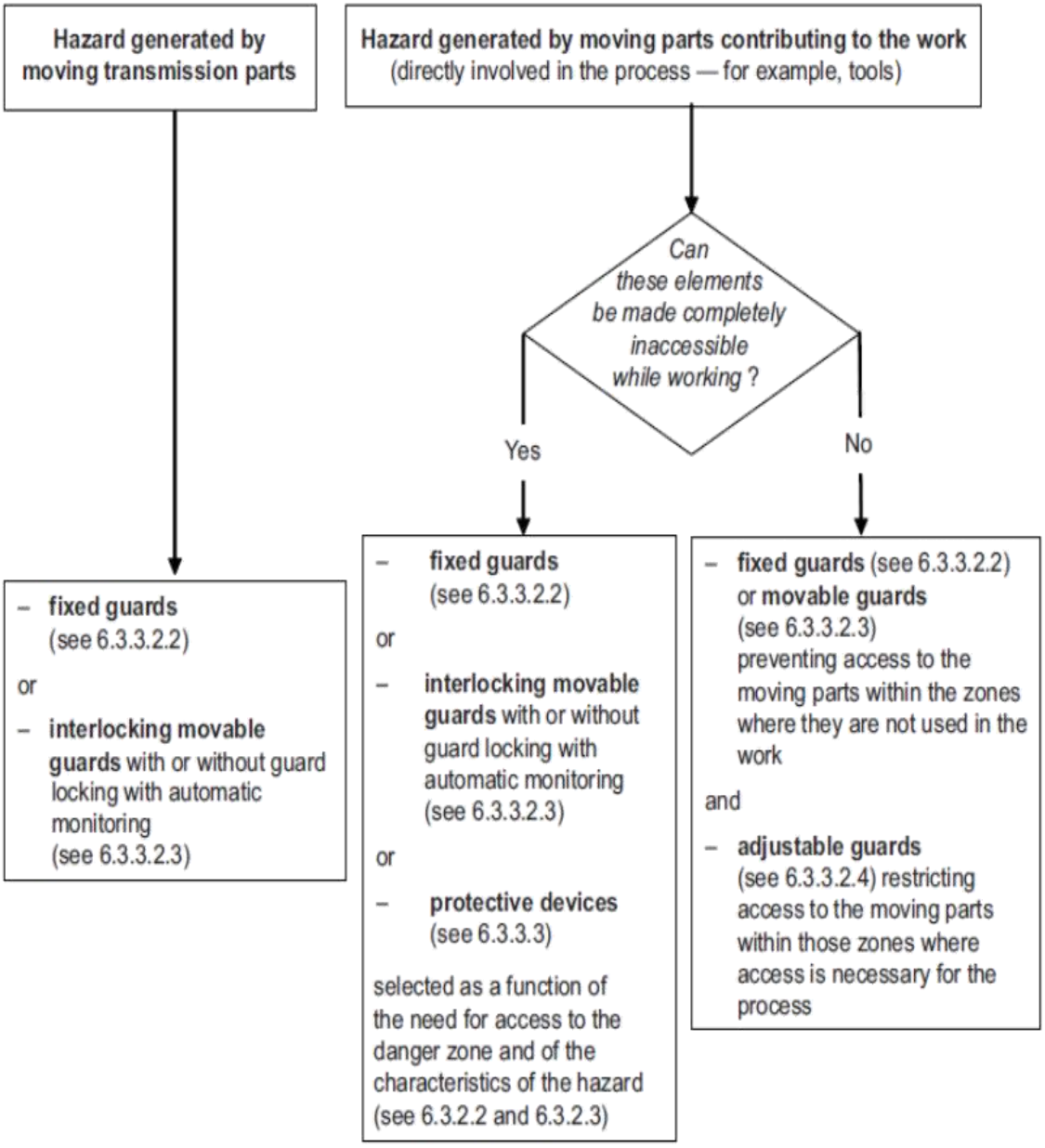


Figure 4 — Guidelines for choosing safeguards against hazards generated by moving parts

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Clause	Requirement + Test	Result-Remark	Verdict
6.3.2.3	Where access to the hazard zone is required during normal operation		N/A
	Where access to the hazard zone is required during normal operation of the machinery, safeguards should be selected from the following:		N/A
	a) interlocking guards with or without guard locking (see also ISO 14119, ISO 14120 and 6.3.3.2.3 of this document);		N/A
	b) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496);		N/A
	c) adjustable guards;		N/A
	d) self-closing guards (see ISO 14120:2002, 3.3.2);		N/A
	e) two-hand control devices (see ISO 13851);		N/A
	f) interlocking guards with a start function (control guard) (see 6.3.3.2.5).		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		N/A
	As far as possible, machines shall be designed so that the safeguards provided for the protection of the production operator also ensure the protection of personnel carrying out setting, teaching, process changeover, fault-finding, cleaning or maintenance, without hindering them in the performance of their task. Such tasks shall be identified and considered in the risk assessment as parts of the use of the machine (see 5.2). NOTE Isolation and energy dissipation for machine shut-down (see 6.3.5.4, and also ISO 14118:2000, 4.1 and Clause 5) ensure the highest level of safety when carrying out tasks (especially maintenance and repair tasks) that do not require the machine to remain connected to its power supply.		N/A
6.3.2.5	Selection and implementation of sensitive protective equipment		N/A
6.3.2.5.1	Selection		N/A
	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. 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 - light curtains, - scanning devices, for example, laser scanners - pressure-sensitive mats, and - trip bars, trip wires.		N/A
	Sensitive protective equipment can be used - for tripping purposes, - for presence sensing, - for both tripping and presence sensing, or - to re-initiate machine operation — a practice		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	subject to stringent conditions.		
	NOTE Some types of sensitive protective equipment can be unsuitable either for presence sensing or for tripping purposes.		N/A
	The following characteristics of the machinery, among others, can preclude the sole use of sensitive protective equipment: - tendency for the machinery to eject materials or component parts; - necessity to guard against emissions (noise, radiation, dust, etc.); - erratic or excessive machine stopping time; - inability of a machine to stop part-way through a cycle.		N/A
6.3.2.5.2	Implementation		N/A
	Consideration should be given to		N/A
	a) the 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) the reaction of the device to fault conditions (see IEC 61496 for electrosensitive protective equipment),		N/A
	c) the possibility of circumvention, and		N/A
	d) detection capability and its variation over the course of time (as a result, for example, of its susceptibility to different environmental conditions such as the presence of reflecting surfaces, other artificial light sources and sunlight or impurities in the air).		N/A
	NOTE 1 IEC 61496 defines the detection capability of electrosensitive protective equipment.		N/A
	Sensitive protective equipment shall be integrated in the operative part and associated with the control system of the machine so that		N/A
	- 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), and therefore the command given by the sensitive protective equipment is 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, and		N/A
	- the position and the shape of the detection field prevents, possibly together with fixed guards, a person or part of a person from entering or being present in the hazard zone without being detected.		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	NOTE 2 Muting is the temporary automatic suspension of a safety function(s) by safety-related parts of the control system (see ISO 13849-1)		N/A
	For detailed consideration of the fault behaviour of, for example, active optoelectronic protective devices, IEC 61496 should be taken into account.		N/A
6.3.2.5.3	Additional requirements for sensitive protective equipment when used for cycle initiation		N/A
	In this exceptional application, the 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:		N/A
	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 the 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 AOPDs 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
	NOTE 1 The hazard zone as referred to in d) is any zone where the hazardous function (including ancillary equipment and transmission elements) is initiated by clearing of the sensing field. NOTE 2 See also IEC/TS 62046.		N/A
6.3.2.6	Protective measures for stability		P
	If stability cannot be achieved by inherently safe design measures such as weight distribution (see 6.2.6), it shall be maintained by the use of protective measures such as		P
	- anchorage bolts,		P

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Clause	Requirement + Test	Result-Remark	Verdict
	- locking devices,		P
	- movement limiters or mechanical stops,		P
	- acceleration or deceleration limiters,		N/A
	- load limiters, and		N/A
	- alarms warning of the approach to stability or tipping limits.		N/A
6.3.2.7	Other protective devices		N/A
	When a machine requires continuous control by the operator (for example, 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 (distance, speed, mass, angle, etc.), and		N/A
	- when hazards can result from operations other than those controlled by the operator.		N/A
	The necessary devices include		N/A
	a) devices for limiting parameters of movement (distance, angle, velocity, acceleration),		N/A
	b) overloading and moment limiting devices,		N/A
	c) devices to prevent collisions or interference with other machines,		N/A
	d) devices for preventing hazards to pedestrian operators of mobile machinery or other pedestrians,		N/A
	e) torque limiting devices, and breakage points to prevent excessive stress of components and assemblies,		N/A
	f) devices for limiting pressure or temperature,		N/A
	g) devices for monitoring emissions,		N/A
	h) devices to prevent operation in the absence of the operator at the control position,		N/A
	i) devices to prevent lifting operations unless stabilizers are in place,		N/A
	j) devices to limit inclination of the machine on a slope, and		N/A
	k) devices to ensure that components are in a safe position before travelling.		N/A
	Automatic protective measures triggered by such devices that take operation of the machinery out of the control of the operator (for example, 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 design of guards and protective devices		P
6.3.3.1	General requirements		P
	Guards and protective devices shall be designed to be suitable for the intended use, taking into account mechanical and other hazards involved.		P

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Clause	Requirement + Test	Result-Remark	Verdict
	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.		
	NOTE For additional information, see ISO 14120, ISO 13849-1, ISO 13851, ISO 14119, ISO 13856, IEC 61496 and IEC 62061.		N/A
	Guards and protective devices shall		P
	a) be of robust construction,		P
	b) not give rise to any additional hazard,		P
	c) not be easy to bypass or render non- operational,		P
	d) be located at an adequate distance from the danger zone (see ISO 13855 and ISO 13857),		P
	e) cause minimum obstruction to the view of the production process, and		N/A
	f) enable essential work to be carried out for the installation and/or replacement of tools and for maintenance by allowing access only to the area where the work has to be carried out — if possible, without the guard having to be removed or protective device having to be disabled.		P
	For openings in the guards, see ISO 13857.		P
6.3.3.2	Requirements for guards		P
6.3.3.2.1	Functions of guards		P
	The functions that guards can achieve are - prevention of access to the space enclosed by the guard, and/or		P
	- containment/capture of materials, workpieces, chips, liquids which can be ejected or dropped by the machine, and reduction of emissions (noise, radiation, hazardous substances such as dust, fumes, gases) that can be generated by the machine.		P
	Additionally, they could need to have particular properties relating to electricity, temperature, fire, explosion, vibration, visibility (see ISO 14120) and operator position ergonomics (for example, usability, operator's movements, postures, repetitive movements).		P
6.3.3.2.2	Requirements for fixed guards		P
	Fixed guards shall be securely held in place either - permanently (for example by welding), or		P
	- by means of fasteners (screws, nuts) making removal/opening impossible without using tools; they should not remain closed without their fasteners (see ISO 14120).		P
	NOTE A fixed guard can be hinged to assist in its opening.		P
6.3.3.2.3	Requirements for movable guards		N/A
	Movable guards which provide protection against hazards generated by moving transmission parts shall a) as far as possible when open remain fixed to		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	the machinery or other structure (generally by means of hinges or guides), and b) be interlocking (with guard locking when necessary) (see ISO 14119). See Figure 4.		
	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 started up, with this able to be achieved by interlocking guards, with guard locking when necessary, - they can be adjusted only by an intentional action, such as the use of a tool or a key, and - the absence or failure of one of their components either prevents starting of the moving parts or stops them, with this able to be achieved by automatic monitoring (see 6.2.11.6). See Figure 4 and ISO 14119.		N/A
6.3.3.2.4	Requirements for adjustable guards		N/A
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed.		N/A
	Manually adjustable guards shall be - designed so that the adjustment remains fixed during a given operation, and - readily adjustable without the use of tools.		N/A
6.3.3.2.5	Requirements for interlocking guards with a start function (control guards)		N/A
	An interlocking guard with a start function may only be used provided that		N/A
	a) all requirements for interlocking guards are satisfied (see ISO 14119),		N/A
	b) the cycle time of the machine is short,		N/A
	c) the maximum opening time of the guard is preset to a low value (for example, equal to the cycle time) and, when this time is exceeded, the hazardous function(s) cannot be initiated by the closing of the interlocking guard with a start function and resetting is necessary before restarting the machine,		N/A
	d) 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
	e) all other guards, whether fixed (removable type) or movable, are interlocking guards,		N/A
	f) the interlocking device associated with the interlocking guard with a start function is designed such that - for example, by duplication of position detectors and use of automatic monitoring (see 6.2.11.6) - its failure cannot lead to an unintended/unexpected start-up, and		N/A
	g) the guard is securely held open (for example, by a spring or counterweight) such that it cannot		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	initiate a start while falling by its own weight.		
6.3.3.2.6	Hazards from guards		P
	Care shall be taken to prevent hazards which could be generated by - the guard construction (sharp edges or corners, material, noise emission, etc.), - the movements of the guards (shearing or crushing zones generated by power-operated guards and by heavy guards which are liable to fall).		P
6.3.3.3	Technical characteristics of protective devices		N/A
	Protective devices shall be selected or designed and connected to the control system such that correct implementation of their safety function(s) is ensured.		N/A
	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 IEC 62061.		N/A
	Protective devices shall be installed and connected to the control system so that they cannot be easily defeated.		N/A
6.3.3.4	Provisions for alternative types of safeguards		N/A
	Provisions should be made to facilitate the fitting of alternative types of safeguards on machinery where it is known that it will be necessary to change the safeguards because of the range of work to be carried out.		N/A
6.3.4	Safeguarding to reduce emissions		P
6.3.4.1	General		P
	If the measures for the reduction of emissions at source specified in 6.2.2.2 are not adequate, the machine shall be provided with additional protective measures (see 6.3.4.2 to 6.3.4.5).		P
6.3.4.2	Noise		P
	Additional protective measures against noise include - enclosures (see ISO 15667), - screens fitted to the machine, and - silencers (see ISO 14163).		P
6.3.4.3	Vibration		N/A
	Additional protective measures against vibration include - vibration isolators, such as damping devices placed between the source and the exposed person, - resilient mounting, and - suspended seats. For measures for vibration isolation of stationary industrial machinery see EN 1299.		N/A
6.3.4.4	Hazardous substances		N/A
	Additional protective measures against hazardous substances include - encapsulation of the machine (enclosure with		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	negative pressure), - local exhaust ventilation with filtration, - wetting with liquids, and - special ventilation in the area of the machine (air curtains, cabins for operators). See ISO 14123-1.		
6.3.4.5	Radiation		N/A
	Additional protective measures against radiation include - use of filtering and absorption, and - use of attenuating screens or guards.		N/A
6.3.5	Complementary protective measures		N/A
6.3.5.1	General		N/A
	Protective measures which are neither inherently safe design measures, nor safeguarding (implementation of guards and/or protective devices), nor information for use, could have to be implemented as required by the intended use and the reasonably foreseeable misuse of the machine. Such measures include, but are not limited to, those dealt with in 6.3.5.2 to 6.3.5.6.		N/A
6.3.5.2	Components and elements to achieve emergency stop function		P
	If, following a risk assessment, a machine needs to be fitted with components and elements to achieve an emergency stop function for enabling actual or impending emergency situations to be averted, the following requirements apply:		P
	- the actuators shall be clearly identifiable, clearly visible and readily accessible; - the hazardous process shall be stopped as quickly as possible without creating additional hazards, but 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 emergency stop control shall trigger or permit the triggering of certain safeguard movements where necessary. NOTE For more detailed provisions,see ISO 13850.		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 reset. This reset shall be possible only at the location where the emergency stop command has been initiated. The reset of the device shall not restart the machinery, but shall only permit restarting.		P
	More details for the design and selection of electrical components and elements to achieve the emergency stop function are provided in IEC 60204.		N/A
6.3.5.3	Measures for the escape and rescue of trapped persons		N/A
	Measures for the escape and rescue of trapped persons may consist, among others, of		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	- escape routes and shelters in installations generating operator-trapping hazards, - arrangements for moving some elements by hand, after an emergency stop, - arrangements for reversing the movement of some elements, - anchorage points for descender devices, - means of communication to enable trapped operators to call for help.		
6.3.5.4	Measures for isolation and energy dissipation		N/A
	Machines shall be equipped with the technical means to achieve isolation from power supply(ies) and dissipation of stored energy by means of the following actions:		N/A
	a) isolating (disconnecting, separating) the machine (or defined parts of the machine) from all power supplies;		N/A
	b) locking (or otherwise securing) all the isolating units in the isolating position;		N/A
	c) dissipating or, if this is not possible or practicable, restraining (containing) any stored energy which can give rise to a hazard;		N/A
	d) verifying, by means of safe working procedures, that the actions taken according to a), b) and c) above have produced the desired effect.		N/A
	See ISO 14118:2000, Clause 5, and IEC 60204-1: 2005, 5.5 and 5.6.		N/A
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 be capable of being provided with suitable attachment devices for transport by means of lifting gear.		P
	These attachments may be, among others, - standardized lifting appliances with slings, hooks, eyebolts, or tapped holes for appliance fixing, - appliances for automatic grabbing with a lifting hook when attachment is not possible from the ground, - fork locating devices for machines to be transported by a lift truck, - lifting and stowing 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.		N/A
	See also 6.4.4 c), item 3).		N/A
6.3.5.6	Measures for safe access to machinery		P
	Machinery shall be so designed as to enable operation and all routine tasks relating to setting and/or maintenance to be carried out as far as possible by a person remaining at ground level.		P
	Where this is not possible, machines shall have built-in platforms, stairs or other facilities to provide safe access for those tasks; however, care should be taken to ensure that such platforms or stairs do not give access to danger zones of machinery.		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	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, shall be provided with suitable guard-rails (see ISO 14122-3).		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 height shall be provided with collective means of protection against falls (for example, guard-rails for stairways, stepladders and platforms and/or safety cages for ladders). As necessary, anchorage points for personal protective equipment against falls from height shall also be provided (for example, 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 (steps, handholds, etc.). 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 interlocking guards for preventing falls when the platform is not present at a level. Movement of the lifting platform shall be prevented while the guards are open.		N/A
	For detailed provisions see ISO 14122.		N/A
6.4	Information for use		P
6.4.1	General requirements		P
6.4.1.1	Drafting information for use is an integral part of the design of a machine (see Figure 2). Information for 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. Information for use is intended for professional and/or non-professional users. NOTE See also IEC 62079 for structuring and presentation of information for use.		P
6.4.1.2	Information shall be provided to the user about the intended use of the machine, taking into account, notably, all its operating modes.		P
	The information shall contain all directions required to ensure safe and correct use of the machine. With this in view, it shall inform and warn the user about residual risk.		P
	The information shall indicate, as appropriate, - the need for training, - the need for personal protective equipment, and - the possible need for additional guards or protective devices (see Figure 2, Footnote d).		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		P

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Clause	Requirement + Test	Result-Remark	Verdict
	would result from using the machine in other ways than the ones described in the information, especially considering its reasonably foreseeable misuse.		
6.4.1.3	Information for use shall cover, separately or in combination, transport, assembly and installation, commissioning, use of the machine (setting, teaching/programming or process changeover, operation, cleaning, fault-finding and maintenance) and, if necessary, dismantling, disabling and scrapping.		P
6.4.2	Location and nature of information for use		P
	Depending on the risk, the time when the information is needed by the user and the machine design, it shall be decided whether the information — or parts thereof — are to be given		P
	a) in/on the machine itself (see 6.4.3 and 6.4.4),		P
	b) in accompanying documents (in particular instruction handbook, see 6.4.5),		P
	c) on the packaging,		P
	d) by other means such as signals and warnings outside the machine		P
	Standardized phrases shall be considered where important messages such as warnings are given (see also IEC 62079).		P
6.4.3	Signals and warning devices		P
	Visual signals, such as flashing lights and audible signals such as sirens may be used to warn of an impending hazardous event such as machine start-up or overspeed. Such signals may also be used to warn the operator before the triggering of automatic protective measures (see 6.3.2.7).		P
	It is essential that these signals		P
	a) be emitted before the occurrence of the hazardous event,		P
	b) be unambiguous,		P
	c) be clearly perceived and differentiated from all other signals used, and		P
	d) be clearly recognized by the operator and other persons.		P
	The warning devices shall be designed and located such that checking is easy. The information for use shall prescribe regular checking of warning devices.		P
	The attention of designers is drawn to the possibility of “sensorial saturation”, which can result from too many visual and/or acoustic signals and which can also lead to defeating the warning devices. NOTE Consultation of the user on this subject is often necessary.		P
6.4.4	Markings, signs (pictograms) and written warnings		P
	Machinery shall bear all markings which are necessary		P
	a) for its unambiguous identification, including at least		P

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Clause	Requirement + Test	Result-Remark	Verdict
	1) the name and address of the manufacturer, 2) the designation of series or type, and 3) the serial number, if any,		
	b) in order to indicate its compliance with mandatory requirements, comprising 1) marking, and 2) written indications, such as the authorized representative of the manufacturer, designation of the machinery, year of construction, and intended use in potentially explosive atmospheres),		P
	c) for its safe use, for example, 1) maximum speed of rotating parts, 2) maximum diameter of tools, 3) mass (in kilograms) of the machine itself and/or of removable parts, 4) maximum working load, 5) necessity of wearing personal protective equipment, 6) guard adjustment data, and 7) frequency of inspection.		P
	Information printed directly on the machine should be permanent and remain legible throughout the expected life of the machine.		P
	Signs or written warnings indicating only “Danger” shall not be used.		P
	Markings, signs and written warnings shall be readily understandable and unambiguous, especially as regards the part of the function(s) of the machine to which they are related. Readily understandable signs (pictograms) should be used in preference to written warnings.		P
	Signs and pictograms should only be used if they are understood in the culture in which the machinery is to be used.		P
	Written warnings shall be drawn up in the language(s) of the country in which the machine will be used for the first time and, on request, in the language(s) understood by operators. NOTE In some countries the use of specific language(s) is covered by legal requirements.		P
	Markings shall comply with recognized standards (for example, ISO 2972 or ISO 7000, for pictograms, symbols and colours in particular).		P
	See IEC 60204-1 as regards marking of electrical equipment.		N/A
	See ISO 4413 and ISO 4414 for hydraulic and pneumatic equipment.		N/A
6.4.5	Accompanying documents (in particular - instruction handbook)		P
6.4.5.1	Contents		P
	The instruction handbook or other written instructions (for example, on the packaging) shall contain, among others, the following:		P

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Clause	Requirement + Test	Result-Remark	Verdict
	a) information relating to transport, handling and storage of the machine, such as 1) storage conditions for the machine, 2) dimensions, mass value(s), position of the centre(s) of gravity, and 3) indications for handling (for example, drawings indicating application points for lifting equipment);		P
	b) information relating to installation and commissioning of the machine, such as 1) fixing/anchoring and dampening of noise and vibration requirements, 2) assembly and mounting conditions, 3) space needed for use and maintenance, 4) permissible environmental conditions (for example, temperature, moisture, vibration, electromagnetic radiation), 5) instructions for connecting the machine to power supply (particularly on protection against electrical overloading), 6) advice on waste removal/disposal, and 7) if necessary, recommendations related to protective measures which have to be implemented by the user — for example, additional safeguards (see Figure 2, Footnote d), safety distances, safety signs and signals;		P
	c) information relating to the machine itself, such as 1) detailed description of the machine, its fittings, guards and/or protective devices, 2) the 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, 3) diagrams (especially schematic representation of safety functions), 4) data on noise and vibration generated by the machine, and on radiation, gases, vapours and dust emitted by it, with reference to the measuring methods (including measurement uncertainties) used, 5) technical documentation of electrical equipment (see IEC 60204), and 6) documents attesting that the machine complies with mandatory requirements;		P
	d) information relating to the use of the machine, such as that related to or describing 1) intended use, 2) manual controls (actuators), 3) setting and adjustment, 4) modes and means for stopping (especially emergency stop), 5) risks which could not be eliminated by the protective measures implemented by the designer,		P

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Clause	Requirement + Test	Result-Remark	Verdict
	6) particular risks which can be generated by certain applications, by the use of certain fittings, and about specific safeguards necessary for such applications, 7) reasonably foreseeable misuse and prohibited applications, 8) fault identification and location, for repair and for restarting after an intervention, and 9) personal protective equipment needed to be used and the training that is required;		
	e) information for maintenance, such as 1) the nature and frequency of inspections for safety functions, 2) specification of the spare parts to be used when these can affect the health and safety of operators, 3) instructions relating to maintenance operations which require a definite technical knowledge or particular skills and hence need to be carried out exclusively by skilled persons (for example, maintenance staff, specialists), 4) instructions relating to maintenance actions (replacement of parts, etc.) which do not require specific skills and hence may be carried out by users (for example, operators), and 5) drawings and diagrams enabling maintenance personnel to carry out their task rationally (especially fault-finding tasks);		P
	f) information relating to dismantling, disabling and scrapping;		P
	g) information for emergency situations, such as 1) the operating method to be followed in the event of accident or breakdown, 2) the type of fire-fighting equipment to be used, and 3) a warning of possible emission or leakage of hazardous substance(s) and, if possible, an indication of means for fighting their effects;		P
	h) maintenance instructions provided for skilled persons [item e) 3) above] and maintenance instructions provided for unskilled persons [item e) 4) above], that need to appear clearly separated from each other.		P
6.4.5.2	Production of instruction handbook		P
	The following applies to the production and presentation of the instruction handbook.		P
	a) The type fount and size of print shall ensure the best possible legibility. Safety warnings and/or cautions should be emphasized by the use of colours, symbols and/or large print.		P
	b) The 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 is to be used,		P

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Clause	Requirement + Test	Result-Remark	Verdict
	each should be readily distinguished from another, and efforts should be made to keep the translated text and relevant illustration together. NOTE In some countries the use of specific language(s) is covered by legal requirements.		
	c) Whenever helpful to the understanding, text should be supported by illustrations. These illustrations should be supplemented with written details enabling, for example, manual controls (actuators) to be located and identified. They should not be separated from the accompanying text and should follow sequential operations.		P
	d) Consideration should be given to presenting information in tabular form where this will aid understanding. Tables should be adjacent to the relevant text.		P
	e) The use of colours should be considered, particularly in relation to components requiring quick identification.		P
	f) When information for use is lengthy, a table of contents and/or an index should be provided.		P
	g) Safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator.		P
6.4.5.3	Drafting and editing information for use		P
	The following applies to the drafting and editing of information for use.		P
	a) Relationship to model: the information shall clearly relate to the specific model of machine and, if necessary, other appropriate identification (for example, by serial number)		P
	b) Communication principles: when information for use is being prepared, the communication process “see – think – use” should be followed in order to achieve the maximum effect and should follow sequential operations. The questions, “How?” and “Why?” should be anticipated and the answers provided.		P
	c) Information for use shall be as simple and as brief as possible, and should be expressed in consistent terms and units with a clear explanation of unusual technical terms.		P
	d) When it is foreseen that a machine will be put to non-professional use, the instructions should be written in a form that is readily understood by the non-professional user. If personal protective equipment is required for the safe use of the machine, clear advice should be given, for example, on the packaging as well as on the machine, so that this information is prominently displayed at the point of sale.		P
	e) Durability and availability of the documents: documents giving instructions for use should be		P

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Clause	Requirement + Test	Result-Remark	Verdict
	produced in durable form (i.e. they should be able to survive frequent handling by the user). It can be useful to mark them “keep for future reference”. Where information for use is kept in electronic form (CD, DVD, tape, hard disk, etc.), information on safety-related issues that need immediate action shall always be backed up with a hard copy that is readily available.		
7	Documentation of risk assessment and risk reduction		P
	The documentation shall demonstrate the procedure that has been followed and the results that have been achieved. This includes, when relevant, documentation of		P
	a) the machinery for which the risk assessment has been made (for example, specifications, limits, intended use);		P
	b) any relevant assumptions that have been made (loads, strengths, safety factors, etc.);		P
	c) the hazards and hazardous situations identified and the hazardous events considered in the risk assessment;		P
	d) the information on which risk assessment was based (see 5.2): 1) the data used and the sources (accident histories, experience gained from risk reduction applied to similar machinery, etc.); 2) the uncertainty associated with the data used and its impact on the risk assessment;		P
	e) the risk reduction objectives to be achieved by protective measures;		P
	f) the protective measures implemented to eliminate identified hazards or to reduce risk;		P
	g) residual risks associated with the machinery;		P
	h) the result of the risk assessment (see Figure 1);		P
	i) any forms completed during the risk assessment.		P
	Standards or other specifications used to select protective measures referred to in f) above should be referenced. NOTE No requirement is given in thismInternational Standard to deliver the risk assessment documentation together with the machine. See ISO/TR 14121-2 for information on documentation.		P

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Clause	Requirement + Test	Result-Remark	Verdict
4	**GENERAL REQUIREMENTS**		-
4.1	General		-
	Hazards relevant to the electrical equipment are assessed as part of the overall risk assessment of the machine.		P
4.2	Selection of equipment		-
	Electrical components/devices suitable for their intended use and applied in accordance with Supplier's instructions.		P
4.2.2	Where possible electrical equipment in compliance with the IEC 60439 series.		P
4.3	Electrical supply		-
4.3.1	Electrical equipment to be designed for correct operation within the conditions of mains power supply - as stated below (cl. 4.3.2 or 4.3.3)		P
	or as stated by the user (record specs in this TR)		P
	or as stated by the supplier [1]		P
4.3.2	AC supplies		-
	Supply Voltage: Steady state voltage: 0,9 ... 1,1 of nominal voltage		P
	Frequency: 0,99 ... 1,01 of nominal frequency continuously; 0,98 ... 1,02 short time.		P
	Harmonics: not exceeding 10 % of the total r.m.s. etc.		P
	Voltage unbalance: not exceeding 2% deviation.		P
	Voltage interruption: interrupted or at zero voltage for not more than 3 ms at any random time in the supply cycle with more than 1 s between successive interruptions.		P
	Voltage dips not exceeding 20 % of the peak voltage of the supply for more than one cycle with more than 1 s between successive dips.		P
4.3.3	DC supplies		-
	Supply Voltage: - other:0,85 to 1,15 of nominal voltage; - battery-operated vehicles: 0,7 to 1,2 of nom. volt. - from converting equipment: 0,9 to 1,1 of nom.volt.		N/A
	Voltage interruption: - other: not exceeding 5 ms - converting equipment: not exceeding 20 ms		N/A
	Ripple (peak-to-peak): not exceed. 0,15 of nom. volt.		N/A
4.3.4	Special supply systems; e.g. on board generators limits acc. 4.3.2 /.3 exceeded, but equipment designed acc. exceeded limits.		N/A
4.4	Physical environment and operating conditions		-
4.4.1	Electrical equipment suitable for the physical environment and operating conditions of its intended use.		P
4.4.2	Electromagnetic compatibility (EMC): Equipment shall not generate electromagnetic		P

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	disturbances above levels that are appropriate for its intended operating environment and shall have a level of immunity to electromagnetic disturbances so that it can function in its intended environment (IEC 61000-6-1 or IEC 61000-6-2 and CISPR 61000-6-3 or IEC 61000-6-4 give general EMC emission and immunity limits.) Are there sufficient measures to limit the generation of electromagnetic disturbances, i.e. conducted and radiated provided? (E.g. power supply filtering; cable shielding; enclosures designed to minimize RF radiation; RF suppression techniques; design of functional bonding system, using conductors with low RF impedance and as short as practicable.		
4.4.3	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. (Minimum requirement: air temperatures of +5 ℃ and +40 ℃)		P
4.4.4	Electrical equipment shall be capable of operating correctly when the relative humidity is up to 50 % at a maximum temperature of +40 ℃		P
4.4.5	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.		P
4.4.6	Electrical equipment shall be adequately protected against the ingress of solids and liquids (see 11.3)		P
4.4.7	Electrical equipment shall withstand ionizing and non- ionizing radiation.		N/A
4.4.8	Electrical equipment shall withstand vibration, shock and bump.		N/A
4.5	Electrical equipment designed to withstand the effects of transportation and storage within a temperature range of - 25 to + 55 ℃.		P
4.6	Heavy or bulky electrical equipment of the machine provided with suitable means for handling.		P
4.7	Electrical equipment is installed and operated in accordance with the supplier’s instruction.		P

5	**INCOMING SUPPLY CONDUCTOR TERMINATIONS AND DEVICES FOR DISCONNECTING AND SWITCHING OFF**		—
5.1	Incoming supply conductor terminal		—
5.1	Electrical equipment of a machine connected to one single power supply (For large complex machinery comprising a number of widely-spaced machines working together in a coordinated manner, there can be a need for more than one incoming supply depending upon the site supply arrangements)		P
	Power supply conductors terminated to main disconnecting device of electrical equipment (unless a plug is provided for disconnection)		P
	Neutral conductor clearly indicated in technical documentation with “N” (see cl. 16.1)		N/A
	No connection between neutral conductor and protective bonding circuit nor combined PEN-terminals.		N/A

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	Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the power supply to the machine for TN-C systems.		
	All terminals of incoming supply clearly marked in ac. with cl. 16.1 (symbols acc. to EN 60445)		N/A
5.2	Terminal for connection to external protective earthing system		P
	For each incoming supply, a terminal shall be provided in the vicinity of the associated phase conductor terminals for connection of the machine to the external protective earthing system or to the external protective conductor, depending upon the supply distribution system.		P
	Cross section of incoming PE conductor acc. to cl. 5.2, table 1. (Where an external protective conductor of a material other than copper is used, the terminal size shall be selected accordingly. See also 8.2.2).		P
	Protective earth identified either by graphic symbol, Letters “PE” , or bicolour combination GREEN / YELLOW		P
5.3	Supply disconnecting device		—
5.3.1	A supply disconnecting device shall be provided: - for each incoming source of supply to a machine - for each on-board power supply.		P
5.3.2	Type of power supply disconnecting device:		—
	a) Switch-disconnector, acc. to EN 60947-3 for appliance category AC-23 B or DC-23 B		P
	b) Disconnector with or without fuses, with aux. contact (acc. to EN 60947-3)		N/A
	c) Power circuit breaker suitable for isolation (acc. to EN 60947-2)		P
	d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1as well as a utilization category		N/A
	e) Plug/socket combination for electrical load (requirements see cl. 5.3.3)		P
5.3.3	Disconnection device has to fulfil all of the following requirements		—
	- isolate the electrical equipment from the supply and have only one OFF (isolated) and only one ON position marked with "O" and "I"		P
	- visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating function have been satisfied		P
	- have an external operating means e.g.a handle (except power operated CB’s)		P
	- coloured black or grey recommended (If used as an emergency stop, red/yellow combination elected)		P
	- be provided with a means permitting it to be locked in the OFF position (padlocks). When so locked, remote as well as local closing shall be prevented		P
	- disconnect all live conductors of its power supply circuit (For TN supply systems, the neutral conductor may		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory.)		
	Requirements for plug/socket combination as a disconnection device: - Breaking capacity of the plug/socket combination: sufficient to interrupt the current of the largest motor when stalled together with the sum of the normal running currents of all other motors and/or loads. - further see. cl. 13.4.5 a) to f)		P
5.3.4	The operating means are easily accessible and located between 0,6 m and 1,9 m above the servicing level.		P
5.3.5	Only the following circuits need not be disconnected by the supply disconnecting device: - lighting circuits for lighting needed during maintenance or repair; - plug and socket outlets for the exclusive connection of repair or maintenance tools and equipment; - under voltage 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 - control circuits for interlocking Such circuits are provided with their own disconnecting device.		N/A
	Circuits not disconnected by the supply Disconnecting device have: - permanent warning labels in accordance with cl.16.1		N/A
	- a statement is included in the maintenance manual		N/A
	- additionally one or more of the following is applied; - a permanent warning label in accordance with 16.1 is affixed in proximity to each excepted circuit, or - the circuit is separated from other circuits, or - the conductors are identified by colour taking into account the recommendation of Cl.13.2.4.		N/A
5.4	Disconnecting devices to prevent of unexpected start-up:		—
	- Devices for the prevention of unexpected start-up are provided These devices are appropriate and convenient for the intended use, are suitably placed, and readily identifiable as to their function and purpose (for example by a durable marking in accordance with cl. 16.1).		P
	- Means are provided to prevent inadvertent and/or mistaken closure of these devices either at the controller or from other locations		P
	- Devices that do not fulfil the isolation function (e.g. a contactor switched off by a control circuit) are only used for situations that include: – inspections; – adjustments; – no hazardous work on the electrical equipment (for example replacement of plug-in devices		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	without disturbing existing wiring)		
5.5	Devices for disconnecting electrical equipment		—
	- Requirements to devices for disconnecting electrical equipment to enable work to be carried out when it is de-energised and isolated: - appropriate and convenient for the intended use; - suitably placed; - readily identifiable as to which part or circuit of the equipment is served (for example by durable marking in accordance with 16.1 where necessary). - Additional means are provided to prevent of inadvertent and/or mistaken closure of these devices either at the controller or from other locations		P
	- Where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of a number of machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device is provided for each part, or for each machine, requiring separate isolation. In addition to the mentioned supply disconnecting device, the following devices that fulfil the isolation function may be provided for this purpose: – devices described in 5.3.2; – disconnectors, withdrawable fuse links and withdrawable links only if located in an electrical operating area (see 3.15) and relevant information is provided with the electrical equipment (see 17.2 b)9) and b)12)).		N/A
5.6	Protection against unauthorized, inadvertent and/or mistaken connection		—
	For devices acc. to cl. 5.4(disconnecting electrical equipment) and 5.5 (prevention of unexpected start-up) locking means in OFF position are provided and no remote reconnection is possible.		N/A
	Where a non-lockable disconnecting device is provided (for example withdrawable fuse-links, withdrawable links), other means of protection against unintended energising are used.		N/A
	Where plug/socket combinations according to 5.3.2 e) are used for the purpose of prevention of unexpected start-up the are so positioned that they can be kept under the immediate supervision of the person carrying out the work.		P

6	**PROTECTION AGAINST ELECTRIC SHOCK**		-
6.1	The electrical equipment shall provide protection of persons against electric shock by —basic protection(see 6.2 and 6.4),		P
	—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 fromEC 60364-4-41. Where those measures are not practicable, for example due to the physicalor operational conditions,		P

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Clause	Requirement + Test	Result-Remark	Verdict
	Other measures from IEC 60364-4-41 are used. (Description!)		N/A
6.2.2	Protection against direct contact		–
	Live parts that are located inside enclosures have to bee conform to the relevant requirements of Clauses 4, 11, and 14 and have to have a protection against direct contact of at least IP2X or IPXXB.		P
	Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against direct contact provided by the top surfaces shall be IP4X or IPXXD.		P
	Opening an enclosure (i.e. opening doors, lids, covers, and the like) is possible only when: a) Either the use of a key or tool is necessary for access and: - all live parts, that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected are protected against direct contact to at least IP2X or IPXXB - live parts on the inside of doors are protected against direct contact to at least IP1X or IPXXA.		P
	b) Or the opening of an enclosure (i.e. opening doors, lids, covers, and the like) is possible only if disconnection is provided for all live parts inside the enclosure before it can be opened. Exception: If a special device or tool (intended for use only by skilled or instructed persons) as prescribed by the supplier is provided that can be used to defeat the interlock and that intends that: －it is possible at all times while the interlock is defeated to open the disconnecting device and lock the disconnecting device in the OFF position or otherwise prevent unauthorised closure of the disconnecting device; －upon closing the door, the interlock is automatically restored －all live parts, that are likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected are protected against direct contact to at least IP2X or IPXXB －live parts on the inside of doors shall be protected against direct contact to at least IP1X or IPXXA －relevant information is provided with the electrical equipment like instructions on the procedures for securing the machine for safe maintenance and information on the residual risks. －means are provided to restrict access to live parts behind doors not directly interlocked with the disconnecting means to skilled or instructed persons. －parts still alive after switching off are protected at least IP 2X or IP XXB and marked with a warning sign in accordance with 16.2.1 		P

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Clause	Requirement + Test	Result-Remark	Verdict
	Excepted from this marking are: －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.		
	c) Or the opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against direct contact to at least IP2X or IPXXB. Where barriers provide this protection, either they shall require a tool for their removal or all live parts protected by them shall be automatically disconnected when the barrier is removed.		P
6.2.3	Protection by insulation of live parts:		－
	Live parts are completely covered with insulation that can only be removed by destruction and that is capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions.		P
	Paint, varnish lacquer etc. not used as the unique insulation layer.		P
6.2.4	Protection against residual voltages		－
	Live parts with residual voltage greater than 60 V after a time period of 5 s after disconnection of the supply shall be discharged until this interferes with the proper functioning of the equipment. Except are components with charges of ≤ 60 µC (→ equivalent to capacitor with less then 1µF @ 60V).		P
	Where pins of plugs or similar devices after withdrawal are exposed, discharge time is ≤ 1s. Otherwise such conductors are protected against direct contact to at least IP2X or IPXXB.		P
	If above requirements cannot be achieved, additional disconnecting devices or appropriate warning devices shall be applied (e.g. warning acc. cl. 16.1).		P
6.2.5	For protection by barriers, 412.2 of IEC 60364-4-41 is applied		N/A
6.2.6	For protection by placing out of reach, 412.4 of IEC 60364-4-41 shall apply. For protection by obstacles, 412.3 of IEC 60364-4-41 is applied.		N/A
6.3	Protection against indirect contact		－
6.3.2	Prevention of the occurrence of a touch voltage		－
6.3.2.2	Protection by provision of: - class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140) or - switchgear and control gear assemblies having total insulation in accordance with IEC 60439-1or - supplementary or reinforced insulation in accordance with 413.2 of IEC 60364-4-41.		N/A
6.3.2.3	Protection by electrical separation. For this type of protection, the requirements of 413.5		P

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Clause	Requirement + Test	Result-Remark	Verdict
	of IEC 60364-4-41 apply.		
6.3.3	Protection by automatic disconnection of supply.		–
6.3.3 a)	Use of overcurrent protective device for automatic cut-off in the event of an insulation failure in a TN-System. Where disconnection within the time specified in Clause A.1 cannot be assured, supplementary bonding is provided as necessary to meet the requirements of Clause A.3.		N/A
6.3.3 b)	Use of residual current protective devices (RCD) for automatic cut-off in the event of an insulation failure in a TN - or TT -System.		N/A
6.3.3 c)	Use of earth fault detection device to initiate automatic disconnection in a IT-System.		N/A
6.4	Protection by the use of PELV		–
6.4.1 a)	PELV circuits shall satisfy all of the following conditions: -the nominal voltage does not exceed: • 25 V a.c. r.m.s. or 60 V ripple-free d.c. when the equipment is normally used in dry locations and when large area contact of live parts with the human body is not expected; or • 6 V a.c. r.m.s. or 15 V ripple-free d.c. in all other cases;		N/A
6.4.1 b)	one side of the circuit or one point of the source of the supply of that circuit is connected to the protective bonding circuit;		N/A
6.4.1 c)	live parts of PELV circuits is electrically separated from other live circuits		N/A
6.4.1 d)	Conductors of each PELV circuit are physically separated from those of any other circuit. If this requirement is impracticable, the insulation provisions of 13.1.3 are fulfilled;		N/A
6.4.1 e)	plugs and socket-outlets for a PELV circuit are conform to the following: 1) plugs do not to enter socket-outlets of other voltage systems; 2) socket-outlets do not admit plugs of other voltage systems.		N/A
6.4.2	Sources for PELV		—
	The source for PELV shall be one of the following: - safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6 or - a source of current with a degree of safety equivalent to that of the safety isolating transformer or - an source independent of circuit with higher voltage - electronic power supply conforming to appropriate standards		N/A

7.	**PROTECTION OF EQUIPMENT**	-
7.2.	Overcurrent protection Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the overcurrent protective device for the supply conductors to the electrical equipment (see Annex B).	N/A

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Clause	Requirement + Test	Result-Remark	Verdict
7.2.2.	On the installation diagram data necessary for selecting the overcurrent protective device are stated for each incoming feeder. (see 7.2.10 and 17.4)		N/A
7.2.3	Power circuits:		—
	Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10, are applied to each live conductor. And, none of the following conductors, as applicable, is disconnected without disconnecting all associated live conductors: – the neutral conductor of a.c. power circuits; – the earthed conductor of d.c. power circuits; – d.c. power conductors bonded to exposed conductive parts of mobile machines.		N/A
	Cross section area of neutral conductor is at least equal to the phase conductor. No overcurrent protective/ disconnecting device is required. (For a neutral conductor with a cross sectional area smaller than that of the associated phase conductors, the measures detailed in 524 of IEC 60364-5-52 shall apply.)	equal to the phase conductor	P
	IT-Systems:, no neutral conductor is used. Or, when it is used, the measures detailed in 431.2.2 of IEC 60364-4-43 are applied.		N/A
7.2.4	Control circuits		–
	Conductors of control circuits directly connected to the supply voltage and of circuits supplying control circuit transformers are protected against overcurrent in accordance with 7.2.3.		N/A
	Conductors of control circuits supplied by a control circuit transformer or d.c. supply: see 9.4.3.1		–
7.2.5	Socket outlets and their associated conductors		–
	Overcurrent protection is provided for the circuits feeding the general purpose socket.		N/A
7.2.6	Lighting circuits		–
	Lighting circuits are protected separate from other circuits.		N/A
7.2.7	Transformers		–
	Transformers are protected in accordance with the manufacturer's instructions and includes: - avoiding tripping due to transformer magnetizing inrush currents - avoiding a winding temperature rise in excess of the permitted value for the insulation class when there is a short circuit at the secondary terminals. - type and setting of the overcurrent protective device in accordance with the recommendations of the transformer supplier.		N/A
7.2.8	Location of overcurrent protective devices:		–
	- located at the point where a reduction in the cross sectional area of the conductors or another change reduces the current-carrying capacity of the conductors.		N/A
	Exceptions: - current carrying capacity of the conductors is at		N/A

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	least equal to that of the load and - conductors between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is ≤ 3 m and - the conductor is protected e.g. by an enclosure or duct.		
7.2.9	Selection of overcurrent protective devices		—
	The rated short-circuit breaking capacity Icn is at least equal to the prospective fault current at the point of installation. Additional currents other than from the supply (e.g. from motors, from power factor correction capacitors) shall be taken into consideration.		N/A
	Reduced breaking capacity is permitted, where another protective device is installed at supply side with the necessary breaking capacity. (In that case, the characteristics of the two devices shall be co-ordinated so that the let-through energy (I^2t) of the two devices in series does not exceed that which can be withstood without damage to the overcurrent protective device on the load side and to the conductors protected by that device. See Annex A of IEC 60947-2).		N/A
	Where fuses are provided as overcurrent protective devices, a type readily available in the country of use shall be selected, or arrangements shall be made for the supply of spare parts.		N/A
7.2.10	Rating and setting of overcurrent protective devices:		—
	Rated current of fuses or overcurrent setting of other protective devices selected as low as possible, but adequate for anticipated overcurrents.		N/A
	The rated current of overcurrent protective device is determined by the current carrying capacity of the conductors to be protected in accordance with Cl. 12.4, D.2 and the maximum allowable interrupting time t in accordance with Clause D.3, taking into account the needs of coordination with other electrical devices in the protected circuit.		N/A
7.3	Protection of motors against overheating		—
7.3.1	Overload protection for all motors provided for ratings of > 0.5 kW in continuous operation.		P
	Protective device may be omitted for motors, which cannot be overloaded.		P
	Exceptions: In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps), the means of detection shall give a warning signal to which the operator can respond.		N/A
7.3.2	Protection achieved by overload protection device: — detection in each live conductor — switching off of all live conductors (not necessary to switch of neutral conductor)		P
	For special duty motors, appropriate protective devices are recommended		N/A
7.3.3	Protection achieved by over-temperature protection device: Is recommended in situations where the cooling can be impaired (for example dusty environments)		P

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7.3.4	Protection achieved by current limiting protection: Where protection against the effects of overheating in three phase motors is achieved by current limitation, the number of current limitation devices may be reduced from 3 to 2.		N/A
7.4	Abnormal temperature protection: Resistance heating or other circuits that are capable of attaining or causing abnormal temperatures and can cause a hazardous situation are provided with suitable detection to initiate an appropriate control response.		P
7.5	Protection against supply interruption or voltage reduction and subsequent restoration: Where a supply interruption or a voltage reduction can cause a hazardous situation, damage to the machine, or to the work in progress, undervoltage protection is provided.		N/A
	Upon restoration of supply voltage, automatic or unexpected restarting of machine prevented.		N/A
	Undervoltage protection does initiate appropriate control responses to ensure necessary coordination of groups of machines working together		N/A
7.6	Motor overspeed protection: Overspeed protection is provided where overspeeding can occur and could possibly cause a hazardous situation.		N/A
7.7	Additional earth fault / residual current protection In addition to providing overcurrent protection for automatic disconnection as described in 6.3 ,earth fault / residual current protection can be provided to reduce damage to equipment due toearth fault currents less than the detection level of the overcurrent protectionThe setting of the devices shall be as low as possible consistent with correct operation of theequipmentIf fault currents with DC components are possible , an RCD of type B in accordance withIEC TR 60755 can be required		N/A
7.8	Phase sequence protection: Where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine, protection shall be provided.		N/A
7.9	Protection against overvoltage due to lightning and to switching surges: - Devices are connected to the incoming terminals of the supply disconnecting device.		N/A

8	**EQUIPOTENTIAL BONDING**		—
8.2	Protective bonding circuit		—
8.2.1	Where the conductance of structural parts of the electrical equipment or of the machine is less than that of the smallest protective conductor connected to the exposed conductive parts, a supplementary bonding conductor is provided.		N/A
	In IT distribution systems, the machine structure is part of the protective bonding circuit and insulation monitoring is provided.		N/A

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	Exposed conductive parts of equipment in accordance with 6.3.2.3 (Protection by electrical separation) are not connected to the protective bonding circuit. (For this type of protection, the requirements of 413.5 of IEC 60364-4-41 apply.)		N/A
8.2.2	Protective conductors		—
	Protective conductors shall be identified in accordance with 13.2.2.		P
	Copper conductors are preferred.		P
	Where other material is used, its electrical resistance per unit length shall not exceed that of the allowable copper conductor and such conductors shall be not less than 16 mm^2 in cross-sectional area.	Copper conductors	N/A
	The cross-sectional area of protective conductors shall be determined in accordance with the requirements of: –543 of IEC 60364-5-54; or –7.4.3.1.7 of IEC 60439-1, as appropriate. This requirement is met in most cases if it is in accordance with Table 1 of this standard (see 5.2).		P
8.2.3	Continuity of the protective bonding circuit		—
	All exposed conductive parts are connected to the protective bonding circuit in accordance with 8.2.1. Parts that are mounted so that they do not constitute a hazard because cannot be touched on large surfaces or grasped with the hand and they are small in size (less than approximately 50 mm × 50 mm) or they are located so that either contact with live parts, or an insulation failure is unlikely need not be connected to the protective bonding circuit		P
	Where a part is removed the protective bonding circuit for the remaining parts isn't interrupted.		P
	Current-carrying capacity of connection and bonding points cannot impaired by mechanical, chemical, or electrochemical influences (e.g. electrolytic corrosion on aluminium parts)		P
	Metal ducts of flexible or rigid construction and metallic cable sheaths are not used as protective conductors. Nevertheless they are connected to the protective bonding circuit.		P
	Where the electrical equipment is mounted on lids, doors, or cover plates, continuity of the protective bonding circuit shall be ensured. The use of a protective conductor (see 8.2.2) is recommended.		P
	For cables that are exposed to damage (for example flexible trailing cables) the continuity of the protective conductors are ensured by appropriate measures (for example monitoring).		P
8.2.4	No means of interruption of the protective bonding conductor are provided.		P
	Exception: links for test or measurement purposes that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area.		N/A
	As well the protective bonding circuit does not incorporate a switching device or an over current		P

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Clause	Requirement + Test	Result-Remark	Verdict
	protective device (for example switch, fuse).		
	Removable current collectors, plug/socket combinations or withdrawable plug-in units: The protective bonding circuit is interrupted by a first make last break contact. (see also 13.4.5)		N/A
8.2.6	Protective conductor connecting points: have no other function and are not intended to attach or connect appliances or parts.		P
	Each protective conductor connecting point is marked or labelled as such using the symbol IEC 60417-5019 or the letters PE or by use of bicolour GREEN / YELLOW		P
8.2.7	Mobile machines with on-board power supplies: The protective bonding system is connected to a single protective bonding terminal. This protective bonding terminal is the connection point for a possible additional external incoming power supply.		N/A
8.2.8	Electrical equipment having earth leakage currents higher than 10 mA a.c. or d.c.: Additional protective bonding requirements: - Cross section of protective conductor ≥ 10 mm ^{2} CU or 16 mm 2 AL - OR Second protective conductor of at least the same cross sectional area if above cross section is impracticable - OR monitoring of continuity of protective conductor with automatic disconnection function.		N/A
	Additionally a warning label is provided adjacent to the PE terminal.		N/A

9	**CONTROL CIRCUITS AND CONTROL FUNCTIONS**		—
9.1.	Control circuit		—
9.1.1	Control circuit supply: Control transformers mandatory only when more then one motor starter or two control devices are used.		N/A
	Control transformers with separate windings are used for supplying the control circuits.		N/A
	Where several transformers are used, the secondary voltages are in phase.		N/A
	Separate windings on transformer for DC supplies connected to PE.		N/A
	Switch-mode units fitted with transformers in accordance with IEC 61558-2-17		N/A
9.1.2	The nominal voltage of control supply does not exceed 277 V when supplied from a transformer.		N/A
9.1.3	Control circuits are provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		N/A
9.2	Control functions		—
	Safety related control functions in accordance with ISO 13849-1 (2006), ISO 13849-2 (2003) and /or IEC 62061 (see 9.4.1)		N/A
9.2.1	Start functions operating by energizing the relevant circuit (see 9.2.5.2).		N/A
9.2.3	Operating modes		—

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Clause	Requirement + Test	Result-Remark	Verdict
	Suitable means are prevented for unauthorized or inadvertent mode selection if hazardous situations can result.		P
	Mode selection by itself does not initiate machine operation. A separate actuation of the start control has to be stated by the operator.		P
	Indication of the selected operating mode is provided (e.g. the position of a mode selector, the provision of an indicating light, a visual display indication).		N/A
9.2.4	Where it is necessary to suspend safety functions and/or protective measures (for example for setting or maintenance purposes), protection is ensured.		N/A
9.2.5	Operation		—
	Prevention of movement of the machine in an unintended or unexpected manner is taken after any stopping of the machine. (e.g. due to locked-off condition, power supply fault, battery replacement, lost signal condition with cableless control)		N/A
	When a machine has more than one control station, measures are provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.		N/A
9.2.5.2	Start of an operation is possible only when all of the relevant safety functions and/or protective measures are in place and are operational.		N/A
	Where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations are by hold-to-run controls, together with enabling devices, as appropriate.		N/A
	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 are: - all required conditions for machine operation are met - and all start control devices are in the released (off) position - then all start control devices have to be actuated concurrently (see 3.6).		N/A
9.2.5.3	Stop category 0 and/or stop category 1 and/or stop category 2 stop functions are provided as indicated by the risk assessment and the functional requirements of the machine (see 4.1).		N/A
	Stop functions override related start functions		N/A
	Facilities to connect protective devices and interlocks are provided, where required. If such a protective device or interlock causes a stop of the machine, it may be necessary for that condition to be signalled to the logic of the control system. The reset of the stop function does not initiate any hazardous situation.		N/A
	Where more than one control station is provided, stop commands from any control station is effective when required by the risk assessment of the machine.		N/A
9.2.5.4	Emergency operations (emergency stop, emergency switching off)		—

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Clause	Requirement + Test	Result-Remark	Verdict
	Emergency stop or emergency switching off commands are sustained until it is reset.		P
	This reset is possible only by a manual action at that location where the command has been initiated.		P
	The reset of the command does not restart the machinery but only permit restarting.		P
	It is not be possible to restart the machinery until all emergency stop commands are reset.		P
	It is not be possible to reenergize the machinery until all emergency switching off commands are reset.		N/A
9.2.5.4.2	The emergency stop does function either as a stop category 0 or as a stop category 1.		P
	- it overrides all other functions and operations in all modes;		P
9.2.5.4.3	Emergency switching off is provided where: -Protection against direct contact is achieved only by placing out of reach or by obstacles (see 6.2.6) - or there is the possibility of other hazards or damage caused by electricity.		P
	Emergency switching off is accomplished by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply.		P
9.2.5.5	Movement or action that can result in a hazardous situation are monitored by providing, for example, overtravel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices.		N/A
9.2.6	Other control functions		—
9.2.6.2	No type 1 two-hand control device is used for the initiation of hazardous operation. It need type 2 or type 3 two-hand control devices for such operations.		N/A
9.2.6.3	Enabling control: Enabling control are arranged in the way to minimize the possibility of defeating, e. g. by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It is not possible to defeat the enabling function by simple means.		N/A
9.2.6.4	Combined start and stop controls: Push-buttons etc. that alternately initiate and stop motion are provided only for functions, which cannot result in a hazardous situation.		N/A
9.2.7	Cableless control station		N/A
9.2.7.1	Means shall be provided to readily remove or disconnect the power supply of the operator control station (see also 9.2.7.3).		N/A
	Means (for example key operated switch, access code) are provided, as necessary, to prevent unauthorized use of the operator control station.		N/A
	Each operator control station carries an unambiguous indication of which machine(s) is (are) intended to be controlled by that operator control station.		N/A
9.2.7.2	Measures shall be taken to ensure that control commands: – affect only the intended machine; – affect only the intended functions.		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	Measures are taken to prevent the machine from responding to signals other than those from the intended operator control station(s).		N/A
	Where necessary, means are provided so that the machine can only be controlled from operator control stations in one or more predetermined zones or locations.		N/A
9.2.7.3	Operator control stations include a separate and clearly identifiable means to initiate the stop function of the machine or of all the operations that can cause a hazardous situation. The actuating means to initiate this stop function are not marked or labelled as an emergency stop device, even though the stop function initiated on the machine can fulfil an emergency stop function.		N/A
	Stopping of the machine and preventing a potentially hazardous operation is automatically initiated in the following situations: – when a stop signal is received; – when a fault is detected in the cableless control system; – when a valid signal (which includes a signal that communication is established and maintained) has not been detected within a specified period of time (see Annex B), except when a machine is executing a pre-programmed task taking it outside the range of the cableless control where no hazardous situation can occur.		N/A
9.2.7.4	Machines having more than one operator control station, including one or more cableless control stations, have measures provided to ensure that only one of the control stations can be enabled at a given time.		N/A
	An indication of which operator control station is in control of the machine is provided at suitable locations as determined by the risk assessment of the machine. Exception: a stop command from any one of the control stations are effective when required by the risk assessment of the machine.		N/A
9.2.7.5	Battery-powered cableless operator control stations: A variation in the battery voltage does not cause a hazardous situation.		N/A
	A clear warning is given to the operator when a variation in battery voltage exceeds specified limits.		N/A
	Under those circumstances, the cableless operator control station remains functional long enough for the operator to put the machine into a non-hazardous situation.		N/A
9.3	Protective interlocks		N/A
9.3.1	The reclosing or resetting of an interlocking safeguard does not initiate hazardous machine operation.		N/A
9.3.2	Where overtraveling an operating limit (for example speed, pressure, position) can lead to a hazardous situation, means are provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action.		N/A

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9.3.3	The correct operation of auxiliary functions is checked by appropriate devices.		N/A
	Appropriate interlocking is provided, when non-operation of 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.		N/A
9.3.4	Interlocks between different operations and for contrary motions are provided if this operations lead to hazardous situations.		N/A
9.3.5	Reverse current braking: Where braking of a motor is accomplished by current reversal, measures prevent the motor starting in the opposite direction at the end of braking where that reversal can cause a hazardous situation or damage to the machine or to the work in progress.		N/A
	For this purpose, a device operating exclusively as a function of time is not permitted.		N/A
	Control circuits are arranged that rotation of a motor shaft, for example manually, does not result in a hazardous situation.		N/A
9.4	Control functions in the event of failure		—
9.4.1	The safety related electrical control circuits have an appropriate level of safety performance that has been determined from the risk assessment at the machine. The requirements of IEC 62061 and/or ISO 13849-1, ISO 13849-2 are met.		P
	Where memory retention is achieved for example, by battery power, measures are taken to prevent hazardous situations arising from failure or removal of the battery.		N/A
	Means are provided to prevent unauthorized or inadvertent memory alteration by, e.g. requiring the use of a key, access code or tool.		N/A
9.4.2	Measures are taken to minimize risk in the event of failure:		—
9.4.2.1	- Use of proven circuit techniques and components		P
9.4.2.2	- Provisions of partial or complete redundancy		P
9.4.2.3	- Provision of diversity		N/A
9.4.2.4	- Provision for functional tests		P
9.4.3	Protection against mal-operation due to earth faults, voltage interruptions and loss of circuit continuity		—
	Earth faults on any control circuit don’t cause unintentional starting, potentially hazardous motions, or prevent stopping of the machine. Methods to meet these requirements include but are not limited to the following:		—
	a) 1) Control circuits, fed by control transformers and connected to the protective bonding circuit at the point of supply. (PELV) (see Figure 3 of this standard)		P
	a) 2) Control circuits, fed by control transformers without connection to the protective bonding circuit at the point of supply in the arrangement according to figure 3 and having a device that interrupts the circuit automatically in the event of an earth fault		N/A
	b) Control circuits fed by a control transformer with a centre-tapped winding, this centre tap connected to		N/A

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	the protective bonding circuit, arranged as shown in Figure 4 of this standard with the overcurrent protective device having switching elements in all control circuit supply conductors.		
	c) Where the control circuit is not fed from a control transformer and is either: 1) directly connected between the phase conductors of an earthed supply, or; 2) directly connected between the phase conductors or between a phase conductor and a neutral conductor of a supply that is not earthed or is earthed through a high impedance, multpole switch that switch all live conductors are used for those functions that can cause hazardous situations or damage to the machine.		N/A
	Or in case of c) 2), a device is provided that interrupts the circuit automatically in the event of an earth fault.		N/A
9.4.3.2	For control systems using a memory device(s), proper functioning in the event of power failure is ensured (e.g. by using a non-volatile memory) to prevent any loss of memory that can result in a hazardous situation.		N/A
9.4.3.3	Upon sliding contacts the loss of continuity of safety-related control circuits depending on, can result in a hazardous situation. Appropriate measures are taken (for example by duplication of the sliding contacts).		N/A
10	**OPERATOR INTERFACE AND MACHINE-MOUNTED CONTROL DEVICES**		—
10.1.1	As far as is practicable, those devices are selected, mounted, and identified or coded in accordance with relevant parts of IEC 61310.		P
10.1.2	As far as is practicable, machine-mounted control devices are: – readily accessible for service and maintenance;		P
	– mounted in such a manner as to minimize the possibility of damage from activities such as material handling.		P
	The actuators of hand-operated control devices are selected and installed so that: – they are not less than 0,6 m above the servicing level and		N/A
	– are within easy reach of the normal working position of the operator;		N/A
	– the operator is not placed in a hazardous situation when operating them.		N/A
	The actuators of foot-operated control devices are selected and installed so that: – they are within easy reach of the normal working position of the operator;		N/A
	– the operator is not placed in a hazardous situation when operating them.		N/A
10.1.3	The degree of protection (see IEC 60529) together with other appropriate measures does afford protection against:		P

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	– the effects of aggressive liquids, vapours, or gases found in the physical environment or used on the machine;		N/A
	– the ingress of contaminants (for example swarf, dust, particulate matter).		N/A
	The operator interface control devices has a minimum degree of protection against direct contact of IPXXD (see IEC 60529).		N/A
10.1.4	Position sensors (for example position switches, proximity switches) are so arranged that they will not be damaged in the event of overtravel.		N/A
	Position sensors in circuits with safety-related control functions shall have direct opening action (see IEC 60947-5-1) or shall provide similar reliability (see 9.4.2).		N/A
10.1.5	Portable and pendant operator control stations and their control devices are so selected and arranged as to minimize the possibility of inadvertent machine operations caused by shocks and vibrations		N/A
10.2	Push-buttons		P
10.2.1	Mandatory: The colour RED is used only for emergency stop and emergency switching off actuators.		P
	The recommend colours of push-buttons are as shown in table 2 of this standard.		P
10.2.2	The recommend markings on push-buttons are as shown in table 3 of this standard.		P
10.3	Indicator lights and displays		—
10.3.1	Indicator lights and displays are selected and installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310-1).		N/A
	Indicator light circuits used for warning lights are fitted with facilities to check the operability of these lights.		N/A
	The recommend colours on Indicator light are as shown in table 4 of this standard.		N/A
	Indicating towers on machines have the applicable colours in the following order from the top down; RED, YELLOW, BLUE, GREEN and WHITE.		N/A
	Where flashing lights or displays are used to provide higher priority information, audible warning devices should also be provided.		N/A
10.4	illuminated push-button actuators are colour-coded in accordance with Tables 2 and 4. Where there is difficulty in assigning an appropriate colour, WHITE is used.		N/A
	The colour RED for the emergency stop actuator shall not depend on the illumination of its light.		N/A
10.5	Devices having a rotational member, such as potentiometers and selector switches, have means of prevention of rotation of the stationary member. Friction alone isn't considered sufficient.		N/A
10.6	Actuators used to initiate a start function or the movement of machine elements (for example slides, spindles, carriers) are constructed and mounted so as to minimize inadvertent operation.		N/A
	However, mushroom-type actuators are used for		N/A

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	two-hand control only. (see also ISO 13851).		
10.7	Emergency stop devices		—
10.7.1	Devices for emergency stop are readily accessible.		—
	They are located at each operator control station and at other locations where the initiation of an emergency stop can be required (exception: see 9.2.7.3).		—
	In circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station, means (for example, information for use) are provided to minimise confusion.		—
10.7.2	Allowed types of device for emergency stop: – a push-button operated switch with a palm or mushroom head type; – a pull-cord operated switch; – a pedal-operated switch without mechanical guard.	a push-button operated switch with mushroom head	—
	The devices are direct opening operation (see IEC 60947-5-1, Annex K).		—
10.7.3	Actuators are coloured RED. If a background exists immediately around the actuator, then this background is coloured YELLOW. See also ISO 13850.		—
10.7.4	The supply disconnecting device may be locally operated to serve the function of emergency stop when: – it is readily accessible to the operator; and – it is of the type described in 5.3.2 a), b), c), or d). When also intended for this use, the supply disconnecting device meets the colours RED/YELLOW.		—
10.8	Emergency switing off device		—
10.8.1	Means are provided, where necessary, to avoid confusion between these devices.		P
10.8.2	The types of device for emergency switching off include: – a push-button operated switch with a palm or mushroom head type of actuator; – a pull-cord operated switch. The devices are direct opening action (see IEC 60947-5-1, Annex K). The push-button operated switch may be in a break-glass enclosure.		P
10.8.3	Actuators are coloured RED. If a background exists immediately around the actuator, then this background is coloured YELLOW. See also ISO 13850.		P
10.8.4	Where the supply disconnecting device is to be locally operated for emergency switching off, it is be readily accessible and meets the colours RED/YELLOW.		P
10.9	Enabling control device		N/A
	An enabling control device as a part of a system, does allow operation when actuated in one position only. In any other position, operation is stopped or prevented.		N/A

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	Functions of two-position types: position 1: off-function of the switch (actuator is not operated); position 2: enabling function (actuator is operated)		N/A
	Functions of three-position types: position 1: off-function of the switch (actuator is not operated); position 2: enabling function (actuator is operated in its mid position); position 3: off-function (actuator is operated past its mid position); when returning from position 3 to position 2, the enabling function is not activated.		N/A
11	**CONTROL GEAR: LOCATION, MOUNTING AND ENCLOSURES**		—
11.2.1	All items of control gear (inclusively terminals that are not part of controlgear components or devices) are placed and oriented so that they can be identified without moving them or the wiring.		P
	For items that require checking for correct operation or that are liable to need replacement, those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers, barriers or obstacles).		N/A
	All control gear are mounted so as to facilitate its operation and maintenance from the front.		P
	Necessary tools to adjust, maintain, or remove a device are supplied.		N/A
	Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0,4 m and 2,0 m above the servicing level.		N/A
	Terminals are least 0,2 m above the servicing level and so placed that conductors and cables can be easily connected to them.		N/A
	Only operating, indicating, measuring, and cooling devices are mounted on doors or on normally removable access covers of enclosures.		P
	Plug-in arrangements of control devices and plug-in-devices:		—
	The connection is clearly identified by shape, marking or reference designation, singly or in combination.		P
	When they have to bee handled during normal operation means are provided with non-interchangeable features where the lack of such a facility can result in malfunctioning.		N/A
	Plug/socket combinations that are handled during normal operation are unobstructedly accessible.		N/A
	Test points for connection of test equipment are: – unobstructedly accessible; – clearly identified to correspond with the documentation; – adequately insulated; – sufficiently spaced.		N/A
11.2.2	Non-electrical parts and devices, not directly associated with the electrical equipment, are not located within enclosures containing control gear.		N/A
	Devices such as solenoid valves are separated from the other electrical equipment (for example in a		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	separate compartment).		
	Control devices mounted in the same location and connected to the supply voltage, or to both supply and control voltages, are grouped separately from those connected only to the control voltages.		N/A
	Terminals shall be separated into groups for: – power circuits; – associated control circuits; – other control circuits, fed from external sources (for example for interlocking).		N/A
	The clearances and creepage distances specified by the supplier are maintained, taking into account the external influences or conditions of the physical environment.		N/A
11.2.3	Heat generating components (for example heat sinks, power resistors) are located so, that the temperature of each component in the vicinity remains within the permitted limit.		N/A
	Control gears are sufficiently protected against: - ingress of solid foreign objects - liquids - dust, coolants, and swarf, taking into account the external influences under which the machine is intended to operate (i.e. the location and the physical environmental conditions).		N/A
	Enclosures of controlgear provide a degree of protection of at least IP22 (see IEC 60529). Exceptions: a) specific electrical operating area b) When with removable collectors on conductor wire or conductor bar systems do not achieve IP22 measures of 6.2.5 are applied.		N/A
11.4	Enclosures, doors and openings		N/A
	Enclosures (inclusively screens of windows (windows: toughened glass or polycarbonate sheet of not less than 3 mm thickness), joints, gaskets of doors and lids) do withstand the foreseeable mechanical, electrical and thermal stresses and other environmental factors and of the aggressive liquids, vapours, or gases used on the machine.		N/A
	Fasteners used to secure doors and covers are of the captive type.		N/A
	Enclosure doors are not wider than 0,9 m and have vertical hinges, with an angle of opening > 95°.		N/A
	Openings in enclosures (for example, for cable access), including those towards the floor or foundation or to other parts of the machine are equipped with means to ensure the degree of protection specified for the equipment. A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away		N/A
	Openings for cable entries shall be easily re-opened on site.		N/A
	No openings between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate.		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	Holes in an enclosure for mounting do not impair the required protection.		N/A
	Equipment that, in normal or abnormal operation, can attain a surface temperature sufficient to cause a risk of fire or harmful effect to an enclosure material is: – located within an enclosure that will withstand, such temperatures; and – is located at a sufficient distance from adjacent equipment allowing safe dissipation of heat (see also 11.2.3); or – is otherwise screened by material that can withstand to the harmful effect.		N/A
11.5	Access to control gear		N/A
	Doors in gangways for access to electrical operating areas: – are at least 0,7 m wide and 2,1 m high; – do open outwards; – have a means (for example panic bolts) to allow opening from the inside without the use of a key or tool.		N/A
	Enclosures which readily allow a person to fully enter are be provided with means to allow escape, e.g. panic bolts on the inside of doors.		N/A
	Enclosures intended for such access, for example for resetting, adjusting, maintenance, shall have a clear width of at least 0,7 m and a clear height of at least 2,1 m When equipment is likely to be live during access with > 1,0m and when on both side with > 1.5m.		N/A
12	**CONDUCTORS AND CABLES**		—
	IMPORTANT: The following requirements do not apply to the integral wiring of assemblies, subassemblies, and devices that are manufactured and tested in accordance with their relevant IEC standard (for example IEC 60439-1).		—
12.2	In general, conductors are of copper. Where aluminium conductors are used, the cross-sectional area is at least 16 mm 2 .		P
	The cross-sectional areas of conductors are according to Table 5 and its notes.		P
	All conductors that are often in movement (> one movement per hour of machine operation) have flexible stranding of class 5 or class 6.		P
	Where the insulation of conductors and cables (for example PVC) can constitute hazards due to the propagation of a fire or the emission of toxic or corrosive fumes adequate means are provided. Special attention is given to the integrity of a circuit having a safety-related function		P
12.3	Minimum insulation test voltages for used cables are: – ≥ 2 000 V a.c. for a duration of 5 min for operation at voltages higher than 50 V a.c. or 120 V d.c., or – ≥ 500 V a.c. for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment).	2000 V a.c. 5 min	P
	Insulation strong enough to withstand damage due		P

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Clause	Requirement + Test	Result-Remark	Verdict
	to operation or during laying, especially for cables pulled into ducts.		
12.4	Current-carrying capacity in normal service in accordance with table 6. Or in accordance with suppliers recommendation.		P
12.6	Flexible cables		—
12.6.1	All flexible cables have Class 5 or Class 6 conductors.		N/A
	Cables under severe duties are adequately protected against: - abrasion due to mechanical handling and dragging across rough surfaces; - kinking due to operation without guides; - stress resulting from guide rollers and forced guiding, being wound and re-wound on cable drums.		N/A
12.6.2	The tensile stress applied to copper conductors does not exceed 15 N/mm^2 of cross-sectional area. Or special measures are taken to withstand the applied stress. For material other than copper the applied stress is within the cable manufacturer's specification.		N/A
12.6.3	For cables installed on drums, the maximum current-carrying capacity in free air is derated in accordance with Table 7.		N/A
12.7	Conductor wires, conductor bars and slip-ring assemblies		N/A
12.7.1	During normal access to the machine, protection against direct contact to conductor wires, conductor bars and slip-ring assemblies is achieved by the application of one of the following protective measures: – protection by partial insulation of live parts, or where this is not practicable; – protection by enclosures or barriers of at least IP2X.		N/A
	Horizontal top surfaces of barriers or enclosures that are readily accessible provide a degree of protection of at least IP4X.		N/A
	Where the required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching off in accordance with 9.2.5.4.3 is applied.		N/A
	Conductor wires and conductor bars are so placed / protected as to: – prevent contact with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains; – prevent damage from a swinging load.		N/A
12.7.2	Protective conductor circuit (PE) and the neutral conductor (N) each use a separate conductor wire, conductor bar or slip-ring.		N/A
	The continuity of the protective conductor circuit using sliding contacts is ensured by taking appropriate measures (for example, duplication of the current collector, continuity monitoring)		N/A
12.7.3	Protective conductor current collectors have a shape or construction so that they are not interchangeable with the other current collectors. Such current		N/A

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

13	**WIRING PRACTICES**		-
13.1	Connections and routing		P
13.1.1	All connections are secured against accidental loosening.		P
	The means of connection are suitable for the cross-sectional areas and nature of the conductors being terminated.		P
	No connection of two or more conductors to one terminal, unless the terminal is designed for it.		P
	No soldered connections to terminals unless they are suitable for it.		P
	Terminals on terminal blocks are plainly marked or labelled corresponding with the diagrams.		P
	Installations of flexible conduits and cables are such that liquids drain away from the fittings.		P
	Retaining means for conductor strand and shields provided (no soldering for that purpose)		P
	Indentification tags legible, permanent, and appropriate for the physical environment.		P

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Clause	Requirement + Test	Result-Remark	Verdict
	Terminal blocks mounted and wired so that the internal and external wiring does not cross over the terminals (see IEC 60947-7-1).		P
13.1.2	Conductors and cables run from terminal to terminal without splices or joints. Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be joints for the purpose of this subclause.		P
	Terminations of cables are adequately supported to prevent mechanical stresses at the terminations of the conductors.		P
	Protective conductor placed close to the associated live conductors in order to decrease the impedance of the loop.		P
13.1.3	Conductors for circuits that operate at different voltages are separated by suitable barriers, or are insulated for the highest voltage that occurs within the same duct.		P
13.2	Connections and routing		P
13.2.1	Each conductor is identifiable at each termination in accordance with the technical documentation.		P
13.2.2	The protective conductor has the bicolour combination GREEN-AND-YELLOW Where the protective conductor can be easily identified colour coding throughout its length is not necessary, but the ends or accessible locations are clearly identified by the graphical symbol or by the bicolour combination GREEN-AND-YELLOW.		P
13.2.3	Neutral conductors are identified by the colour LIGHT BLUE. That colour is not used for identifying any other conductor where confusion is possible.		P
	Bare conductors used as neutral conductors have at minimum a stripe in LIGHT BLUE 15 mm to 100 mm wide in each compartment or unit and at each accessible location.		P
	Identification by colour for other conductors: Colours GREEN or YELLOW are not used. (Details to colour coding see this norm Cl. 13.2.3)		P
13.3	Wiring inside enclosures		N/A
	Conductors inside enclosures are supported where necessary. Conductors and cables that do not run in ducts are adequately supported.		N/A
	Non-metallic supports are made with a flame-retardant insulating material (see IEC 60332 series)		N/A
	Connections to devices mounted on doors or to other movable parts are using flexible conductors in accordance with 12.2 and 12.6.		N/A
13.4	Wiring outside enclosures		N/A
13.4.2	Conductors and their connections external to the electrical equipment are placed in suitable ducts (see cl.13.5). Exceptions: - Cables with special suitable protection. - Position switches or proximity switches supplied		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	with a dedicated cable which is sufficiently short.		
	Connections to moving elements of the machine are made of flexible cable in accordance with 12.2 and 12.6.		N/A
	Bending radius of the cable are of at least 10 times the diameter of the cable		N/A
	Cables close to moving parts, maintain a space of at least 25 mm between the moving parts and the cables or barriers are provided.		N/A
	Cable handling systems: Lateral cable angles do not exceeding 5°, at being wound on and off cable drums or approaching and leaving cable guidance devices. The bending radius is in accordance with table 8.		N/A
	Flexible conduit: - is not used for connections to rapidly or frequently moving parts, except when specifically designed for that purpose. - is supported when adjacent to moving parts		N/A
13.4.4	Interconnection of devices on the machine is made through adequate terminals.		N/A
13.4.5	Requirements to plug/socket combinations outside of enclosures: Exceptions: components connected to a bus system by a plug/socket combination a) Prevention for unintentional contact with live parts at any time. At least IPXXB. (PELV circuits are excepted from this requirement.) b) First make last break protective bonding contact if used in TN- or TT-systems. c) Sufficient load-breaking capacity, when intended to be disconnected under running conditions. When rated at ≥ 30 A interlocked with a switching device d) When rated at ≥ 16 A having a retaining means to prevent unintended or accidental disconnection. e) when unintended or accidental disconnection +can cause a hazardous situation, having a retaining means. f) Component remaining live after disconnection having at least IP2X or IPXXB, taking into account the required clearance and creepage distances.(PELV circuits are excepted from this requirement.) g) Metallic housings of plug/socket combinations being connected to the protective bonding circuit. (PELV circuits are excepted from this requirement.) h) Having retaining means to prevent unintended or accidental disconnection and being marked that they are not intended to be disconnected under load. i) Clearly identifiable if more then one plug / socket per device. It is recommended that mechanical coding being used. j) When used in control circuits fulfilling the applicable requirements of IEC 61984. Exception: see item k). k) No plug/socket combinations intended for household and similar general purposes used for control circuits. In plug/socket combinations in		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	accordance with IEC 60309-1, only those contacts shall be used for control circuits which are intended for those purposes. Exception: The requirements of item k) do not apply to control functions using high frequency signals on the power supply.		
13.4.6	Protection of Plug / socket from the physical environment during transportation and storage.		N/A
13.5	Ducts, connection boxes and other boxes		N/A
	Provided with a degree of protection suitable for the application.		N/A
	No sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come into contact.		N/A
	Where human passage is required, least 2 m above the working surface.		N/A
	Not used as connection for protective bonding circuit.		N/A
	Where cable trays are a.s.o. are only partially covered, the cables used are of a suitable type.		N/A
13.5.2	Filling the percentage of ducts adapted to the straightness and length of the duct and the flexibility of the conductors.		N/A
13.5.3.	Rigid metal conduit and fittings shall galvanized steel or of a corrosion-resistant material		N/A
	Fittings compatible with the conduit.		N/A
	Conduit bends properly made		N/A
13.5.4	Flexible metal tubing or woven wire armour suitable for the expected physical environment.		N/A
13.5.5	Flexible non-metallic conduit resistant to kinking and suitable for the expected physical environment.		N/A
13.5.6	Requirements to cable trunking systems: - Rigidly supported and clear of all moving or contaminating portions of the machine - Covers overlapping the sides and attached.		N/A
13.5.7	The compartments of machine used as cable trunking systems are isolated from coolant or oil reservoirs and are entirely enclosed, and the conductors are secured.		N/A
13.5.8	Connection boxes and other boxes used for wiring: - Are accessible for maintenance. - 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). - Do not have unused knockouts etc.		P
13.5.9	Motor connection boxes: Encloses only connections to the motor and motor-mounted devices (e.g brakes, temperature sensors)		P
14	**ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT**		-
14.1	Electric motors are conform to the relevant parts of IEC 60034 series.	for the electric start	P
	There protection is conform to the requirements given in 7.2 for overcurrent protection, in 7.3 for overload protection, and in 7.6 for overspeed protection.		P

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	Motor control equipment is located and mounted in accordance with Clause 11.		P
14.2	Minimal IP23 protection for all motors. More stringent requirements depending on the application and the physical environment.	for the electric start	P
14.4	Motors incorporated as an integral part of the machine are adequately protected from mechanical damage.		P
	motors and its associated parts (inclusively motor connection box) are easily accessible for inspection and maintenance etc		P
	Cooling is ensured and the temperature rise remains within the limits of the insulation class (see IEC 60034-1)		P
	No opening between the motor compartment and any other compartment that does not meet the motor compartment requirements.		P
14.5	The characteristics of motors and associated equipment are selected in accordance with the anticipated service and physical environmental conditions (see 4.4). Detailed criteria see 14.5 of this norm.		P
14.6	Overload and overcurrent protective devices for mechanical brake actuators initiate simultaneously the deenergization (release) of the associated motors.		P
15	**ACCESSORIES AND LIGHTING**		N/A
15.1	Requirements for socket-outlets for accessory equipment: – conform to IEC 60309-1 (Where that is not practicable, they are clearly marked with voltage and current ratings); –continuity of the protective bonding circuit to the socket-outlet is ensured, except where protected by PELV; – unearthed conductors connected to the socket-outlet are overcurrent- and if required overload- protected – protection is separately from other circuits; – power supply to the socket-outlet is not disconnected by the supply disconnecting device for the machine or the section of the machine, the requirements of 5.3.5 apply.		N/A
15.2.1	Requirements for local lighting of the machine and equipment: - protective bonding circuit in accordance with 8.2.2. - ON/OFF switch incorporated in the lamp-holder or in the flexible connecting cords. - Stroboscopic effects avoided. - Where fixed lighting electromagnetic compatibility is taken into account.		N/A
15.2.2	Requirements to the power supply for local lighting: – Nominal voltage not exceeding 250 V between conductors – isolating transformer connected to the load side of the supply with overcurrent protection in the secondary circuit; or		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	– isolating transformer connected to the line side of the supply disconnecting device with overcurrent protection in the secondary circuit. That source is permitted for maintenance lighting circuits in control enclosures only; or – from a machine circuit with dedicated overcurrent protection; or – from an isolating transformer connected to the line side of the supply disconnecting device, provided with a dedicated primary disconnecting means and secondary overcurrent protection, and mounted within the control enclosure adjacent to the supply disconnecting device; or – from an externally supplied lighting circuit (for example factory lighting supply). This shall be permitted in control enclosures only, and for the machine work light(s) where their total power rating is not more than 3 kW. Exception: Where fixed lighting is out of reach of operators during normal operations, the provisions of this subclause do not apply.		
15.2.3	All unearthed conductors of circuits supplying lighting have their own overcurrent protecting devices.		N/A
15.2.4	Requirements to the fittings for local lighting: – Adjustable lighting fittings are suitable for the physical environment. – lamp holders are in accordance with the relevant IEC standard; – lamp holders are constructed with an insulating material protecting the lamp cap – Reflectors are supported by a bracket and not by the lamp holder. Exception: where fixed lighting is out of reach of operators during normal operation, the provisions of this subclause do not apply.		N/A

16	**MARKING, WARNING SIGNS AND REFERENCE DESIGNATIONS**		-
16.1	Warning signs, nameplates, markings, and identification plates are of sufficient durability to withstand the physical environment.		P
16.2.1	Enclosures that do not clearly show that they contain electrical equipment that has a risk of electric shock are marked with the graphical symbol  plainly visible on the enclosure door or cover. Exception: – enclosure equipped with a supply disconnecting device; – operator-machine interface or control station; – a single device with its own enclosure (for example position sensor).		P
16.2.2	Hazardous hot surfaces of the electrical equipment, are equipped with the graphical warning symbol 		P

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Clause	Requirement + Test	Result-Remark	Verdict
16.2.3	Control devices, visual indicators, and displays are clearly and durably marked to their functions.		P
16.2.4	Equipment (e.g. controlgear assemblies) is legibly and durably marked. A nameplate is attached to the enclosure adjacent to each incoming supply with: – name or trade mark of supplier; – certification mark, when required; – serial number, where applicable; – rated voltage, number of phases and frequency (if a.c.), – full-load current for each supply; – short-circuit rating of the equipment; – main document number (see IEC 62023).		P
16.2.5	All enclosures, assemblies, control devices, and components are plainly identified with the same reference designation as shown in the technical documentation.		P
17	**TECHNICAL DOCUMENTATION**		-
17.1	Documentation in agreed language provided.		P
17.2	Information provided with the electrical equipment include: a) A main document (parts list or list of documents); b) Complementary documents including: 1) a clear, comprehensive description of the equipment, installation and mounting, and the connection to the electrical supply(ies); 2) electrical supply(ies) requirements; 3) information on the physical environment (for example lighting, vibration, noise levels, atmospheric contaminants) where appropriate; 4) overview (block) diagram(s) where appropriate; 5) circuit diagram(s); 6) information (as applicable) on: • programming, as necessary for use of the equipment; • sequence of operation(s); • frequency of inspection; • frequency and method of functional testing; • guidance on the adjustment, maintenance, and repair, particularly of the protective devices and circuits; • recommended spare parts list; • list of tools supplied. 7) a description (including interconnection diagrams) of the safeguards, interlocking functions, and interlocking of guards against hazards, particularly for machines operating in a co-ordinated manner; 8) a description of the safeguarding and of the means provided where it is necessary to suspend the safeguarding (for example for setting or maintenance), (see 9.2.4); 9) instructions on the procedures for securing the machine for safe maintenance; (see also 17.8);		P

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Clause	Requirement + Test	Result-Remark	Verdict
	10) information on handling, transportation and storage; 11) information regarding load currents, peak starting currents and permitted voltage drops, as applicable; 12) information on the residual risks due to the protection measures adopted, indication of whether any particular training is required and specification of any necessary personal protective equipment.		
17.3	Unless otherwise agreed between manufacturer and user: – the documentation is in accordance with relevant parts of IEC 61082; – reference designations are in accordance with relevant parts of IEC 61346; – instructions / manuals are in accordance with IEC 62079. – parts lists where provided are in accordance with IEC 62027, class B.		P
17.4	Installation documents giving all information necessary for the preliminary work of setting up the machine (including commissioning) are provided. (In complex cases, it may be necessary to refer to the assembly drawings for details.)		P
	The recommended position, type, and cross-sectional areas of the supply cables to be installed on are clearly indicated.		P
	Data necessary for choosing the type, characteristics, rated currents, and setting of the overcurrent protective device for the supply conductors to the electrical equipment of the machine is stated (see 7.2.2).		P
	The size, purpose, and location of any ducts in the foundation that are to be provided by the user are detailed (see Annex B).		P
	The size, type, and purpose of ducts, cable trays, or cable supports between the machine and the associated equipment that are to be provided by the user are detailed (see Annex B).		P
	A diagram indicates where space is required for the removal or servicing of the electrical equipment.		P
	An interconnection diagram or table is provided, where it is appropriate. They give full information about all external connections.		P
	Where the electrical equipment is intended to be operated from more than one source of electrical supply, the interconnection diagram or table does indicate the modifications or interconnections required for the use of each supply.		P
17.5	Where it is necessary to facilitate the understanding of the principles of operation, an overview diagram is provided.		P
17.6	The circuit diagram shows the electrical circuits on the machine and its associated electrical equipment.		P
	Any graphical symbol not shown in IEC 60617-DB:2001 are separately described on the diagrams or supporting documents.		P
	The symbols and identification of components and devices are consistent throughout all documents		P

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	and on the machine.		
	Switch symbols on the electromechanical diagrams are shown with all supplies turned off (for example electricity, air, water, lubricant) and with the machine and its electrical equipment ready for a normal start.		P
	Conductors are identified in accordance with 13.2.		P
	Characteristics relating to the function of the control devices and components which are not evident from their symbolic representation are included on the diagrams adjacent to the symbol or referenced to a footnote.		P
17.7	An operating manual detailing proper procedures for set-up and use of the electrical equipment is provided.		P
	Particular attention is given to the safety measures.		P
	Where the operation of the equipment can be programmed, detailed information on methods of programming, equipment required, program verification, and additional safety procedures (where required) is given.		P
17.8	A maintenance manual detailing proper procedures for adjustment, servicing and preventive inspection, and repair is provided. Recommendations on maintenance/service intervals and records are part of that manual. Where methods for the verification of proper operation are provided (for example software testing programs), the use of those methods is detailed		P
17.9	The parts list, where provided, comprises, as a minimum, information necessary for ordering spare or replacement parts (for example components, devices, software, test equipment, technical documentation) required for preventive or corrective maintenance including those that are recommended to be carried in stock by the user of the equipment.		P

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

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	with a current between at least 0,2 A. And the resistance measured is in the expected range according to the length, the cross sectional area and the material of the related protective bonding conductor.		
	Test 2: Fault loop impedance verification and suitability of the associated overcurrent protective device.		N/A
	The connections of the power supply and of the incoming external protective conductor to the PE terminal of the machine are verified by inspection.		N/A
	The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A a verified by both: 1) A verification of the fault loop impedance by - calculation, or - measurement in accordance with A.4, and		N/A
	2) A confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A or table 10		N/A
18.3	Insulation resistance tests (facultative) The insulation resistance measured at 500 V d.c. between the power circuit conductors and the protective bonding circuit are not less than 1 MΩ.		P
18.4	Voltage test (facultative) Testing voltage; twice the rated supply voltage of the equipment or 1 000 V whichever is the greater With test voltage applied between the power circuit conductors and the protective bonding circuit for a period of approximately 1 s. there is no disruptive discharge occurred.		P
18.5	Protection against residual voltages (facultative) Compliance with 6.2.4. is ensured		P
18.6	Functional tests The function of circuits for electrical safety (for example earth fault detection) is insured.		P

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Clause	Requirement + Test	Result-Remark	Verdict

ATTACHMENT TO TEST REPORT EN 60204-1
EUROPEAN GROUP DIFFERENCES AND NATIONAL DIFFERENCES
SAFETY OF MACHINERY - ELECTRICAL EQUIPMENT OF MACHINES
PART 1: GENERAL REQUIREMENTS

Differences according to ..... : EN 60204-1:2018

Attachment Form No. ..... : EU_GD_IEC60204_1A

Attachment Originator ..... : Electrosuisse

Master Attachment ..... : 2011-12

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	CENELEC COMMON MODIFICATIONS (EN)		
1.	Scope		—
	– are sewing machines, units, and systems; NOTE 7 For sewing machines, see EN 60204-31. – are hoisting machines. NOTE 8 For hoisting machines, see EN 60204-32.		—
3.	Terms and definitions		P
3.56	Uncontrolled stop NOTE This definition does not imply any particular state of other (for example, non- electrical) stopping devices, for example mechanical or hydraulic brakes that are outside the scope of this standard.		P
4.2	Section of equipment		P
4.2.2	The electrical equipment of the machine shall satisfy the safety requirements identified by the risk assessment of the machine. Depending upon the machine, its intended use and its electrical equipment, the designer may select parts of the electrical equipment of the machine that are in compliance with EN 60439-1 and, as necessary, other relevant parts of the EN 60439 series (see also Annex F).		P
4.4	Physical environment and operating conditions		P
4.4.1	The electrical equipment shall be suitable for the physical environment and operating conditions of its intended use. The requirements of 4.4.2 to 4.4.8 cover the physical environment and operating conditions of the majority of machines covered by this part of EN 60204. When special conditions apply or the limits specified are exceeded, an agreement between user and supplier (see 4.1) is recommended (see Annex B).		P
4.4.3	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. The minimum requirement for all electrical equipment is correct operation between air temperatures of +5 °C and +40 °C. For very hot environments (for example hot climates, steel mills, paper mills) and for cold environments, additional measures are recommended (see Annex B).		P
4.4.7	When equipment is subject to radiation (for example microwave, ultraviolet, lasers, X-rays), additional		N/A

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Clause	Requirement + Test	Result-Remark	Verdict
	measures shall be taken to avoid malfunctioning of the equipment and accelerated deterioration of the insulation. A special agreement is recommended between the supplier and the user (see Annex B).		
4.4.8	Undesirable effects of vibration, shock and bump (including those generated by the machine and its associated equipment and those created by the physical environment) shall be avoided by the selection of suitable equipment, by mounting it away from the machine, or by provision of anti- vibration mountings. A special agreement is recommended between the supplier and the user (see Annex B).		N/A
5	Incoming supply conductor terminations and devices for disconnecting and switching off		P
5.1	Add: See 17.8 for the provision of instructions for maintenance.		—
5.4	NOTE 2 Further information on the location and actuation of devices such as those used for the prevention of unexpected start-up is provided in EN 60447. After the fifth paragraph, replace note 2 with: NOTE 3 The selection of a device should take into account, for example, information derived from the risk assessment, intended use and foreseeable misuse of the device. For example, the use of disconnectors, withdrawable fuse links		—
9.	Control circuits and control functions		
9.2.6.3	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		N/A
	b) when de-activated – initiates a stop function in accordance with 9.2.5.3, and – prevents initiation of machine operation.		N/A
	Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated. It should not be possible to defeat the enabling function by simple means.		N/A
9.2.7.3	Stop:		—
	Cableless control stations shall include a separate and clearly identifiable means to initiate the stop function of the machine or of all the operations that can cause a hazardous situation. The actuating means to initiate this stop function shall not be marked or labelled as an emergency stop device (see10.7).		N/A
10	Operator interface and machine-mounted control devices		
	Replace table 2 with		P

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Clause	Requirement + Test	Result-Remark	Verdict

Table 2 – Colour coding for push-button actuators and their meanings

Colour	Meaning	Explanation	Examples of application
RED	Emergency	Actuate in the event of a hazardous situation or emergency	Emergency stop Initiation of emergency function (see also 10.2.1)
YELLOW	Abnormal	Actuate in the event of an abnormal condition	Intervention to suppress abnormal condition Intervention to restart an interrupted automatic cycle
BLUE	Mandatory	Actuate for a condition requiring mandatory action	Reset function
GREEN	Normal	Actuate to initiate normal conditions	(See 10.2.1)
WHITE	No specific meaning assigned	For general initiation of functions except for emergency stop	START/ON (preferred) STOP/OFF
GREY			START/ON STOP/OFF
BLACK			START/ON STOP/OFF (preferred)

12	Conductors and cables		P
12.7.8	Construction and installation of conductor wire, conductor bar systems and slip- ring assemblies		—
	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 bonding circuit, their continuity shall be verified (see Clause 18)		P
17.	Technical documentation		
17.2	Information to be provided 3) information on the physical environment (forexample lighting, vibration, atmospheric contaminants) where appropriate;		P
18	Verification		N/A
18.1	General (5 th paragraph) For tests in accordance with 18.2 and 18.3, measuring equipment in accordance with the EN 61557 series is applicable. NOTE For other tests as required by this standard measuring equipment in accordance with relevant IEC or European Standards should be used.		N/A
ZA	**ANNEX ZA, Normative references to IEC standards (normative)**		P
	Normative references to international publications with their corresponding European publications The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies. NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.		—
ZZ	**ANNEX ZZ, Essential requirements EC directives (informative)**		P
	Coverage of Essential Requirements of EC Directives This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and within its scope the standard covers only the following essential requirements out of those given in Annex I of the EC Directive 98/37/EC:		—

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Clause	Requirement + Test	Result-Remark	Verdict
	– 1.1.2 – 1.2 – 1.5.1 – 1.5.4 – 1.6.3 (for isolation of electrical supplies of machinery) – 1.6.4 (for access to electrical equipment) – 1.7.0 – 1.7.1 – 1.7.2 (for residual risks of an electrical nature) – 1.7.4(c) Compliance with this standard provides one means of conformity with the specified essential requirements of the Directive concerned. WARNING: Other requirements and other EC Directives may be applicable to the products falling within the scope of this standard.		

EN 60204-1			
Clause	Requirement + Test	Result-Remark	Verdict

18.3	**TABLE: Insulation resistance**		P
Test voltage applied between:		500Vd.c	—
Leakage current between	R (MΩ)	Min. allowed R (MΩ)	
Power circuit conductors and the protective bonding circuit	＞500	1	
Supplementary information:			

18.4	**TABLE: Dielectric strength**	P
Test voltage applied between	Test potential applied (V)	Breakdown (Yes/No)
Power circuit conductors and the protective bonding circuit	1000	No
Supplementary information:		

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Detail of: Table CUT-200

View:

[X] general

[ ] front

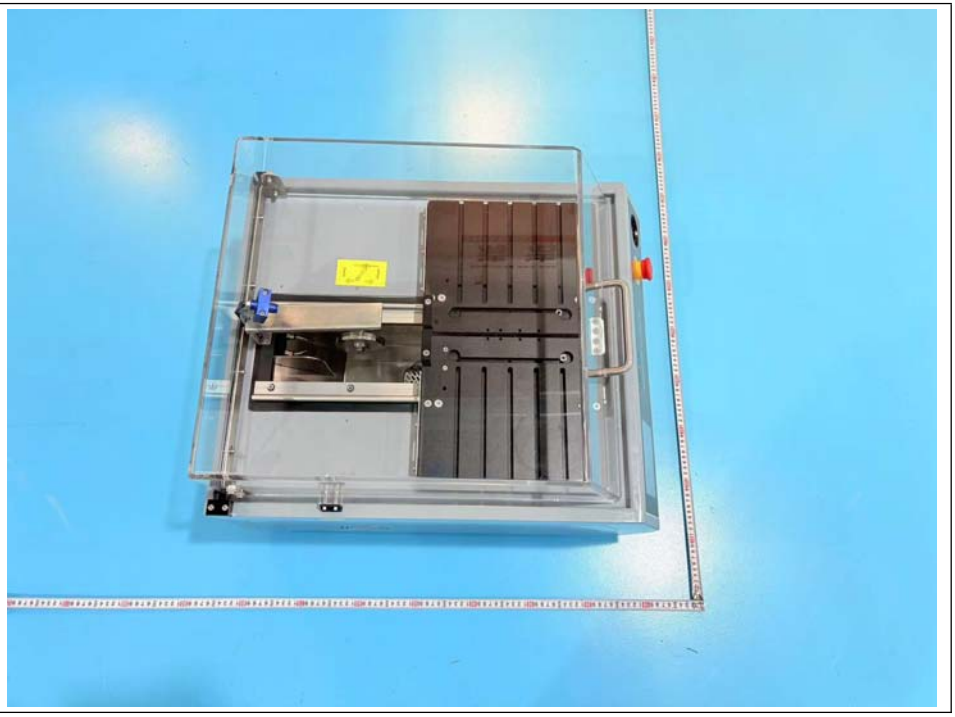
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Detail of: Table CUT-200

View:

[X] general

[ ] front

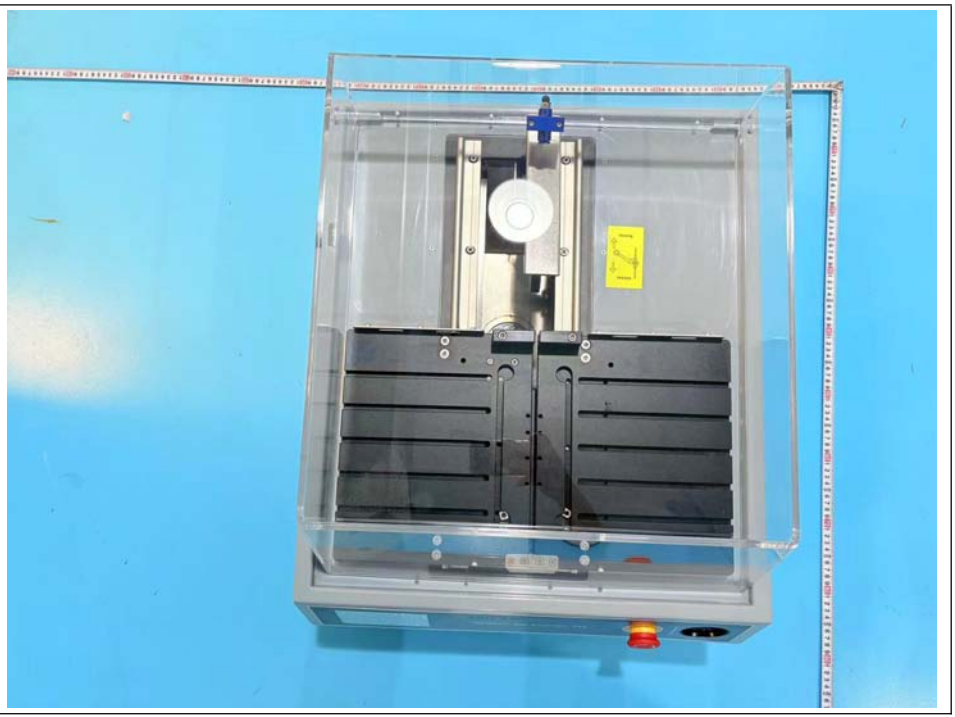
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Detail of: Close-up view for Table CUT-200

View:

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Detail of: Close-up view for Table CUT-200

View:

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Detail of: Close-up view for Table CUT-200

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Detail of: Close-up view for Table CUT-200

View:

[ ] general

[ ] front

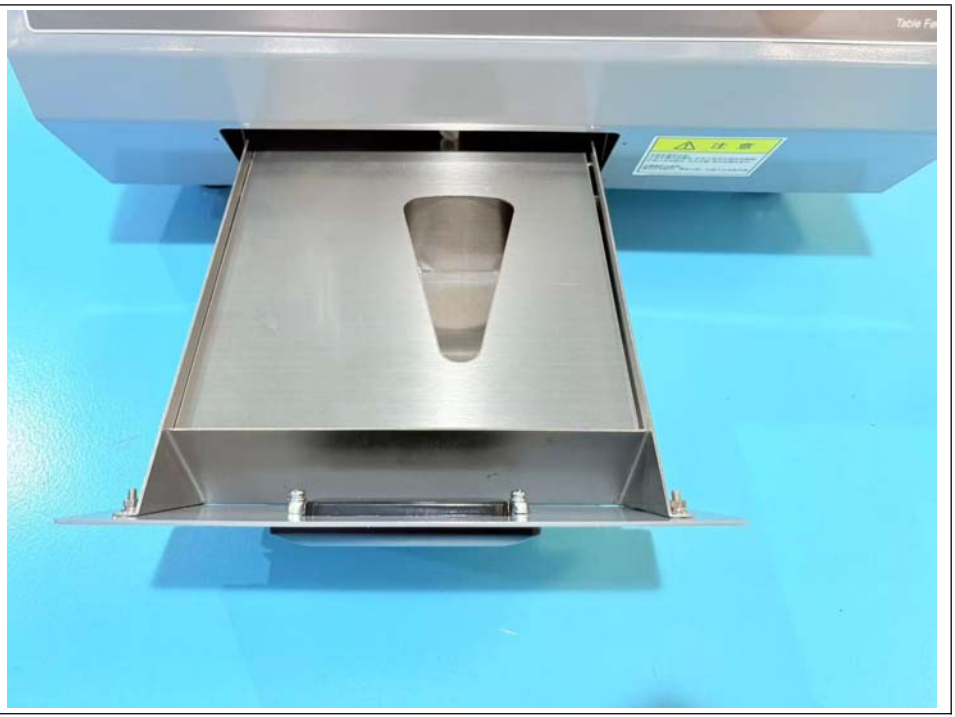
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Detail of: Internal view for Table CUT-200

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Detail of: Internal view for Table CUT-200

View:

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