Technical Construction File (TCF)

ON BEHALF OF

BORUNTE ROBOT CO., LTD.

ROBOT FOR INJECTION MOLDING MACHINERY

Prepared For :	**BORUNTE ROBOT CO., LTD.**
	No.83 Shafu Road, Shabu Village, Dalang Town, Dongguan City
Prepared By :	**OCT TECHNOLOGY TESTING CO., LTD.**
	Unit 1103-2, Yuefang Center Huangge Sub-district, Nansha District, Guangzhou City

Date of Test	**:**	**Dec 09-16,2025**
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Technical Construction File (TCF)

EN ISO 12100
Safety of machinery-
General principles for design-risk assessment and risk reduction
EN 60204
Safety of machinery- electrical equipment of machines-
Part 1: General requirement
EN ISO 10218
Robotics - Safety requirements
Part 1: Industrial robots
Part 2: Industrial robot applications and robot cells

Testing laboratory ..... :	Oct Technology Testing Co., Ltd.
Address..... :	Unit 1103-2, Yuefang Center Huangge Sub-district, Nansha District, Guangzhou City
Report body..... ……..... :	Oct Technology Testing Co., Ltd.
Address ..... ……..... :	Unit 1103-2, Yuefang Center Huangge Sub-district, Nansha District, Guangzhou City
Applicant ……..... :	BORUNTE ROBOT CO., LTD.
Address …… ..... :	No.83 Shafu Road, Shabu Village, Dalang Town, Dongguan City
Standard ……..... ..... :	EN ISO 12100:2010; EN 60204-1:2018; EN ISO 10218-1:2025; EN ISO 10218-2:2025.
Test Result..... :	Compliance with EN ISO 12100:2010; EN 60204-1:2018; EN ISO 10218-1:2025; EN ISO 10218-2:2025.
Procedure deviation ..... :	N.A.
Non-standard test method ..... :	N.A.
Trademark ..... :	N.A.
Type of test object ……..... :	ROBOT FOR INJECTION MOLDING MACHINERY
Model/type reference ……..... :	BRTB07IDS5PC,BRTN17WSS3PC,BRTR09WDS5P0,BRTR11WDS5PC,BRTR13WDS5PC,BRTR07WDS5PC,BRTIRTR1010A,BRTN17WSS5PC,BRTNN15WSS5P,BRTR17WDS5PC,BRTN24WSS5PC,BRTN30WSS5PC,BRTV09WDS5P0,BRTV13WDS5P0,BRTV17WSS5PC,BRTNG09WSS3P,BRTM09IDS5PC,BRTR08TDS5PC,BRTNN15WSS4P,BRTNN11WSS3P,BRTNG11WSS3P,BRTP07ISS1PC,BRTP08WSS0PC,BRTP06ISS0PC,BRTB08WDS1P0,BRTB08WDS1F0,BRTB10WDS1P0,BRTB10WDS1F0
Manufacturer ……..... :	BORUNTE ROBOT CO., LTD.
Address …… ..... :	No.83 Shafu Road, Shabu Village, Dalang Town, Dongguan City

General remarks

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

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

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

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

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

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

Remark:

Photos view:
(See appendix 1)

Possible test 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)

Name and address of the testing laboratory: **Oct Technology Testing Co., Ltd.**
Unit 1103-2, Yuefang Center Huangge Sub-district, Nansha District, Guangzhou City

Reported by : _____ Dec 16,2025
Signature Date

Approved by : _____ Dec 16,2025
Signature Date

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5	Risk assessment		P
5.1	General		P
	Risk assessment comprises (see Figure 1)		P
	-risk analysis, comprising		P
	1) determination of the limits of the machinery (see 5.3),		P
	2) hazard identification (5.4 and Annex B), and		P
	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
	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.	See manual	P
	a) Related to machinery description:		P
	1) user specifications;		P
	2) anticipated machinery specifications, including		P
	i) a description of the various phases of the whole life cycle of the machinery,		P
	ii) design drawings or other means of establishing the nature of the machinery, and	Assembly drawing supplied	P
	iii) required energy sources and how they are supplied;	Electric appliance	P
	3) documentation on previous designs of similar machinery, if relevant;		P
	4) information for use of the machinery, as available.	See manual	P
	b) Related to regulations, standards and other applicable documents:		P
	1) applicable regulations;		P
	2) relevant standards;		N
	3) relevant technical specifications;		P
	4) relevant safety data sheets.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	c) Related to experience of use:		P
	1) any accident, incident or malfunction history of the actual or similar machinery;		P
	2) the history of damage to health resulting, for example, from emissions (noise, vibration, dust, fumes, etc.), chemicals used or materials processed by the machinery;		P
	3) the experience of users of similar machines and, whenever practicable, an exchange of information with the potential users.		P
	d) Relevant ergonomic principles.		P
	The information shall be updated as the design develops or when modifications to the machine are required.		P
	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.		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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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		P
	1) operators,		P
	2) maintenance personnel or technicians,		P
	3) trainees and apprentices, and		P
	4) the general public;		P
	d) exposure of other persons to the hazards associated with the machinery where it can be reasonably foreseen:	Don't put your hands to the hazards area	P
	1) persons likely to have a good awareness of the specific hazards, such as operators of adjacent machinery;		P
	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;		P
	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		P
	a) the range of movement,		P
	b) space requirements for persons interacting with the machine, such as during operation and maintenance,		P
	c) human interaction such as the operator–machine interface, and		P
	d) the machine–power supply interface.		P
5.3.4	Time limits		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Aspects of time limits to be taken into account include		P
	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		P
	b) recommended service intervals.		P
5.3.5	Other limits	Such information shall be applied in instructions.	P
5.4	Hazard identification		P
	-transport, assembly and installation;		P
	-commissioning;		P
	-use;		P
	-dismantling, disabling and scrapping.		P
	The designer shall identify hazards taking into account the following.		P
	a) Human interaction during the whole life cycle of the machine		P
	b) Possible states of the machine		P
	c) Unintended behaviour of the operator or reasonably foreseeable misuse of the machine		P
5.5	Risk estimation		P
5.5.1	General		P
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		P
	1) the exposure of person(s) to the hazard,		P
	2) the occurrence of a hazardous event, and		P
	3) the technical and human possibilities to avoid or limit the harm.		P
5.5.2.2	Severity of harm		P
	The severity can be estimated by taking into account the following:		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	a) the severity of injuries or damage to health, for example,		P
	-slight,		P
	-serious,		P
	-death.		P
	b) the extent of harm, for example, to		P
	-one person,		N
	-several persons.		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, maintenance or repair, etc.),		P
	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).		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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	a) different persons who can be exposed to the hazard(s), for example,		P
	-skilled,	Only for skilled person	P
	-unskilled;		N
	b) how quickly the hazardous situation could lead to harm, for example,		P
	-suddenly,	The harm may be suddenly	P
	-quickly,	The harm may be quickly	P
	-slowly;		N
	c) any awareness of risk, for example,		P
	-by general information, in particular, information for use,	Information for use is applied on the machinery and manual.	P
	-by direct observation,	Direct observation used	P
	-through warning signs and indicating devices, in particular, on the machinery;	Warning signs are applied 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,		P
	-of the machinery,		P
	-of similar machinery,		N
	-no experience.		N
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
5.5.3.3	Relationship between exposure and effects		P
5.5.3.4	Human factors		P
	Human factors can affect risk and shall be taken into account in the risk estimation.		P
5.5.3.5	Suitability of protective measures		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Risk estimation shall take into account the suitability of protective measures and shall	Recommended protective measures shall be supplied in manual	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
	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
5.5.3.6	Possibility of defeating or circumventing protective measures		P
	a) the protective measure slows down production or interferes with another activity or preference of the user,		P
	b) the protective measure is difficult to use,		P
	c) persons other than the operator are involved, or		P
	d) the protective measure is not recognized by the user or not accepted as being suitable for its function.		P
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.	Protective measures shall be maintained in the condition	P
5.5.3.8	Information for use		P
	Risk estimation shall take into account the information for use, as available. See also 6.4.	See user manual or instructions	P
5.6	Risk evaluation		P
5.6.1	General		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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-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
	-the similar machinery is in accordance with the relevant type-C standard(s);		P
	-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
	Step 1: Inherently safe design measures		P
	Step 2: Safeguarding and/or complementary protective measures		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Step 3: Information for use		P
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
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
	-the travelling and working area of mobile machines;		P
	-the zone of movement of lifted loads or of the carrier of machinery for lifting persons;		P
	-the area of contact of the tool of a hand-held or hand-guided machine with the material being worked.		N
	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.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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;	See user manual or instructions	P
	b) limiting the mass and/or velocity of the movable elements, and hence their kinetic energy;	See user manual or instructions	P
	c) limiting the emissions by acting on the characteristics of the source using measures for reducing	See user manual or instructions	P
	1) noise emission at source (see ISO/TR 11688-1),		P
	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 2030-1)],		P
	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		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	4) radiation emissions, including, for example, avoiding the use of hazardous radiation sources, limiting the power of radiation to the lowest level sufficient for the proper functioning of the machine, designing the source so that the beam is concentrated on the target, increasing the distance between the source and the operator or providing for remote operation of the machinery [measures for reducing emission of non-ionizing radiation are given in 6.3.4.5 (see also EN 12198-1 and EN 12198-3)].		P
6.2.3	Taking into account 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		P
	-stress limitation by implementation of correct calculation, construction and fastening methods as regards, for example, bolted assemblies and welded assemblies,		P
	-stress limitation by overload prevention (bursting disk, pressure-limiting valves, breakage points, torque-limiting devices, etc.),		P
	-avoiding fatigue in elements under variable stresses (notably cyclic stresses), and		P
	-static and dynamic balancing of rotating elements,		P
	b) materials and their properties such as		P
	-resistance to corrosion, ageing, abrasion and wear,		P
	-hardness, ductility, brittleness,		P
	-homogeneity,		P
	-toxicity, and		P
	-flammability, and		P
	c) emission values for		P
	-noise,		P
	-vibration,		P
	-hazardous substances, and		P
	-radiation.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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		P
	-appropriately selected pneumatic or hydraulic control system and machine actuators,		P
	-intrinsically safe electrical equipment (see IEC 60079-11);		P
	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		P
	-electrical instead of pneumatic equipment,		P
	-in certain conditions, water-cutting instead of mechanical equipment.		P
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).		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,		P
	-the weight distribution, including loading,		P
	-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,		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-vibration,		P
	-oscillations of the centre of gravity,		P
	-characteristics of the supporting surface in case of travelling or installation on different sites (ground conditions, slope, etc.), and		P
	-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;		P
	-ease of handling, taking into account human capabilities;		P
	-limitation of the number of special tools and equipment.		P
6.2.8	Observing ergonomic principles		P
	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
	Account shall be taken of body sizes likely to be found in the intended user population, strengths and postures, movement amplitudes, frequency of cyclic actions (see ISO 10075 and ISO 10075-2).		P
	All elements of the operator–machine interface, such as controls, signaling 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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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).		P
	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.		N
	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.		P
	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
	f) Select, locate and identify manual controls (actuators) so that		P
	-they are clearly visible and identifiable, and appropriately marked where necessary (see 6.4.4),		P
	-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),		P
	-their location (for push-buttons) and their movement (for levers and hand wheels) are consistent with their effect (see IEC 61310-3), and		P
	-their operation cannot cause additional risk.		P
	Where a control is designed and constructed to 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.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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.		P
	g) Select, design and locate indicators, dials and visual display units so that		P
	-they fit within the parameters and characteristics of human perception,		P
	-information displayed can be detected, identified and interpreted conveniently, i.e. long-lasting, distinct, unambiguous and understandable with respect to the operator's requirements and the intended use, and		P
	-the operator is able to perceive them from the control position.		P
6.2.9	Electrical hazards		P
	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.	See EN 60204-1	P
6.2.10	Pneumatic and hydraulic hazards		P
	Pneumatic and hydraulic equipment of machinery shall be designed so that		P
	-the maximum rated pressure cannot be exceeded in the circuits (using, for example, pressure-limiting devices),		P
	-no hazard results from pressure fluctuations or increases, or from loss of pressure or vacuum,		P
	-no hazardous fluid jet or sudden hazardous movement of the hose (whiplash) results from leakage or component failures,		P
	-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,		P
	-all elements of the equipment, especially pipes and hoses, are protected against harmful external effects,		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-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		P
	-all elements which remain under pressure after isolation of the machine from its power supply are 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.		P
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		P
	-an unsuitable design or modification (accidental or deliberate) of the control system logic,		P
	-a temporary or permanent defect or failure of one or several components of the control system,		P
	-a variation or a failure in the power supply of the control system, and		P
	-inappropriate selection, design and location of the control devices.		P
	Typical examples of hazardous machine behaviour are		P
	-unexpected start-up (see ISO 14118),		P
	-uncontrolled speed change,		P
	-failure to stop moving parts,		P
	-dropping or ejection of part of the machine or of a workpiece clamped by the machine, and		P
	-machine action resulting from inhibition (defeating or failure) of protective devices.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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).		P
	Control systems shall be designed to enable the operator to interact with the machine safely and easily. This requires one or several of the following solutions:		P
	-systematic analysis of start and stop conditions;		N
	-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);		N
	-clear display of the faults;		N
	-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
	-maintained stop commands (for example, interlock) to prevent restarting that could result in dangerous machine behaviour (see ISO 14118:2000, Figure 1).		P
	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).		P
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
6.2.11.3	Starting/stopping of a mechanism		P
	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 (where state 1 represents the highest energy state).		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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).		P
	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.		P
	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.		P
6.2.11.4	Restart after power interruption		P
	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).		P
6.2.11.5	Interruption of power supply		P
	Machinery shall be designed to prevent hazardous situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met:		P
	-the stopping function of the machinery shall remain;		P
	-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);		P
	-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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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
	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 beginning of the machine cycle).		N
	-The protective measure may be, for example,		N
	-preventing the restart of this process after the first stop following the failure, or		N
	-the triggering of an alarm.		N
6.2.11.7	Safety functions implemented by programmable electronic control systems		P
6.2.11.7.1	General		P
	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.		P
6.2.11.7.2	Hardware aspects		P
	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		P
	-architectural constraints (the configuration of the system, its ability to tolerate faults, its behaviour on detection of a fault, etc.),		P
	-selection, and/or design, of equipment and devices with an appropriate probability of dangerous random hardware failure, and		P
	-the incorporation of measures and techniques within the hardware so as to avoid systematic failures and control systematic faults.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.2.11.7.3	Software aspects		P
	The software, including internal operating software (or system software) and application software, shall be designed so as to satisfy the performance specification for the safety functions (see also IEC 61508-3).		P
	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)].		P
	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).		P
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.		P
	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.		P
	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.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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.		P
	f) Control actuators shall be designed or guarded so that their effect, where a risk is involved, cannot occur without intentional operation (see ISO 9355-1, ISO 9355-3 and ISO 447).		P
	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).		P
	h) For cableless control, an automatic stop shall be performed when correct control signals are not received, including loss of communication (see IEC 60204-1).		P
6.2.11.9	Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance		P
	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		P
	a) disables all other control modes,		P
	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,		N
	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		P
	d) prevents any operation of hazardous functions by voluntary or involuntary action on the machine's sensors.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	This control mode shall be associated with one or more of the following measures:		P
	-restriction of access to the danger zone as far as possible;		P
	-emergency stop control within immediate reach of the operator;		P
	-portable control unit (teach pendant) and/or local controls (allowing sight of the controlled elements). See IEC 60204-1.		P
6.2.11.10	Selection of control and operating modes		P
	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.		P
	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).		P
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		P
	Diagnostic systems to aid fault-finding should be included in the control system so that there is no need to disable any protective measure.		P
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
6.2.12.3	Use of “oriented failure mode” components		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.2.12.4	Duplication (or redundancy) of components or subsystems		P
	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.		P
	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.		P
	Diversity of design and/or technology can be used to avoid common cause failures (for example, from electromagnetic disturbance) or common mode failures.		P
6.2.13	Limiting exposure to hazards through reliability of equipment		P
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring intervention, thereby reducing exposure to hazards.		P
	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.		P
	Safety-related components (for example, certain sensors) of known reliability shall be used.		P
	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.		P
6.2.14	Limiting exposure to hazards through mechanization or automation of loading (feeding)/ unloading (removal) operations		P
	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.		P
	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.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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. Suitable safeguards (see 6.3) shall be provided if this cannot be ensured.		P
	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.		P
6.2.15	Limiting exposure to hazards through location of setting and maintenance points outside danger zones		P
	The need for access to danger zones shall be minimized by locating maintenance, lubrication and setting points outside these zones.		P
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.		P
	Certain safeguards may be used to avoid exposure to more than one hazard.		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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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
	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),		P
	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).		P
	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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	b) interlocking guards with or without guard locking (see also 6.3.3.2.3, ISO 14119 and ISO 14120);		P
	c) self-closing guards (see ISO 14120:2002, 3.3.2);		N
	d) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496) or pressure-sensitive protective devices (see ISO 13856).		N
6.3.2.3	Where access to the hazard zone is required during normal operation		P
	Where access to the hazard zone is required during normal operation of the machinery, safeguards should be selected from the following:		P
	a) interlocking guards with or without guard locking (see also ISO 14119, ISO 14120 and 6.3.3.2.3 of this document);		P
	b) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496);		N
	c) adjustable guards;		N
	d) self-closing guards (see ISO 14120:2002, 3.3.2);		N
	e) two-hand control devices (see ISO 13851);		N
	f) interlocking guards with a start function (control guard) (see 6.3.3.2.5).		P
6.3.2.4	Where access to the hazard zone is required for machine setting, teaching, process changeover, fault-finding, cleaning or maintenance		P
6.3.2.5	Selection and implementation of sensitive protective equipment		N
6.3.2.5.1	Selection		N
6.3.2.5.2	Implementation		N
	Consideration should be given to		N
	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
	b) the reaction of the device to fault conditions (see IEC 61496 for electrosensitive protective equipment),		N
	c) the possibility of circumvention, and		N

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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
	Sensitive protective equipment shall be integrated in the operative part and associated with the control system of the machine so that		N
	-a command is given as soon as a person or part of a person is detected,		N
	-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
	-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
	-the machine cannot operate during interruption of the detection function of the sensitive protective equipment, except during muting phases, and		N
	-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
	For detailed consideration of the fault behaviour of, for example, active optoelectronic protective devices, IEC 61496 should be taken into account.		N
6.3.2.5.3	Additional requirements for sensitive protective equipment when used for cycle initiation		N
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
	-locking devices,		P
	-movement limiters or mechanical stops,		P
	-acceleration or deceleration limiters,		P
	-load limiters, and		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-alarms warning of the approach to stability or tipping limits.		P
6.3.2.7	Other protective devices		P
	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		P
	when the operator has insufficient visibility of the hazard zone,		P
	when the operator lacks knowledge of the actual value of a safety-related parameter (distance, speed, mass, angle, etc.), and		P
	when hazards can result from operations other than those controlled by the operator.		P
	The necessary devices include		P
	a) devices for limiting parameters of movement (distance, angle, velocity, acceleration),		P
	b) overloading and moment limiting devices,		P
	c) devices to prevent collisions or interference with other machines,		P
	d) devices for preventing hazards to pedestrian operators of mobile machinery or other pedestrians,		P
	e) torque limiting devices, and breakage points to prevent excessive stress of components and assemblies,		P
	f) devices for limiting pressure or temperature,		P
	g) devices for monitoring emissions,		P
	h) devices to prevent operation in the absence of the operator at the control position,		P
	i) devices to prevent lifting operations unless stabilizers are in place,		P
	j) devices to limit inclination of the machine on a slope, and		P
	k) devices to ensure that components are in a safe position before travelling.		P
	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).		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
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. Guards and protective devices shall be compatible with the working environment of the machine and designed so that they cannot be easily defeated.		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		P
	-prevention of access to the space enclosed by the guard		P
	-containment/capture of materials, workpieces, chips, liquids which can be ejected or dropped by the machine, and reduction of emissions.		P
6.3.3.2.2	Requirements for fixed guards		P
	Fixed guards shall be securely held in place either		P
	-permanently		P
	-by means of fasteners (screws, nuts) making removal/opening impossible without using tools.		P
6.3.3.2.3	Requirements for movable guards		P
	Movable guards which provide protection against hazards generated by moving transmission parts shall		P
	a) as far as possible when open remain fixed to the machinery or other structure (generally by means of hinges or guides), and		P
	b) be interlocking (with guard locking when necessary) (see ISO 14119).		P
	Movable guards against hazards generated by non-transmission moving parts shall be designed and associated with the machine control system so that		P
	-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,		P
	-they can be adjusted only by an intentional action, such as the use of a tool or a key, and		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-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).		P
6.3.3.2.4	Requirements for adjustable guards		P
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed.		P
	Manually adjustable guards shall be		P
	-designed so that the adjustment remains fixed during a given operation, and		P
	-readily adjustable without the use of tools.		P
6.3.3.2.5	Requirements for interlocking guards with a start function (control guards)		P
	An interlocking guard with a start function may only be used provided that		P
	a) all requirements for interlocking guards are satisfied (see ISO 14119),		P
	b) the cycle time of the machine is short,		P
	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,		P
	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),		P
	e) all other guards, whether fixed (removable type) or movable, are interlocking guards,		P
	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		P
	g) the guard is securely held open (for example, by a spring or counterweight) such that it cannot initiate a start while falling by its own weight.		P
6.3.3.2.6	Hazards from guards		P
	- the guard construction	No sharp edges or corners	P
	- the movements of the guards	No fall occur	P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.3.3.3	Technical characteristics of protective devices	Installed and connected to the control system and cannot be easily defeated.	P
6.3.3.4	Provisions for alternative types of safeguards		P
6.3.4	Safeguarding to reduce emissions		P
6.3.4.1	General		P
6.3.4.2	Noise		P
6.3.4.3	Vibration	Please wear gloves when working	P
6.3.4.4	Hazardous substances		P
6.3.4.5	Radiation		P
6.3.5	Complementary protective measures		P
6.3.5.1	General		P
6.3.5.2	Components and elements to achieve emergency stop function		N
	- the actuators shall be clearly identifiable, clearly visible and readily accessible		N
	- the hazardous process shall be stopped as quickly as possible without creating additional hazards		N
	- the emergency stop control shall trigger or permit the triggering of certain safeguard movements		N
6.3.5.3	Measures for the escape and rescue of trapped persons		P
6.3.5.4	Measures for isolation and energy dissipation		P
	a) isolating the machine from all power supplies		P
	b) locking all the isolating units in the isolating position		P
	c) dissipating or restraining any stored energy which may		P
	d) verifying, by means of a safe working procedure		P
6.3.5.5	Provisions for easy and safe handling of machines and their heavy component parts		P
6.3.5.6	Measures for safe access to machinery		P
6.4	Information for use	See manual	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.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
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
	All directions required to ensure safe and correct use of the machine.		P
	Inform and warn the user about residual risk.		P
	Information for use shall not compensate for design deficiencies		P
6.4.1.3	Information for use shall cover, separately or in combination, transport, commissioning, use and if necessary, de-commissioning, dismantling and disposal.		P
6.4.2	Location and nature of information for use		P
	a) in/on the machine itself (see 6.4.3 and 6.4.4),	On enclosure of machine itself	P
	b) in accompanying documents (in particular instruction handbook, see 6.4.5),	In instructions/manual	P
	c) on the packaging,	On packaging	P
	d) by other means such as signals and warnings outside the machine.	Signals and warnings applied	P
6.4.3	Signals and warning devices		P
	a) be emitted before the occurrence of the hazardous event,		P
	b) be unambiguous,	Not unambiguous	P
	c) be clearly perceived and differentiated from all other signals used, and	No misunderstanding	P
	d) be clearly recognized by the operator and other persons.	Clearly	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.	On conspicuous position	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.		P
6.4.4	Markings, signs (pictograms) and written warnings	See enclosure of equipment	P
	Machinery shall bear all markings which are necessary		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	a) for its unambiguous identification, including at least	See marking lable	P
	1) the name and address of the manufacturer,	See marking lable	P
	2) the designation of series or type, and		P
	3) the serial number, if any,	On machine	P
	b) in order to indicate its compliance with mandatory requirements, comprising		P
	1) marking, and	CE	P
	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),	See enclosure of equipment and markings	P
	c) for its safe use, for example,	Refer to user manual	P
	1) maximum speed of rotating parts,		P
	2) maximum diameter of tools,		P
	3) mass (in kilograms) of the machine itself and/or of removable parts,		P
	4) maximum working load,		P
	5) necessity of wearing personal protective equipment,		P
	6) guard adjustment data, and		P
	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.		P
	Markings shall comply with recognized standards.		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.4.5	Accompanying documents (in particular — instruction handbook)	See manual or instructions	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
	a) information relating to transport, handling and storage of the machine, such as		P
	1) storage conditions for the machine,		P
	2) dimensions, mass value(s), position of the centre(s) of gravity, and		P
	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		P
	1) fixing/anchoring and dampening of noise and vibration requirements,		P
	2) assembly and mounting conditions,		P
	3) space needed for use and maintenance,		P
	4) permissible environmental conditions,		P
	5) instructions for connecting the machine to power supply,		P
	6) advice on waste removal/disposal, and		P
	7) if necessary, if necessary, recommendations about prevention measures which have to be taken by the user;		P
	c) information relating to the machine itself, such as		P
	1) detailed description of the machine, its fittings, guards and/or protective devices,		P
	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,		P
	3) diagrams (especially schematic representation of safety functions),		P
	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,		P
	5) technical documentation of electrical equipment (see IEC 60204), and		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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		P
	1) intended use,		P
	2) manual controls (actuators),		P
	3) setting and adjustment,		P
	4) modes and means for stopping (especially emergency stop),		P
	5) risks which could not be eliminated by the protective measures implemented by the designer,		P
	6) particular risks which can be generated by certain applications, by the use of certain fittings, and about specific safeguards necessary for such applications,		P
	7) reasonably foreseeable misuse and prohibited applications,		P
	8) fault identification and location, for repair and for restarting after an intervention, and		P
	9) personal protective equipment needed to be used and the training that is required;		P
	e) information for maintenance, such as	See manual or instructions	P
	1) the nature and frequency of inspections for safety functions,		P
	2) specification of the spare parts to be used when these can affect the health and safety of operators,		P
	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),		P
	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		P
	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		P
	1) the operating method to be followed in the event of accident or breakdown,		P
	2) the type of fire-fighting equipment to be used, and		N

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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) Type 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) Information for use shall be given in the official language(s) of the country in which the machine is to be used.		P
	c) Whenever possible, text should be supported by illustrations.		P
	d) Consideration should be given to presenting information in tabular form where this will aid understanding.		P
	e) The use of colours should be considered		P
	f) When information for use is lengthy, a table of contents and/or an index should be given.		P
	g) Safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator		P
6.4.5.3	Drafting and editing information for use		P
	The following applies to the drafting and editing of information for use.		P
	a) Relationship to model		P
	b) Communication principles		P

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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 users.		P
	e) Durability and availability of the documents		P
7	Documentation of risk assessment and risk reduction		P
	The documentation shall demonstrate the procedure that has been followed and the results that have been achieved. This includes, when relevant, documentation of		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):		P
	1) the data used and the sources (accident histories, experience gained from risk reduction applied to similar machinery, etc.);		P
	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.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5	Safety requirements and risk reduction measures.		P
5.1	General		P
5.2	Design		P
5.2.1	General ,		P
	The design shall be based on the information for use provided with the robot, end-effector and the associated machinery and equipment. The design shall conform with the requirements as described in 5.2.2 through 5.2.16.		P
5.2.2	Materials, mechanical strength and mechanical design.		P
5.2.3	Provisions for lifting or moving		P
	Instructions and provisions for lifting or moving parts of the robot application shall be provided when intended to be moved after initial installation. The provisions shall be capable of handling the anticipated load.		P
5.2.4	Hazardous substances.		P
	Robot applications shall be designed and constructed in such a way that risks of inhalation, ingestion or contact of hazardous materials and substances shall be prevented. . Where the use of hazardous substances cannot be eliminated, the robot application shall be designed such that those substances can be contained, evacuated, precipitated by water spraying, fitered or treated by another effective method.		P
5.2.5	Stability		P
	To prevent tipping and filling over, components of robot applications shall be: -affixed to be stable (eg. to other components, rails, tracks, mobile platforms, the floor or parts of the building structure); or - stable itself for installation, operation and use.		P
5.2.6	Temperature and fire risks		P
	The design of the robot application shall be such that the temperatures of accessible surfaces are according to ISO 13732-1:2006 and ISO 13732-3:2005.		P
5.2.7	Special equipment		P
5.2.8	Position holding.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5.2.9	Additional axis (axes)		P
5.2.10	Power loss or change.		P
	Loss or change of electrical, hydraulic, pneumatic or vacuum power shall not result in a hazardous situation. Re-initiation of power shall not lead to any hazardous movements or a change of the safety-related parameters.		P
5.2.11	Component malfunction.		P
	Robot application components shall be designed, constructed, secured, or contained in accordance with 5.2.2, so that risks caused by breaking or loosening, or releasing, including those related to stored energy, are prevented as far as practicable.		P
5.2.12	Hazardous energy .		P
5.2.12.1	General		P
	Release of stored energy shall not cause hazardous situation(s). A means shall be provided to prevent uncontrolled or hazardous release of stored energy. If the hazardous energy is potential, there shall be a means to secure it in a position which can be either the energized or de-energized position.		P
5.2.13	Electrical, pneumatic and hydraulic parts.		P
	Electrical parts shall be designed and implemented in accordance with the relevant requirements of IEC 60204-1:2016+AMD1:2021.		P
5.2.14	Tool centre point (TCP) setting.		P
	When the capability to enter tool centre point (TCP) settings has been provided in the robot (ISO 10218-1:2025, 5.1.14) and failure to enter these settings can create a hazard, the TCP setting shall be entered in accordance with the robot information for use.		P
5.2.15	Payload setting.		P
	Where the payload setting is provided in the robot (ISO 10218-1:2025, 5.1.15) and failure to enter these settings can create a hazard, the payload setting shall be entered in accordance with the robot information for use,		P
5.2.16	Cybersecurity.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	A cybersecurity threat assessment shall be conducted. If the cybersecurity threat assessment identifies that a threat could result in safety risk(s), cybersecurity measures shall be provided to prevent unauthorized access to the control system(s), its hardware, software, configuration data and the application program(s).		P
5.3	Robot cell integration		P
5.3.1	General		P
5.3.2	Span-of-control		P
	In the case of multiple robot applications, multiple robot cells or other machinery, different span-of-control may be applied. In such cases, the span-of-control shall be set according to the requirements of the task(s) to be performed or the characteristics of the system (e.g. process flow, equipment structure, entry locations through perimeter safeguarding. location of other protective devices, hazards inside the safeguarded space).		P
5.3.3	Span-of-control of emergency stop function		P
	Actuation of an emergency stop function shall stop: -all hazardous motion of the robot, end effector, and work piece; and -other hazardous movements and hazardous functions: - in the robot application or robot cell; and -at the interface(s) between robots, end-effectors, robot applications and robot cells.		P
5.3.4	Operational modes with multi-robot applications or robot cells.		P
	In a robot cell with more than one robot system or robot application, mode(s) may be selected: -individully on each robot control; or - - for each robot application; or -be common for all associated robot applications in the robot cell.		P
5.3.5	Local control, remote control and single-point-of-control.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The following shall be fulfilled: -determining what is considered remote control shall be according to 5.7.6.1; - local control shall be according to 5.7.6.2; -remote control shall be according to 5.7.6.3; -single-point-of-control shall be according to 5.7.5.		P
5.3.6	Automatic workpiece feeding		P
	Where workpieces are automatically fed, hazards caused by breakage shall be prevented or the risks shall be minimized by the design and integration.		P
5.4	Layout.		P
5.4.1	General.		P
	The design shall be such that the operator can safely perform all intended and reasonably foreseeable tasks. The location of the robot application(s), equipment and machinery within the robot cell should not introduce additional hazards. If additional hazards are introduced, protective measures shall be applied to reduce the risks associated with these hazards, in accordance with Clauses 4 and 5.		P
5.4.2	Use and limits.		P
5.4.3	Design		P
5.4.4	Design for collaborative applications.		P
5.4.5	Prevention of trapping within the safeguarded space.		P
5.4.6	Establishing restricted spaces.		P
5.4.7	Limiting motion		P
5.5	Safety functions		P
5.5.1	General.		P
	Control systems shall be designed so reasonably foreseeable human error during operation does not lead to hazardous situations.		P
5.5.2	Functional safety standards.		N
5.5.3	Performance .		N

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The integrator shall determine the performance of each required safety function according to one ofthe below: -functional safety PL, or required SIL. listed in Annex C Table C1; or - the results of a comprehensive risk assessment where the risk estimation meets the requirements of IS0 12100:2010 and either ISO 13849-1:2023 or IEC 62061:2021.		N
5.5.4	Failure or fault detection.		P
5.5.5	Parameterization of safety functions.		N
5.5.6	Speed limit[(s) monitoring		P
5.5.7	Start / restart interlock and reset		P
5.5.8	Monitored- standstill		P
5.5.9	Communications		P
5.5.10	Electromagnetic requirements.		P
	Safety-related control systems shall fulfil the requirements of IEC 61000-6-7:2014.		P
5.6	Stopping		P
5.6.1	General.		P
	Every robot application or robot cell shall have a protective stop function, a normal stop and an independent emergency stop function. . The control system shall be designed such that stop functions have precedence over any other control functions. When a stop function has been initiated, no other control functions shall enable robot application functions until the stop condition has been achieved.		P
5.6.2	Emergency stop.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Each control station, including pendants, capable of initiating robot motion or other hazardous situations shall have a manually initiated emergency stop function that: a)complies with the requirements of 5.6.2; b) takes precedence over all other functions; c) causes all hazardous machine functions within the span-of-control (5.3.3) to stop; d) removes drive power; and e) remains active until the emergency stop device is disengaged in accordance with ISO 13850:2015, 4.1.4.		P
5.6.3	Protective stop.		P
	The robot application shall have one or more protective stop functions that have the capability to be initiated by an internal safety function or external protective devices. The following shall be fulfilled: a) the protective stop function shall conform with 5.5; b) selection of stop category 0, 1 or 2, in accordance with IEC 60204-1:2016+AMD1:2021, shall be determined by the risk assessment; a monitored-standstill safety function according to 5.5.8 shall be required when a stop category 2 according to IEC 60204-1:2016+AMD1:2021 is used for the protective stop.		P
5.6.4	Normal stop		P
	The control station(S) for the application shall be fitted with a normal stop control device to stop some or all the functions, according to the span-of-control. This stop function, when activated, shall result in a category 0 or category 1 stop according to IEC 60204-1:2016+AMD1:2021. Once the hazardous functions have stopped, the energy supply to the hazardous function actuators shall be removed.		P
5.6.5	Associated equipment stopping		P
	The robot application shall be integrated and installed so stopping, e.g. emergency or protective stop, of associated equipment shall not result in a hazard or hazardous situation(s).		P
5.7	Control functions.		P
5.7.1	General		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Control functions shall meet the requirements of IEC 60204-1:2016+AMD1:2021. The control functions shall be designed to be consistent with the requirements of ISO 10218-1:2025. Control functions that initiate power or motion shall be designed and implemented to meet the requirements in 5.7.2 to 5.79.		P
5.7.2	Modes		P
5.7.3	Protection from unexpected start-up		P
5.7.4	Status indication and warning devices ...		P
5.7.5	Single-point-of-control.		P
5.7.6	Local and remote control		P
5.7.7	Enabling devices.		P
5.7.8	Control stations		P
	The robot application shall have the means to control, program/teach, configure and troubleshoot (e.g. teach pendant or other control stations), At least one of the following means shall be provided: -control panel or teach pendant; -remote control capability and the corresponding connectivity (cabled or wireless).		P
5.7.9	Simultaneous motion.		P
	A single teach pendant may control simultaneous motion of a robot application with multiple robots. Each robot (and if necessary, end-effectors, additional axes and other parts of the robot application] shall be selected before being activated. To be selected, all robots shall be in the same operational mode (e.g reduced-speed manual mode). An indication of what will be activated (selected to be moved) shall be provided in accordance with ISO 10218-1:2025. Only what is selected shall be activated. Any robot not selected shall not move and shall not present hazards by means in accordance with 5.2.8,		P
5.8	Safeguards and their use		P
5.8.1	General.		P
5.8.2	Establishing a safeguarded space.		P
5.8.3	Perimeter safeguarding.		P
5.8.4	Overriding of protective devices		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5.8.5	Guards		P
5.8.6	Sensitive protective equipment.		P
5.8.7	Muting.		P
5.8.8	Overriding of SPE		P
	There are circumstances that could require overriding a SPE (e.g. for purposes of material entry/exit, threading or feeding set-up). Providing this capability shall be according to 5.7.2.4 and IEC 62046:2018. When provided, the overriding means shall provide the same level of risk reduction as the SPE. See 5.8.4.		P
5.8.9	Minimum distances.		P
5.8.10	Safeguarding to protect from unexpected restart		P
	From each control station, the visibility to all the locations within the safeguarded space[s] where operators can be, shall be ensured. Where this is not practicable, presence sensing shall be provided to detect any person throughout the safeguarded space. Where this is not practicable, sequenced time-limited reset devices located inside the safeguarded space shall be provided. The final reset device shall be located outside the safeguarded space and shall not be within reach by any person within the safeguarded space.		P
5.9	End-effector		P
5.9.1	General..		P
5.9.2	Risk reduction measures.		P
5.9.3	Shape and surfaces.		P
5.9.4	Protective devices and/or safety functions		P
5.9.5	End-effectors and robot application design....		P
5.9.6	End-effectors exchange systems		P
5.10	Vertical transfer components.		P
5.10.1	Mechanical design.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The movement of the carrier of vertical transfer components serving fixed landings shall be rigidly guided to and at the landings.		P
5.10.2	Prevention of falling hazard		P
5.10.3	Prevention of crushing hazards.		P
5.10.4	Control of movements.		P
5.11	Lasers and laser equipment_		P
5.12	Material handling, manual load/unload stations and material flow.		P
	Material handing.		P
	Manual load/unload stations and other manual stations.		P
	Material flow		P
5.13	Adjacent robot cells		P
	Safeguarding shall be provided to a ensure that operators in a robot cell are not exposed to hazards from adjacent robot cells; b) reduce risks to operators due to the transfer of materials into and out of adjoining robot cells; c before operators would be exposed to hazards in or caused by adjacent robot cells, either -prevent operator access to adjacent robot cells from within a robot cell; or - bring hazards within adjacent robot cells to a safe state.		P
5.14	Collaborative application		P
	General		P
	Safeguarded spaces.		P
	Transitions		P
	Hand-guided control (HGC)		P
	Speed and separation monitoring (SSM)		P
	Power and force limiting (PFL).		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	In a PFL collaborative application, contact between moving parts of the robot application and operator(s) can occur. Collaborative applications designed to rely upon power and force limiting shall use robots that conform with the requirements of IS0 10218-1:2025, 5.10.4. The collaborative application shall be designed to adequately reduce risks of injury by not exceeding the applicable threshold limits for contact events. Contact events between moving parts of a collaborative application and operator(s) are identified during the risk assessment. Contact parameters of pressure and force shall be verified of the identified contact event(s).		P
5.15	Assembly, installation and commissioning		P
	Commissioning of robot applications.		P
	Environmental conditions.		P
	Power		P
	Lighting		P
	When darkness or shadows due to lighting cause hazardous situation(S) for operators to perform tasks, suitable lighting shall be provided in accordance with relevant standards. For requirements of lighting of workplaces, ISO 8995-1:2002 shall be applied for indoors and IS0/CIE 8995 -3:2018 shall be applied for outdoors.		P
	Labelling.		P
	Controls shall be labelled to clearly indicate their function, according to IEC 60204-1:2016+AMD1:2021, IEC 61310-1:2007 and IEC 61310-2:2007 (e.g. power on "I", power off "0]). See Annex G.		P
5.16	Maintenance.		P
	Movement without drive power.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	If the application requires movement without drive power capability, the integration shall fulfil this requirement. When the robot's capabilities of movement without drive power are used, the implementation shall conform with the instructions for use of the robot's movement without drive power capabilities. The integrator shall update any warnings and information.		P
6	Verification and validation.		P
	Verification and validation method		P
	Verification and validation of guards, protective devices, safety function parameter settings and biomechanical threshold limits		P
	Guards and protective devices.		P
	Safety function parameter settings		P
	Biomechanical limits.		P
	Complementary protective measures.		P
	It shall be verified that complementary protective measures are provided: a) instructions; b) training materials; c)warnings; d) information about the required personal protective equipment; e) procedures; f) other appropriate measures.		P
7	Information for use.		P
7.1	General		P
7.2	Signals and warning devices.		P
7.3	Marking.		P
7.4	Signs (pictograms) and written warnings.		P
7.5	Instruction handbook.		P
7.5.1	General.		P
7.5.2	Identification.		P
	Intended use.		P
	Transport, handling and lifting.		P
	Installation		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Commissioning and programming.		P
	Abnormal and emergency situations		P
	Instructions for emergency situations shall include, where applicable: a where blocking (5.10.3) cannot be avoided, the guidance to safely block and unblock the equipment; b guidance on the means for the release of operator(s) trapped; c type of fire-fighting equipment to be used, if specific; d warning about possible emission or leakage of harmful substance(s) and means to fight their effects (if practicable); e) instructions and recommendations for training operator(s) on responding to emergency or abnormal situations including emergency recovery of system equipment.		P
	Settings and operation.		P
	Maintenance.		P
	Decommissioning.		P
	Remote interventions.		P
	Hazardous energy.		P
	Limiting devices and restricted space.		P
	Movement without drive power.		P
	Control station		P
	Functional safety.		P
	Operating modes		P
	Enabling devices.		P
	Vibration		P
	End-effector		P
	Manual load/ unload stations.		P

EN ISO 10218-1+ EN ISO 10218-2			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The instructions for use shall contain the information required for the correct use of the manual load/ unload station. Residual risk information and warnings shall be provided to the user. Examples of symbols used for safety signs include: -no climbing, see ISO 7010:2019-P009; - no stepping on surface, see IS0 7010:2019-P019.		P
	Collaborative applications.		P
	Cybersecurity.		P
	Information shall be provided regarding any implemented cybersecurity features and methodologies to enable the user to implement measures such as firewalls, creation of a recovery plan and implementation of a continuous lifecycle approach (e.g. review of security risk assessment in light of new threats and vulnerabilities and to implement required software patches).		P

EN 60204-1			
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 as described		--
4.2	**Selection of equipment**		--
4.2.1	Electrical components and devices shall be: - suitable for their intended use - conform to IEC standards where such exist - be applied in accordance with supplier's instructions		P
4.2.2	Where appropriate electrical equipment in compliance with IEC 61439 series		P
4.3	**Electrical supply**		--
4.3.1	Electrical equipment to be designed for correct operation within the conditions of mains power supply		P
	- as stated below (4.3.2 or 4.3.3)		P
	- or as specified by the user		N/A
	- or as specified by the supplier (4.3.4)		N/A
4.3.2	AC supplies		--
	Supply Voltage: Steady state voltage: 0.9.... 1.1 of nominal voltage		--
	Frequency: 0.99 ... 1.01 of nominal frequency continuously; 0.98 ... 1.02 short time.		--
	Harmonics: not exceeding 12 % 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 rms 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: - batteries: 0.85 – 1.15 of nominal voltage - battery-operated vehicles: 0.7 – 1.2 of nom. volt. - from converting equipment: 0.9 – 1.1 of nom. volt.		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Voltage interruption: - batteries: 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, DC bus) limits acc. 4.3.2 /.3 may be exceeded, provided equipment is designed accordingly		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	Immunity and/or emission tests required unless		P
	- incorporated devices and components comply with the relevant product standard and		P
	- installation and wiring according supplier instructions or Annex H:		P
4.4.3	Electrical equipment shall be capable of operating correctly in the intended ambient air temperature. (Minimum requirement: air temperatures of +5 °C and +40 °C)		P
4.4.4	Electrical equipment shall be capable of operating correctly when the relative humidity is up to 50 % at a maximum temperature of +40 °C		P
	Harmful effects of condensation shall be avoided		P
4.4.5	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level		P
	For equipment to be used at higher altitudes the reduction of dielectric strength, switching capability and cooling effects shall be taken into account		P
4.4.6	Electrical equipment shall be adequately protected against the ingress of solids and liquids (see 11.3)	Enough IP protection degree	P
4.4.7	When equipment is subjected to radiation, additional measures shall be taken		N/A
4.4.8	Undesirable effects of vibration, shock and bump avoided by suitable mans		P
4.5	Electrical equipment designed to withstand the effects of transportation and storage within a temperature range of - 25 to + 55 °C		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
4.6	Heavy or bulky electrical equipment of the machine provided with suitable means for handling		P
5	**INCOMING SUPPLY CONDUCTOR TERMINATIONS AND DEVICES FOR DISCONNECTING AND SWITCHING OFF**		--
5.1	**Incoming supply conductor terminations**		--
	Recommendation that electrical equipment of a machine is connected to a single supply (For large complex machinery, there can be a need for more than one incoming supply)		P
	Unless a plug is provided, supply conductors should be terminated at the supply disconnecting device		P
	Neutral conductor clearly indicated in technical documentation with "N" (see cl. 16.1)	No neutral conductor	N/A
	A separate terminal, labelled N provided (it may be part of the supply disconnecting device)		N/A
	No connection between neutral conductor and protective bonding circuit		N/A
	Exception: a connection may be made between the neutral terminal and the PE terminal at the point of the connection of the electrical equipment to a TN-C supply system.		N/A
	For machines supplied from parallel sources the requirements of IEC 60364-1 apply		N/A
	All terminals of incoming supply clearly marked in ac. with IEC 60445)		P
5.2	**Terminal for connection of external protective conductor (PE)**		--
	For each incoming supply, a terminal shall be provided in the same compartment as the line conductor terminals for connection to the external protective conductor		P
	Terminal size according to table 1 in relation to the line conductors		P
	Where an external protective conductor other than copper is used, the terminal size and type shall be selected accordingly		N/A
	At each incoming point this terminal shall be marked or labelled with the letters PE		N/A
5.3	**Supply disconnecting device**		--

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5.3.1	A supply disconnecting device shall be provided: – for each incoming supply to a machine – for each on-board power supply		P
	Where two or more such devices exist, interlocks shall be provided to prevent hazardous situations		N/A
5.3.2	The supply disconnecting device shall be one of the following:		—
	a) a switch-disconnector, acc. to IEC 60947-3 for at least appliance category AC-23 B or DC-23 B		N/A
	b) a control and protective switching device suitable for insulation acc. to IEC 60947-6-2		N/A
	c) a circuit-breaker suitable for isolation (acc. to IEC 60947-2)		P
	d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements and the appropriate utilization category and/or specified endurance requirements		N/A
	e) a plug/socket combination for a flexible cable supply		N/A
5.3.3	A disconnection device acc. to 5.3.2 a) to d) has to fulfil all of the following requirements		—
	- isolate the electrical equipment from the supply and have one OFF (isolated) and one ON position marked with "O" and "I"		P
	- have a visible contact gap or a position indicator which cannot indicate OFF (isolated) until all contacts are actually open and the requirements for the isolating function have been satisfied		P
	- have an operating means (see 5.3.4)		P
	- coloured black or grey recommended (If used as an emergency stop, red/yellow combination selected)	Black	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	Can be locked	P
	- disconnect all live conductors of its power supply circuit For TN supply systems, the neutral conductor may or may not be disconnected except in countries where disconnection of the neutral conductor (when used) is compulsory		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- have a braking capacity to interrupt the system, when the largest motor is stalled		P
	A plug/socket combination used as a disconnection device shall: - comply with 13.4.5 have a braking capacity to interrupt the system, when the largest motor is stalled		N/A
5.3.4	Operating means of supply disconnecting devices (e.g. a handle) shall be external to the enclosure		P
	Exception: for power-operated switchgear this can be some other means (e.g. pushbutton) instead of a handle		N/A
	The operating means shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level (upper limit of 1,7 m is recommended)		P
	Where intended for emergency operation, see 10.7.3 or 10.8.3		N/A
	Where not intended for emergency operation - the colours black or grey are recommended a supplementary cover or door that can be readily opened without a key or tool may be provided. It shall clearly show its function, e.g. by relevant symbols		P
5.3.5	The following circuits need not be disconnected by the supply disconnecting device: lighting circuits for lighting needed during maintenance or repair; socket outlets for the exclusive connection of repair or maintenance tools and equipment; undervoltage protection circuits that are only provided for automatic tripping in the event of supply failure; circuits supplying equipment that should normally remain energized for correct operation Such circuits should be provided with their own disconnecting device.		N/A
	Where expected circuits are not disconnected by the supply disconnecting device:		—
	- permanent warning labels shall be placed close to the operating means		N/A
	- a statement shall be included in the maintenance manual and		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-the conductors are identified by colour, taking into account the recommendation of Cl.13.2.4, or -expected circuits are separated from other circuits, or -expected circuits are identified by permanent warning labels		N/A
5.4	**Devices for removal of power for prevention of unexpected start-up**		--
	Devices for removal of power for the prevention of unexpected start-up shall be provided where this can create a hazard	Disconnection device can fully meet this requirement	P
	They shall be appropriate and convenient for the intended use, suitably placed, and readily identifiable as to their function and purpose		P
	Where not obvious, they shall be marked to indicate the extent of removal of power		P
	Devices in accordance with 5.3.2 may be used for this purpose		P
	Disconnectors, withdrawable fuse links and withdrawable links only used, if located in enclosed electrical operator area (see 3.1.23)		P
	Devices that do not fulfil the isolation function (e.g. a contactor switched off by a control circuit etc.) only used for tasks such as: – inspections; – adjustments; – work on the electrical equipment where there are only minor risks (as described)		N/A
5.5	**Devices for isolating electrical equipment**		--
	Devices shall be provided for isolating electrical equipment or parts of it to enable work	Disconnection device can fully meet this requirement	P
	Such devices shall be: - appropriate and convenient for the intended use; - suitably placed; - readily identifiable as to which part or circuit of the equipment is served. They shall be marked unless their function and purpose is obvious		P
	Where it is necessary to work on individual parts of the electrical equipment of a machine, or on one of a number of machines fed by a common conductor bar, conductor wire or inductive power supply system, a disconnecting device is provided for each part, or for each machine, requiring separate		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	isolation		
	In addition, the following devices that fulfil the isolation function may be provided for this purpose: - devices described in 5.3.2; - disconnectors, withdrawable fuse links and withdrawable links only used, if located in enclosed electrical operator area (see 3.1.23) and information provided (see cl 17)	devices described in 5.3.2	P
5.6	**Protection against unauthorized, inadvertent and/or mistaken connection**		--
	Where devices acc. to cl. 5.4 and 5.5 are located outside an enclosed electrical operator area, locking means in OFF position shall be provided When so secured, local and remote reconnection shall be prevented		P
	Where these devices are located inside an enclosed electrical operator area, other means of protection against unintended reconnection can be sufficient		N/A
	Where a plug/socket combinations is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for securing in the disconnected state are not needed		N/A
6	**PROTECTION AGAINST ELECTRIC SHOCK**		--
6.1	The electrical equipment shall provide protection against electric shock by basic protection and fault protection		P
	Where the measures for protection as in 6.2, 6.3 and 6.4 are not practicable, other measures from IEC 60364-4-41 may be used (e.g. SELV)		N/A
6.2	**Basic protection**		--
6.2.1	For each circuit the measures of 6.2.2, 6.2.3 and, where applicable, 6.2.4 shall apply		P
	Where not appropriate, other measures as defined in IEC 60364-4-41 may be applied (see also 6.2.5 and 6.2.6)		N/A
	For equipment in places open to all persons including children, 6.2.2 with a minimum protection of IP4X or IPXXD, or 6.2.3 shall be applied		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.2.2	Live parts shall be located inside enclosures that provide protection against contact with live parts of at least IP2X or IPXXB.	At least IP2X	P
	Where the top surfaces of the enclosure are readily accessible, the minimum degree of protection against contact with live parts provided by the top surfaces shall be IP4X or IPXXD.	At least IP4X	P
	Opening an enclosure (i.e. opening doors, lids, covers, etc) shall be possible only under one of the following conditions:		—
	a) The use of a key or tool is necessary for access All live parts (including those on the inside of doors) likely to be touched when resetting or adjusting devices intended for such operations while the equipment is still connected, are protected against contact to at least IP2X or IPXXB Other live parts on the inside of doors are protected against unintentional direct contact to at least IP1X or IPXXA.	Need a tool for access	P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The disconnection of live parts inside the enclosure before it can be opened (see explanation) Exception: a key or tool as prescribed by the supplier can be used to defeat the interlock, provided that the following conditions are met: - it is possible at all times while the interlock is defeated to open the disconnecting device and lock the disconnecting device in the OFF position or otherwise prevent unauthorised closure of the disconnecting device; - upon closing the door, the interlock is automatically restored - all live parts (), likely to be touched … are protected against unintentional contact to at least IP2X or IPXXB and other live parts on the inside of doors shall be protected against unintentional contact to at least IP1X or IPXXA - relevant information about the procedure for the defeat of the interlock is provided with the instructions for use of the electrical equipment - means are provided to restrict access to live parts behind doors that are not directly interlocked with the disconnecting means to skilled or instructed persons All parts still alive after switching off the disconnecting device shall be protected against direct contact to at least IP 2X or IP XXB and be marked with a warning sign in accordance with 16.2.1 except for: - 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		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	c) Opening without the use of a key or a tool and without disconnection of live parts shall be possible only when all live parts are protected against contact to at least IP2X or IPXXB. Where barriers provide this protection, either they shall require a tool for their removal or all live parts protected by them shall be automatically disconnected when the barrier is removed. Where a hazard can be caused by manual action of devices () , such action shall be prevented by barriers or obstacles that require a tool for their removal		N/A
6.2.3	Live parts protected by insulation shall be completely covered with insulation that can only be removed by destruction and that is capable of withstanding the mechanical, chemical, electrical, and thermal stresses to which it can be subjected under normal operating conditions		P
	Note: Paint, varnish lacquer etc. alone are generally considered inadequate		P
6.2.4	Live parts having a residual voltage greater than 60 V when disconnected, shall be discharged to 60 V or less within 5 s, if this does not interfere with the proper functioning of the equipment		N/A
	Exempted are components having stored charges of 60 µC or less		N/A
	Where not possible , an appropriate warning shall be placed according to the details given		N/A
	In case of pins of plugs etc. the discharge time shall not exceed 1s. Otherwise such conductors shall be protected to at least IP2X or IPXXB.		N/A
	If above requirements cannot be achieved, additional disconnecting devices or appropriate warning devices shall be provided		N/A
	When equipment is accessible to all persons incl. children, warnings are not sufficient and a protection of IP4X or IPXXD is required		N/A
6.2.5	For protection by barriers, the requirements of IEC 60364-4-41 shall apply (412.2)		N/A
6.2.6	For protection by placing out of reach or protection by obstacles, the requirements of IEC 60364-4-41 shall apply (412.4 and 412.3)		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	For conductor wire or bar systems with less than IP2X or IPXXB, see 12.7.1		N/A
6.3	**Fault protection**		P
6.3.1	For each circuit or part of el. equipment at least one of the measures of 6.3.2 to 6.3.3 shall be applied:		—
	-Prevention of the occurrence of a touch voltage		N/A
	-Protection by automatic disconnection of supply	Overcurrent protective device	P
6.3.2	Prevention of the occurrence of a touch voltage		N/A
6.3.2.2	Protection by provision of one or more of the following:		—
	- class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation in accordance with IEC 61140) or		N/A
	- switchgear and control gear assemblies having total insulation in accordance with IEC 61439-1or		N/A
	- supplementary or reinforced insulation in accordance with IEC 60364-4-41(413.2)		N/A
6.3.2.3	For protection by electrical separation the requirements of IEC 60364-4-41 apply (413.5)		N/A
6.3.3	Protection by automatic disconnection of supply		P
	This measure consists of the interruption of one or more line conductors in a time within the limits specified in Annex A for TN and TT systems		P
	This requires co-ordination between: -the type of supply, the source impedance and the earthing system -several impedance values -characteristics of protective devices -(For details see 18.2)		P
	This protective measure comprises both:		—
	-protective bonding of exposed parts (8.2.3)		P
	-one of the following:		—
	a) In TN systems, the following protective devices may be used:		P
	• overcurrent protective device or		P
	• residual current protective devices (RCDs) and associated overcurrent protective devices		N/A
	b) In TT systems either:		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	• RCDs and associated overcurrent protective devices or		N/A
	• overcurrent protective devices provided a low fault loop impedance is assured		N/A
	c) In IT-Systems the requirements of IEC 60364-4-41 shall be fulfilled		N/A
	During an insulation fault an acoustic and an optical signal shall be sustained. The acoustic signal may manually be muted		N/A
	Where automatic disconnection is provided under a) and disconnection acc. to A.1.1 cannot be assured, supplementary protective bonding shall be provided to fulfil A.1.3		N/A
	Where protection of a PDS (power drive system) is not provided by the converter, the necessary protection shall be acc. to the converter manufacturer's instructions		N/A
6.4	**Protection by the use of PELV**		N/A
6.4.1	PELV circuits shall satisfy all of the following conditions:		—
	a) the nominal voltage does not exceed: -25 V AC r.m.s. or 60 V ripple-free AC when the equipment is normally used in dry locations and when large area contact of live parts with the human body is not expected; or -6 V AC r.m.s. or 15 V ripple-free DC in all other cases;		N/A
	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
	c) live parts of PELV circuits shall be electrically separated from other live circuits (see IEC 61558)		N/A
	d) conductors of each PELV circuit shall be physically separated from those of any other circuit. If this requirement is impracticable, the insulation provisions of 13.1.3 shall apply		N/A
	e) plugs and socket-outlets for a PELV circuit shall conform to the following: -plugs shall not to enter socket-outlets of other voltage systems -socket-outlets shall not admit plugs of other voltage systems		N/A
6.4.2	The sources for PELV shall be one of the following:		—

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6 or		N/A
	- a source of current with a degree of safety equivalent to that of the safety isolating transformer or		N/A
	- a source independent of circuit with higher voltage (e.g. battery or diesel –driven) or		N/A
	- electronic power supply conforming to appropriate standards		N/A
7.	**PROTECTION OF EQUIPMENT**		P
7.2	**Overcurrent protection**		P
7.2.1	Overcurrent protection shall be provided where the current in any circuit can exceed the rating of a component or the capacity of a conductor		N/A
7.2.2	Supply conductors		—
	Unless otherwise specified by the user, the supplier of the electrical equipment is not responsible for providing the supply conductors or the overcurrent protective device for it		P
	In the installation documents, the data necessary for conductor dimensioning and selecting the overcurrent protective device are stated (see 7.2.10 and 17.4)		P
7.2.3	Power circuits		P
	Devices for detection and interruption of overcurrent, selected in accordance with 7.2.10, are applied to each live conductor including supplies to control circuit transformers.		P
	The following conductors shall not be disconnected without disconnecting all associated live conductors: -the neutral conductor of AC power circuits; -the earthed conductor of DC power circuits; -DC power conductors bonded to exposed conductive parts of mobile machines.		P
	Where the cross-section area of the neutral conductor is at least equal to the line conductor, no overcurrent detection nor disconnecting device is required for that conductor		N/A
	Otherwise the measures detailed in 524 of IEC 60364-5-52:2009 shall apply		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	In IT-Systems, it is recommended that no neutral conductor is used. Where a neutral conductor is used, the measures detailed in 431.2.2 of IEC 60364-4-43:2008 shall apply		N/A
7.2.4	Control circuits		P
	Conductors of control circuits directly connected to the supply shall be protected against overcurrent in accordance with 7.2.3.		N/A
	Conductors of control circuits supplied by a transformer or DC supply shall be protected against overcurrent (see also 9.4.3.1.1):		—
	-In control circuits, connected to the protective bonding circuit, by an overcurrent protective device in the switched conductor		P
	-In circuits, not connected to the protective bonding circuit: • Where all control circuits have the same current carrying capacity, by an overcurrent protective device in the switched conductor • Otherwise, by an overcurrent protective device in both, switched and common conductors of each control circuit		N/A
	Exception: Where a supply unit provides current limiting below the capacity of the conductors and the connected components, no overcurrent protective device is required		N/A
7.2.5	Overcurrent protection shall be provided for circuits feeding general purpose socket outlets		N/A
7.2.6	Unearthed conductors of lighting circuits shall be protected separately from other circuits.		N/A
7.2.7	Transformers shall be 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		P
7.2.8	Location of overcurrent protective devices		P
	It shall be located at the point where a reduction in the cross sectional area of the conductors or another change reduces the current-carrying capacity of the conductors except:		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-current carrying capacity of the conductors is at least equal to that of the load and -conductors between the point of reduction of current-carrying capacity and the position of the overcurrent protective device is ≤ 3 m and -the conductor is protected e.g. by an enclosure or duct.		P
7.2.9	Overcurrent protective devices		P
	The rated short-circuit breaking capacity Icn shall be at least equal to the prospective fault current at the point of installation. Additional currents other than from the supply (e.g. from motors, from power factor correction capacitors) shall be taken into consideration.		P
	Where fuses are provided as overcurrent protective devices, a type readily available in the country of use shall be selected, or arrangements shall be made for the supply of spare parts.		P
7.2.10	Rating and setting of overcurrent protective devices:		P
	Rated current of fuses or overcurrent setting of other protective devices selected as low as possible, but adequate for anticipated overcurrents.		P
	The rated current of overcurrent protective device for conductors is determined by the current carrying capacity of the conductors to be protected in accordance with Cl. 12.4, D.2 and the maximum allowable interrupting time *t* in accordance with Clause D.3.		P
7.3	**Protection of motors against overheating**		P
7.3.1	Protection shall be provided for each motor rated at more than 0.5 kW.		P
	Exception: In applications where an automatic interruption of the motor operation is unacceptable (for example fire pumps), the means of detection shall give a warning signal to which the operator can respond.		N/A
	Automatic restarting prevented where this can cause a hazard		P
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

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	For special duty motors, appropriate protective devices are recommended		N/A
	For motors that cannot be overloaded, overload protection is not required.		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
7.4	Equipment shall be protected against abnormal temperatures that can result in a hazardous situation.		P
7.5	**Protection against the effects of supply interruption or voltage reduction and subsequent restoration**		N/A
	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 **o**verspeed protection shall be provided where overspeeding can occur and could possibly cause a hazardous situation.		N/A
7.8	Phase sequence protection shall be provided, where an incorrect phase sequence of the supply voltage can cause a hazardous situation or damage to the machine.		P
7.9	Surge protective devices (SPDs) can be provided to protect against the effects of overvoltages due to lightning or to switching surges.		N/A
7.10	The short-circuit current rating of the electrical equipment shall be determined by the application of design rules or by calculation or by test.		P
8	**EQUIPOTENTIAL BONDING**		P
8.2	**Protective bonding circuit**		P
8.2.1	All parts of the protective bonding circuit shall be so designed that they are capable of withstanding the highest thermal and mechanical stresses		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Protective conductors which does not form part of a cable shall not be less than:		—
	-2.5 mm^2 Cu or 16 mm^2 Al if protection against mechanical damage is provided		P
	-4 mm^2 Cu or 16 mm^2 Al if protection against mechanical damage is not provided		N/A
	Exposed conductive parts of equipment in accordance with 6.3.2.3 (Protection by electrical separation) shall not be connected to the protective bonding circuit.		N/A
	Small parts and other conductive parts that do not constitute a hazard need not to be earthed		P
8.2.2	Protective conductors		P
	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 conductor used only for grounding	N/A
	Metal enclosures or frames or mounting plates may be used as protective conductors if they satisfy the following three requirements: -protection against mechanical, chemical or electrochemical deterioration -compliant with 543.1 of IEC 60364-5-54: -permit the connection of other protective conductors where foreseen		P
	The cross-section of protective conductors shall be calculated according to 543.1.2 of IEC 60364-5-54, or selected in accordance with Table 1.		P
	Each protective conductor shall: -be part of a multicore cable, or; -be in a common enclosure with the line conductor, or; -have a cross-sectional area of at least; • 2.5 mm^2 Cu or 16 mm^2 Al with protection against mechanical damage • 4 mm^2 Cu or 16 mm^2 Al without protection against mechanical damage		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	A protective conductor not forming part of a cable is considered to be mechanically protected if it is installed in a conduit, trunking or protected in a similar way.		N/A
	The following parts shall be connected to the protective bonding circuit but shall not be used as protective conductors: -conductive structural parts of the machine; -metal ducts of flexible or rigid construction; -metallic cable sheaths or armouring; -metallic pipes containing flammable materials such as gases, liquids, powder. -flexible or pliable metal conduits; -constructional parts subject to mechanical stress in normal service; -• flexible metal parts; support wires; cable trays and cable ladders.		P
8.2.3	Continuity of 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 not impaired by mechanical, chemical, or electrochemical influences (e.g. electrolytic corrosion on aluminium parts)		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).	No exposed cables except for supply cord	N/A
	Where the continuity can be interrupted, a first make last break contact is required.		N/A
8.2.4	Protective conductor connecting points are not intended to attach appliances or parts.		P
	Each connecting point shall be marked or labelled as such using the symbol IEC 60417-5019 or the letters PE or by use of bicolour GREEN / YELLOW 		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
8.2.5	Mobile machines with on-board power supplies: The protective bonding system is connected to a single protective bonding terminal. This protective bonding terminal is the connection point for a possible additional external incoming power supply		N/A
8.2.6	**Additional requirements for electrical equipment having earth leakage currents higher than 10 mA**		N/A
	Where electrical equipment has an earth leakage current greater than 10 mA AC or DC the associated protective bonding circuit shall satisfy one of the following:		—
	a)the protective conductor is completely enclosed or otherwise protected		N/A
	b)the protective conductor has a cross-sectional area of at least 10 mm^2 Cu or 16 mm^2 Al		N/A
	c)a second protective conductor of at least the same cross-sectional area is provided		N/A
	d)the supply is automatically disconnected in case of loss of continuity of the protective conductor		N/A
	e)where a plug-socket combination is used, an industrial connector in accordance with IEC 60309 series is provided		N/A
	A statement shall be given in the instructions for installation that the equipment shall be installed as described in this 8.2.6.		N/A
8.3	Measures to restrict the effects of high leakage current can be taken as described		N/A
8.4	If functional bonding is used, the connecting points should be marked with symbol IEC 60417-5020 		N/A
9	**CONTROL CIRCUITS AND CONTROL FUNCTIONS**		P
9.1.	**Control circuit**		P
9.1.1	Where control circuits are supplied from an AC source, transformers having separate windings shall be used to separate the power supply from the control supply.		P
	Examples include: control transformers acc. to IEC 61558-2-2, SMPS acc. to IEC 61558-2-16 power supplies acc. to IEC 61204-7		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Where several transformers are used, it is recommended that the secondary voltages are in phase.		N/A
	Exception: Transformers or switch mode power supply units fitted with transformers are not mandatory for machines with a single motor starter and/or a maximum of two control devices		N/A
	Where DC control circuits derived from an AC supply are connected to the protective bonding, they shall be supplied from a separate winding		P
9.1.2	The nominal voltage of control circuits should preferably not exceed -230 V @ 50 Hz -277 V @ 60 Hz -220 V @ DC		P
9.1.3	Control circuits are provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		P
9.2.	**Control functions**		P
9.2.2	Categories of stop functions are stop category 0, 1, 2	Category 0	P
9.2.3	Operation		P
9.2.3.1	Where a machine has more than one control station, measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.	One control station	N/A
9.2.3.2	Start functions shall operate by energizing the relevant circuit.		P
	Start of an operation shall be possible only when all of the relevant safety functions and/or protective measures are in place and are operational.		P
	Where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations are by hold-to-run controls, together with enabling devices, as appropriate.		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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 shall be met and - all start control devices shall be in the released (off) position, then - all start control devices have to be actuated concurrently (see 3.1.7).		N/A
9.2.3.3	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).	Stop category 0	P
	Stop functions shall override related start functions		P
	Where more than one control station is provided, stop commands from any control station is effective when required by the risk assessment of the machine.		N/A
9.2.3.4	Emergency operations (emergency stop, emergency switching off)		P
9.2.3.4.1	Emergency stop or emergency switching off commands shall be sustained until it is reset.		P
	This reset shall be possible only by a manual action at that location where the command has been initiated.		P
	The reset of the command shall not restart the machinery but only permit restarting.		P
	It shall not be possible to restart the machinery until all emergency stop commands are reset.		P
	It shall not be possible to reenergize the machinery until all emergency switching off commands are reset.		N/A
9.2.3.4.2	The emergency stop does function either as a stop category 0 or as a stop category 1.	stop category 0	P
	- it shall override all other functions and operations in all modes - it shall stop the hazardous motion as quickly as practicable without creating other hazards - a reset shall not initiate a restart		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
9.2.3.4.3	Emergency switching off should be 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		N/A
	Emergency switching off is accomplished by electromechanical switching devices, effecting a stop category 0 of machine actuators connected to this incoming supply		N/A
9.2.3.5	Operating modes		N/A
	Where machinery uses several control or operating modes requiring different protective measures and having a different impact on safety, it shall be fitted with a mode selector which can be locked in each position		N/A
	Another selection method can be used (for example an access code)		N/A
	Mode selection by itself does not initiate machine operation. A separate actuation of the start control has to be stated by the operator.		N/A
	Indication of the selected operating mode shall be provided (e.g. the position of a mode selector, the provision of an indicating light, a visual display indication)		N/A
9.2.3.6	Movement or action that can result in a hazardous situation shall be monitored by providing, for example, overtravel limiters, motor overspeed detection, mechanical overload detection or anti-collision devices		N/A
9.2.3.7	Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation		N/A
9.2.3.8	Two-hand controls shall be one of the following types and have the following features		N/A
	Type I: this type requires: - the provision of two control devices and their concurrent actuation by both hands; - continuous concurrent actuation during the hazardous situation; - machine operation shall cease upon the release		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Type II: a Type I control requiring the release of both control devices before machine operation can be reinitiated		N/A
	Type III: a Type II control requiring concurrent actuation of the control devices as follows: - it shall be necessary to actuate the control devices within a certain time limit of each other, not exceeding 0.5 s - where this time limit is exceeded, both control devices shall be released before machine operation can be initiated		N/A
9.2.3.9	Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated		N/A
9.2.3.10	Combined start and stop controls: Push-buttons etc. that alternately initiate and stop motion shall only be provided for functions, which cannot result in a hazardous situation.		N/A
9.2.4	Cableless control system		N/A
9.2.4.1	The CCS shall have functionality and a response time suitable for the application based on the risk assessment.		N/A
9.2.4.2	The ability of a CCS to control a machine shall be automatically monitored, either continuously or at suitable intervals.		N/A
	If the communication signal has degraded (e.g., reduced signal level, low battery power) a warning shall be given		N/A
	When the ability to control a machine has been lost, an automatic stop of the machine shall be initiated.		N/A
	Its restoration shall not restart the machine.		N/A
9.2.4.3	Measures shall be taken to prevent the machine from responding to signals other than those from the intended operator control station(s).		N/A
	Cableless operator control station(s) shall only control the intended machine(s) and shall affect only the intended machine functions.		N/A
9.2.4.4	When more than one cableless operator control station is used, then:		__

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	-only one control station shall be enabled at a time except as necessary for the operation		N/A
	- transfer of control shall require a deliberate manual action at the station having control		N/A
	- transfer shall only be possible if both stations are in the same mode		N/A
	- a transfer shall not change the mode of operation or function		N/A
	- on the station that has control, a visual indication shall indicate this		N/A
9.2.4.5	Portable cableless operator control stations shall be provided with means to prevent unauthorized use		N/A
	Each machine should have an indication when it is under cableless control		N/A
	When possible to be connected to several machines, means shall be provided on the portable device to select		N/A
	Selecting a machine shall not initiate control commands.		N/A
9.2.4.6	A deliberate disabling shall meet the requirements of 9.2.4.2.		N/A
	Where disabling without interrupting machine operation is necessary, appropriate means shall be provided to transfer control		N/A
9.2.4.7	Emergency stop devices on portable cableless operator control stations shall not be the sole means of initiating an emergency stop		N/A
	Confusion between active and inactive emergency stop devices shall be avoided		N/A
9.2.4.8	Restarting of a cableless control shall not result in a reset of an emergency stop condition		N/A
	The instructions shall state that a reset shall only be performed when it can be seen that the reason has been cleared		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

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
9.3.2	Where an operating limit (for example speed, pressure, position) can be exceeded leading to a hazardous situation, means shall be provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action		N/A
9.3.3	The correct operation of auxiliary functions shall be checked by appropriate devices		N/A
	Where the non-operation of a device can cause a hazard, appropriate interlocking shall be provided		N/A
9.3.4	Interlocks between different operations and for contrary motions shall be provided, if these operations can lead to hazardous situations		N/A
9.3.5	Where braking of a motor is accomplished by current reversal, measures shall prevent the motor starting in the opposite direction at the end of braking where that reversal can cause a hazardous situation or damage to the machine or to the work in progress		N/A
	For this purpose, a device operating exclusively as a function of time is not permitted		N/A
	Control circuits shall be so arranged that rotation of a motor shaft, for example manually, does not result in a hazardous situation		N/A
9.3.6	Where it is necessary to suspend safety functions and/or protective measures, the control or operating mode selector shall simultaneously:		N/A
	- disable all other operating (control) modes		N/A
	- permit operation only by the use of a hold-to-run device or by a similar control device positioned so as to permit sight of the hazardous elements		N/A
	- prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors		N/A
	If these four conditions cannot be fulfilled, the mode selector shall activate other protective measures to ensure a safe intervention zone. In addition, the operator shall be able to control operation of the parts he is working on from the adjustment point.		N/A
9.4	Control functions in the event of failure		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
9.4.1	The electrical control system(s) shall have an appropriate performance that has been determined from the risk assessment of the machine		P
	The requirements for safety-related control functions of IEC 62061 and/or ISO 13849-1, ISO 13849-2 shall apply		P
	Where memory retention is achieved for example, by battery power, measures shall be taken to prevent hazardous situations arising from failure, undervoltage or removal of the battery		N/A
	Means shall be provided to prevent unauthorized or inadvertent memory alteration by, for example, requiring the use of a key, access code or tool		N/A
9.4.2	Measures to minimize risk in the event of failure		P
9.4.2.2	Use of proven circuit techniques and components (see examples)		P
9.4.2.3	Provisions of partial or complete redundancy		P
9.4.2.4	Provision of diversity (see examples)		P
9.4.2.5	Provision for functional tests		P
9.4.3	Protection against malfunction of control circuits		P
9.4.3.1.1	Measures shall be provided to reduce the probability that insulation faults on any control circuit can cause malfunction		P
9.4.3.1.2	Method a) – Earthed control circuits fed by transformers		P
	The common conductor shall be connected to the protective bonding circuit at the point of supply.		P
	All control elements are to be inserted on the other side of the components		P
9.4.3.1.3	Method b) – Non-earthed control circuits fed by transformers shall either		N/A
	1) have 2-pole control switches that operate on both conductors; or		N/A
	2) be provided with a device that interrupts the circuit automatically in the event of an earth fault; or		N/A
	3) where 2) above would increase the risk, it can be sufficient to provide an insulation monitoring device hat will initiate an acoustic and optical signal		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
9.4.3.1.4	Method c) – Control circuits fed by transformer with an earthed centre-tap winding shall have overcurrent protective devices that break both the conductors		N/A
	The control switches shall be 2-pole types that operate on both conductors		N/A
9.4.3.1.5	Method d) – Control circuits not fed by a transformer are only allowed for machines with a maximum of one motor starter and/or maximum of two control devices, in accordance with 9.1.1		N/A
	Possible cases are:		—
	1) directly connected to an earthed supply system (TN- or TT-system)		N/A
	If powered between two lines, multi-pole control switches are required		N/A
	2) directly connected to a supply system that is not earthed or is earthed through a high impedance (IT-system)		N/A
	A device shall be provided that interrupts the circuit automatically in the event of an earth fault		N/A
9.4.3.2	Where the loss of memory due to a power failure can result in a hazardous situation, appropriate measures shall be taken		N/A
9.4.3.3	Where the loss of continuity of control circuits depending upon sliding contacts can result in a hazard, appropriate measures shall be taken		N/A
10	**OPERATOR INTERFACE AND MACHINE-MOUNTED CONTROL DEVICES**		P
10.1.1	Control devices for operator interface shall, as far as is practicable, be selected, mounted, and identified or coded in accordance with IEC 61310 series		P
10.1.2	As far as is practicable, machine-mounted control devices shall be:		—
	- readily accessible for service and maintenance		P
	- mounted in such a manner as to minimize the possibility of damage from activities such as material handling		P
	The actuators of hand-operated control devices are selected and installed so that:		—
	- they are not less than 0,6 m above the servicing level and are within easy reach of the normal working position of the operator		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	- the operator is not placed in a hazardous situation when operating them		P
	The actuators of foot-operated control devices are selected and installed so that:		—
	- they are within easy reach of the normal working position of the operator		N/A
	- the operator is not placed in a hazardous situation when operating them		N/A
10.1.3	The degree of protection (IP rating in accordance with IEC 60529) together with other appropriate measures shall provide protection against:		P
	– the effects of liquids, vapours, or gases found in the physical environment or used on the machine		P
	– the ingress of contaminants (for example swarf, dust, particulate matter)		P
	The operator interface control devices shall have a minimum degree of protection against contact with live parts of IPXXD (see IEC 60529)	At least IPXXD	P
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	No position sensor	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 machine operations caused by inadvertent actuation, shocks and vibrations		N/A
10.2	**Actuators**		P
10.2.1	Actuators shall be colour-coded as follows:		P
	The colours for START/ON actuators should be WHITE, GREY, BLACK or GREEN with a preference for WHITE. RED shall not be used	GREEN	P
	The colour RED shall be used for emergency stop and emergency switching off actuators		P
	If a background exists, it shall be coloured YELLOW		N/A
	The colours for STOP/OFF actuators should be BLACK, GREY, or WHITE with a preference for BLACK. GREEN shall not be used. RED is permitted	RED	P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	WHITE, GREY, or BLACK are the preferred colours for actuators that alternately act as START/ON and STOP/OFF actuators. The colours RED, YELLOW, or GREEN shall not be used		N/A
	The same is applicable for “hold-to-run” actuators		N/A
	Reset actuators shall be BLUE, WHITE, GREY, or BLACK. Where they also act as a STOP/OFF actuator, the colours WHITE, GREY, or BLACK are preferred with the main preference being for BLACK. GREEN shall not be used.		N/A
	The colour YELLOW is reserved for use in abnormal conditions		N/A
	Where the same colours are used for various functions, a supplementary means of coding shall be used for the identification		P
10.2.2	Recommended markings for actuators are given in table 2 and 3		P
10.3	**Indicator lights and displays**		P
10.3.1	Indicator lights and displays shall be selected and installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310-1).		N/A
	Circuits used for visual or audible devices used to warn persons of an impending hazardous event shall be fitted with facilities to check the operability of these devices	Audible device	P
10.3.2	Indicator lights should be colour-coded with respect to the condition (status) of the machine in accordance with Table 4.		N/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
10.3.3	For further distinction or information and especially to give additional emphasis, flashing lights and displays can be provided		N/A
	Where flashing lights or displays are used to provide higher priority information, additional acoustic warnings should be considered		N/A
10.4	illuminated push-button actuators shall be colour-coded in accordance with Tables 2 and 4. Where there is difficulty in assigning an appropriate colour, WHITE is used.		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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, shall 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 shall be constructed and mounted so as to minimize inadvertent operation		N/A
10.7	**Emergency stop devices**		P
10.7.1	Devices for emergency stop are readily accessible		P
	Emergency stop devices shall be provided at each location where the initiation of an emergency stop can be required		P
	In circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station, means (for example, information for use) are provided to minimise confusion.		P
10.7.2	The types of device for emergency stop include, but are not limited to: a push-button device for actuation by the palm or the fist (e.g. mushroom) – a pull-cord operated switch – a pedal-operated switch without mechanical guard	a push-button device for actuation by the palm	P
	The devices shall be in accordance with IEC 60947-5-5.		P
10.7.3	Where a stop category 0 is suitable, the supply disconnecting device may serve the function of emergency stop where: – it is readily accessible to the operator; and – it is of the type described in 5.3.2 a), b), c), or d)		N/A
	Where intended for emergency use, the supply disconnecting device shall meet the colour requirements of 10.2.1		N/A
10.8	**Emergency switching off devices**		N/A
10.8.1	Such devices shall be located as necessary for the given application.		N/A
	Means are provided, where necessary, to avoid confusion between these devices.		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
10.8.2	The types of device for emergency switching off include: a push-button operated switch with a palm or mushroom head type of actuator – a pull-cord operated switch		N/A
	The devices shall have direct opening action		N/A
10.8.3	Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and shall meet the colour requirements of 10.2.1		N/A
10.9	**Enabling control device**		N/A
	Enabling control devices shall be selected and arranged so as to minimize the possibility of defeating		N/A
	They shall be designed in accordance with ergonomic principles		N/A
	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	**CONTROLGEAR: LOCATION, MOUNTING AND ENCLOSURES**		P
11.2.1	All items of controlgear (inclusively terminals that are not part of controlgear components or devices) are placed and oriented so that they can be identified without moving them or the wiring		P
	For items that require checking for correct operation or that are liable to need replacement, those actions should be possible without dismantling other equipment or parts of the machine (except opening doors or removing covers, barriers or obstacles)		P
	All controlgear are mounted so as to facilitate its operation and maintenance		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Necessary tools to adjust, maintain, or remove a device are supplied		P
	Where access is required for regular maintenance or adjustment, the relevant devices shall be located between 0.4 m and 2.0 m above the servicing level		P
	Recommendation, that terminals be least 0.2 m above the servicing level and so placed that conductors and cables can be easily connected		P
	Only operating, indicating, measuring, and cooling devices are mounted on doors or on normally removable access covers of enclosures		P
	Where connected through plug-in arrangements, their association shall be made clear by type (shape), marking or reference designation		P
	Plug-in devices that are handled during normal operation shall be provided with non-interchangeable features		N/A
	Plug/socket combinations that are handled during normal operation are unobstructedly accessible.		N/A
	Test points for connection of test equipment shall be: – mounted to provide unobstructed access – clearly identified to correspond with the documentation – adequately insulated – sufficiently spaced		N/A
11.2.2	Physical separation or grouping		P
	Non-electrical parts and devices, not directly associated with the electrical equipment, shall not be located within enclosures containing controlgear		P
	Devices such as solenoid valves should be separated from the other electrical equipment (for example in a separate compartment)		P
	Control devices mounted in the same location and connected to the supply voltage, or to both supply and control voltages, should be grouped separately from those connected only to the control voltages		P
	Terminals shall be separated into groups for: – power circuits – associated control circuits – other control circuits, fed from external sources (for example for interlocking)		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The clearances and creepage distances specified by the supplier shall be maintained, taking into account the external influences or conditions of the physical environment.		P
11.2.3	The temperature rise inside electrical equipment enclosures shall not exceed the ambient temperature specified by the component manufacturers		P
	Heat generating components (for example heat sinks, power resistors) are located so, that the temperature of each component in the vicinity remains within the permitted limit		P
11.3	**Degrees of protection**		P
	The protection of controlgear against ingress of solid foreign objects and of liquids shall be adequate taking into account the external influences under which the machine is intended to operate and shall be sufficient against dust, coolants, lubricants and swarf		P
	Enclosures of controlgear provide a degree of protection of at least IP22 (see IEC 60529)	at least IP22	P
	Exception, where: an electrical operating area provides an appropriate degree of protection removable collectors on conductor wire or conductor bar systems are used and the measures of 12.7.1 are applied		N/A
11.4	**Enclosures, doors and openings**		P
	Enclosures shall be constructed using materials capable of withstanding the mechanical, electrical and thermal stresses as well as the effects of humidity and other environmental factors that are likely to be encountered in normal service		P
	Fasteners used to secure doors and covers should be of the captive type		P
	Windows of enclosures shall be of a material suitable to withstand expected mechanical stress and chemical attack		N/A
	It is recommended that enclosure doors having vertical hinges be not wider than 0,9 m, with an angle of opening of at least 95°		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Joints or gaskets of doors, lids, etc. shall withstand the chemical effects of the aggressive liquids, vapours, or gases used on the machine.		P
	They shall: - be securely attached - not deteriorate due to removal or replacement of the door		P
	Openings in enclosures (for example, for cable access), including those towards the floor or foundation or to other parts of the machine shall be equipped with means to ensure the degree of protection specified for the equipment.		P
	A suitable opening may be provided in the base of enclosures within the machine so that moisture due to condensation can drain away		P
	Openings for cable entries shall be easily re-opened on site		P
	There shall be no opening between enclosures containing electrical equipment and compartments containing coolant, lubricating or hydraulic fluids, or those into which oil, other liquids, or dust can penetrate.		P
	Holes in an enclosure for mounting shall not impair the required protection.		P
	Equipment that, in normal or abnormal operation, can attain a surface temperature sufficient to cause a risk of fire or harmful effect to an enclosure material shall: – be located within an enclosure that will withstand, such temperatures; and be located at a sufficient distance from adjacent equipment allowing safe dissipation of heat (see also 11.2.3); or be otherwise screened by material that can withstand to the harmful effect.		P
11.5	**Access to electrical equipment**		N/A
	Doors in gangways for access to electrical operating areas shall: - be at least 0.7 m wide and 2.0 m high - open outwards - have a means (for example panic bolts) to allow opening from the inside without the use of a key or tool		N/A
12	**CONDUCTORS AND CABLES**		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
12.1	Conductors and cables shall be selected so as to be suitable for the operating conditions and external Influences that can exist		P
	These requirements do not apply to the integral wiring of assemblies, subassemblies, and devices that are manufactured and tested in accordance with their relevant IEC standard (for example IEC 61800 series).		—
12.2	Conductors should be of copper. Where aluminium conductors are used, the cross-sectional area shall be at least 16 mm^2.	Copper conductor	P
	The cross-sectional area of conductors should not be less than as shown in Table 5		P
	Smaller cross-sectional areas or other constructions than shown in Table 5 may be used, provided adequate mechanical strength is achieved by other means		N/A
	Class 1 and class 2 conductors are primarily intended for use between rigid, non-moving parts where vibration is not likely to cause damage		P
	All conductors that are subject to frequent movement should have flexible stranding of class 5 or class 6.		N/A
12.3	Where the insulation of conductors and cables can constitute hazards due for example to the propagation of a fire or the emission of toxic or corrosive fumes adequate means are provided. Special attention is given to the integrity of a circuit having a safety-related function		P
	The insulation of cables and conductors used, shall be suitable for a test voltage:		—
	- not less than 2 000 V AC for a duration of 5 min for operation at voltages higher than 50 V AC or 120 V DC, or	Insulation test were conducted and passed.	P
	- not less than 500 V AC for a duration of 5 min for PELV circuits (see IEC 60364-4-41, class III equipment).		N/A
	The insulation shall be such that it cannot be damaged in operation or during laying, especially for cables pulled into ducts.		P
12.4	Current-carrying capacity in normal service in accordance with table 6. Or in accordance with suppliers recommendation.		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
12.5	The voltage drop from the point of supply to the load in any power circuit cable shall not exceed 5 % of the nominal voltage under normal operating conditions.		P
	In control circuits, the voltage drop shall not reduce the voltage at any device below the manufacturer's specification for that device, taking into account inrush currents.		P
12.6	**Flexible cables**		P
12.6.1	Flexible cables shall have Class 5 or Class 6 conductors		P
	Cables that are subjected to severe duties shall be of adequate construction to protect 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 shall not exceed 15 N/mm^2 of cross-sectional area Or special measures are taken to withstand the applied stress		N/A
	For material other than copper the applied stress shall be within the cable manufacturer's specification		N/A
12.6.3	For cables of circular cross-sectional area installed on drums, the maximum current should be derated in accordance with Table 7		N/A
12.7	**Conductor wires, conductor bars and slip-ring assemblies**		P
12.7.1	During normal access to the machine, **protection** to conductor wires, conductor bars and slip-ring assemblies shall be achieved by the application of one of the following protective measures:		P
	- protection by partial insulation of live parts, or where this is not practicable		N/A
	- protection by enclosures or barriers of at least IP2X or IPXXB	Enclosure at least IP2X	N/A
	Horizontal top surfaces of barriers or enclosures that are readily accessible shall provide a degree of protection of at least IP4X or IPXXD	Enclosure at least IP4X	P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Where the required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching off in accordance with 9.2.5.4.3 shall be applied		N/A
	Conductor wires and conductor bars shall be so placed and/or protected as to:		—
	-prevent contact, especially for unprotected conductor wires and conductor bars, with conductive items such as the cords of pull-cord switches, strain-relief devices and drive chains		P
	- 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		P
	The continuity of the protective conductor circuit using sliding contacts shall be ensured by taking appropriate measures (for example, duplication of the current collector, continuity monitoring)		N/A
12.7.3	Protective conductor current collectors shall have a shape or construction so that they are not interchangeable with the other current collectors. Such current collectors shall be of the sliding contact type		P
12.7.4	Removable current collectors 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 shall be suitable for at least a rated impulse voltage of an overvoltage category III in accordance with IEC 60664-1		P
12.7.6	Creepage distances between conductors and adjacent systems shall be suitable suitable for operation in the intended environment, e.g. open air, inside buildings, protected by enclosures		P
	In abnormally dusty, moist or corrosive environments, the following creepage distance requirements apply:		P
	- unprotected conductor wires, conductor bars, and slip-ring assemblies: 60 mm		P
	- enclosed conductor wires, insulated multipole conductor bars and insulated individual conductor bars: 30 mm		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
12.7.7	Conductor system divided into isolated sections: suitable design measures shall be employed to prevent the energization of adjacent sections by the current collectors themselves		P
12.7.8	Conductor wires, conductor bars and slip-ring assemblies in power circuits shall be grouped separately from those in control circuits		P
	They shall be capable of withstanding, without damage, the mechanical forces and thermal effects of short-circuit currents		P
	Removable covers cannot be opened by one person without the aid of a tool		P
	Where common metal enclosures are used, the individual sections shall be bonded together and connected to the protective bonding circuit		P
	Conductor bar ducts that can be subject to accumulation of liquid shall have drainage facilities		N/A
13	**WIRING PRACTICES**		P
13.1	Connections and routing		P
13.1.1	All connections shall be secured against accidental loosening		P
	The means of connection shall be suitable for the cross-sectional areas and nature of the conductors being terminated		P
	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 shall be legible, permanent, and appropriate for the physical environment		P
	Terminal blocks mounted and wired so that the wiring does not cross over the terminals		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
13.1.2	Conductors and cables shall be run from terminal to terminal without splices or joints		P
	Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be splices or joints for the purpose of this subclause		N/A
	Exceptions are possible as described		N/A
	Terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors		P
	Protective conductor shall be placed close to the associated live conductors in order to decrease the impedance of the loop		P
13.1.3	Conductors for circuits that operate at different voltages are separated by suitable barriers, or are insulated for the highest voltage that occurs within the same duct		P
13.1.4	Conductors of AC circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit, including the protective conductor of each circuit, are contained in the same enclosure		P
	Single-core cables armoured with steel wire or steel tape should not be used for AC circuits		P
13.1	The cable between the pick-up and the pick-up converter of an inductive power supply system shall be:		N/A
	- as short as practicable		N/A
	- adequately protected against mechanical damage		N/A
13.2.1	Each conductor shall be identifiable at each termination in accordance with the technical documentation		P
13.2.2	When identification of the protective conductor is by colour alone, the bicolour combination GREEN-AND-YELLOW shall be used throughout the length of the conductor	Identification by colour and symbol	P
	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

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Exception: Protective bonding conductors may be marked with the letters PB and/or the symbol IEC 60417-5021		N/A
13.2.3	Where a neutral conductor is identified by colour alone, the colour shall be BLUE (preferably light blue)		N/A
	In this case that colour shall not be used for identifying any other conductor where confusion is possible		N/A
	Bare conductors used as neutral conductors shall have at minimum a stripe in LIGHT BLUE 15 mm to 100 mm wide in each compartment or unit and at each accessible location		N/A
13.2.4	Where colour-coding is used, BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE may be used		P
	GREEN and YELLOW should not be used where there is a possibility of confusion with the bicolour combination GREEN-AND-YELLOW		P
13.3	**Wiring inside enclosures**		P
	Conductors inside enclosures shall be supported where necessary		P
	Non-metallic supports shall be made with a flame-retardant insulating material (see IEC 60332 series)		P
	Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors in accordance with 12.2 and 12.6.		P
	Conductors and cables that do not run in ducts shall be adequately supported		P
13.4	**Wiring outside enclosures**		P
13.4.1	Conductors of a circuit shall not be distributed over different multi-core cables, conduits, etc.		P
13.4.2	Conductors and their connections external to the electrical equipment shall be **placed in suitable ducts** (see cl.13.5) Exceptions: - Cables with special suitable protection. - Position switches or proximity switches supplied with a dedicated cable which is sufficiently short		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
13.4.3	Connections to moving parts shall take into account the foreseeable frequency of movement and shall be made using conductors in accordance with 12.2 and 12.6		N/A
	The bending radius of the cable shall be at least 10 times the diameter of the cable		N/A
	Flexible cables of machines shall be so installed or protected as to minimize the possibility of external damage (run over, forces, rubbing, heat, etc.)		N/A
	Cables close to moving parts, shall maintain a space of at least 25 mm between the moving parts and the cables or barriers are provided		N/A
	Cable handling systems: Lateral cable angles not exceeding 5°, at being wound on and off cable drums or approaching and leaving cable guidance devices. The bending radius shall be in accordance with Table 8		N/A
	Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically designed for that purpose		N/A
13.4.4	Where several machine-mounted devices are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points		N/A
13.4.5	**Plug/socket combinations**		N/A
	Components or devices inside an enclosure, terminated by fixed plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination, are excluded		N/A
	Where the plug/socket contains a contact for the protective bonding circuit, it shall have a first make last break contact (see also 8.2.4).		N/A
	Plug/socket combinations intended to be connected or disconnected during load conditions shall have sufficient load-breaking capacity		N/A
	Where the plug/socket combination is rated at 30 A, or greater, it shall be interlocked		N/A
	Plug/socket combinations that are rated at more than 16 A shall have a retaining means to prevent unintended or accidental disconnection.		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Where an unintended or accidental disconnection of plug/socket combinations can cause a hazardous situation, they shall have a retaining means.		N/A
	The installation of plug/socket combinations shall fulfil the following requirements as applicable: a) The component which remains live after disconnection shall have a degree of protection of at least IP2X or IPXXB b) Metallic housings of plug/socket combinations shall be connected to the protective bonding circuit c) Plug/socket combinations intended to carry power loads but not to be disconnected during load conditions shall have a retaining means to prevent unintended or accidental disconnection and shall be clearly marked accordingly d) Where more than one plug/socket combination is provided in the same electrical equipment, the associated combinations shall be clearly identifiable. Mechanical coding is recommended e) Plug/socket combinations used in control circuits shall fulfil the applicable requirements of IEC 61984. Exception: combinations in accordance with IEC 60309-1, only those contacts shall be used for control circuits which are intended for those purposes. This exception does not apply to control circuits using high frequency signals superimposed on the power circuits.		N/A
13.4.6	Where it is necessary that wiring be disconnected for shipment, terminals or plug/socket combinations shall be provided at the sectional points.		N/A
13.4.7	When spare conductors are provided, they shall be connected to spare terminals or isolated to prevent contact with live parts		N/A
13.5	**Ducts, connection boxes and other boxes**		P
	Ducts shall provide a degree of protection (see IEC 60529) suitable for the application		P
	No sharp edges, flash, burrs, rough surfaces, or threads with which the insulation of the conductors can come into contact		P
	Where human passage is required, least 2 m above the working surface		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Where cable trays are only partially covered, the cables used shall be of a type suitable for installation on open cable trays.		N/A
13.5.2	Rigid metal conduit and fittings shall be of galvanized steel or of a corrosion-resistant material		P
	Fittings shall be compatible with the conduit and should be threaded		P
	Conduit bends shall be properly made		P
13.5.3	A flexible metal conduit shall consist of a flexible metal tubing or woven wire armour	No flexible metal conduit	N/A
13.5.4	Flexible non-metallic conduit shall be resistant to kinking		P
13.5.5	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving and of sources of contamination	No cable trunking system	N/A
	Where furnished in sections, the joints shall fit tightly but need not be gasketed		N/A
	The only openings permitted shall be those required for wiring or for drainage		N/A
13.5.6	The use of compartments or cable trunking systems within the column or base of a machine to enclose conductors is permitted provided they are isolated from coolant or oil reservoirs and are entirely enclosed		N/A
	Conductors shall be so secured		N/A
13.5.7	Connection boxes and other boxes used for wiring purposes shall be accessible for maintenance.		P
	Those boxes shall provide protection against the ingress of solid bodies and liquids		P
	They shall not have opened but unused knockouts nor any other openings		P
13.5.8	Motor connection boxes shall enclose only connections to the motor and motor-mounted devices (e.g. brakes, temperature sensors		P
14	**ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT**		P
14.1	Electric motors should conform to the relevant parts of IEC 60034 series		P
14.2	Enclosures for motors should be in accordance with IEC 60034-5		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The degree of protection shall be dependent on the application and the physical environment	IP55	P
	The dimensions of motors shall conform to those given in the IEC 60072 series		P
14.4	Motors and its accessories shall be so mounted that they are adequately protected and are easily accessible for inspection, maintenance, etc.		P
	Proper cooling shall be ensured and the temperature rise shall remain within the limits of the insulation class (see IEC 60034-1)		P
	There shall be no opening between the motor compartment and any other compartment that does not meet the motor compartment requirements		P
14.5	The characteristics of motors and associated equipment shall be selected in accordance with the anticipated service and physical environmental conditions		P
14.6	Operation of the overload and overcurrent protective devices for mechanical brake actuators shall initiate the simultaneous de-energization (release) of the associated machine actuators		P
15	**SOCKET-OUTLETS AND LIGHTING**		N/A
15.1	For socket-outlets intended for accessory equipment, the following apply:		N/A
	- they should conform to IEC 60309-1. Where not practicable, they should be clearly marked with the voltage and current ratings	No socket outlets	N/A
	- the continuity of the protective bonding circuit to the socket-outlet shall be ensured		N/A
	- all unearthed conductors connected to the socket-outlet shall be protected against overcurrent and, when required, overload		N/A
	– where the power supply to the socket-outlet is not disconnected by the supply disconnecting device for the machine or the section of the machine, the requirements of 5.3.5 apply		N/A
	– where fault protection is provided by automatic disconnection of supply, the disconnection time shall be in accordance with Table A.1 for TN systems or Table A.2 for TT systems		N/A
	–socket-outlets with a rating not exceeding 20 A shall be provided with an RCD not exceeding 30 mA		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
15.2	**Local lighting of the machine and of the equipment**		N/A
15.2.1	The ON/OFF switch shall not be incorporated in the lampholder or in the flexible connecting cord	No local lighting	N/A
	Stroboscopic effects from lights shall be avoided		N/A
15.2.2	The nominal voltage of the local lighting circuit shall not exceed 250 V between conductors. A voltage not exceeding 50 V is recommended		N/A
	Lighting circuits shall be supplied from one of the following sources:		N/A
	– a dedicated isolating transformer connected to the supply disconnecting device. Overcurrent protection shall be provided in the secondary circuit		N/A
	– a dedicated isolating transformer connected before the supply disconnecting device. This is permitted for maintenance lighting in control enclosures only. Overcurrent protection shall be provided in the secondary circuit		N/A
	– a circuit of the electrical equipment of the machine for lighting, with dedicated overcurrent protection		N/A
	– an isolating transformer connected before the supply disconnecting device, provided with a dedicated primary disconnecting means (see 5.3.5) and secondary overcurrent protection, and mounted within the control enclosure adjacent to the supply disconnecting device		N/A
	– an externally supplied lighting circuit (for example factory lighting supply). This shall be permitted in control enclosures only, and for the machine work light(s) where their total power rating is not more than 3 kW		N/A
	– power supply units, for DC supply to LED light sources, fitted with isolating transformers		N/A
	Exception: where fixed lighting is out of reach of operators during normal operations, the provisions of this 15.2.2 do not apply		N/A
15.2.3	Local lighting circuits shall be protected in accordance with 7.2.6		N/A
15.2.4	Adjustable lighting fittings shall be suitable for the physical environment		N/A
	The lampholders shall be:		N/A
	– in accordance with the relevant IEC standard		N/A

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	– constructed with an insulating material protecting the lamp cap so as to prevent unintentional contact		N/A
	Reflectors shall be supported by a bracket and not by the lampholder		N/A
	Exception: where fixed lighting is out of reach of operators during normal operations, the provisions of this 15.2.4 do not apply		N/A
16	**MARKING, WARNING SIGNS AND REFERENCE DESIGNATIONS**		P
16.1	Warning signs, nameplates, markings, labels and identification plates shall be of sufficient durability		P
16.2.1	Enclosures that do not otherwise clearly show that they contain electrical shall be marked with the graphical symbol ISO 7010-W012 		P
	It may be omitted (see also 6.2.2 b)) for: an enclosure equipped with a supply disconnecting device – an operator-machine interface or control station a single device with its own enclosure (for example position sensor)		N/A
16.2.2	Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures, the graphical symbol ISO 7010-W017 shall be used 		P
16.3	Control devices and visual indicators, shall be clearly and durably marked with regard to their functions		P
16.4	The following information shall be legibly and durably marked - plainly visible after installation on enclosures that receive incoming power supplies: • name or trade mark of supplier • certification mark or other marking where applicable • type designation or model, where applicable • serial number where applicable main document number (see IEC 62023) where applicable rated voltage, number of phases and frequency (if AC), and full-load current for each incoming supply It is recommended that this information is provided adjacent to the main incoming supply(ies)		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
16.5	All enclosures, assemblies, control devices, and components shall be plainly identified with the same reference designation as shown in the technical documentation		P
17	**TECHNICAL DOCUMENTATION**		P
17.1	The information necessary for identification, transport, installation, use, maintenance, decommissioning and disposal of the electrical equipment shall be supplied		P
	Annex I should be considered as guidance for the preparation of information and documents		P
17.2	**Information related to the electrical equipment**		P
	The following shall be supplied:		P
	a) where more than one document is provided, a main document for the electrical equipment as a whole, listing the complementary documents		P
	b) identification of the electrical equipment		P
	information on installation and mounting including: • a description of installation and mounting, and its connection to the electrical and other supplies • short-circuit current rating for each incoming power supply • rated voltage, number of phases and frequency (if AC.), type of distribution system (TT, TN, IT) and full-load current for each incoming supply • any additional electrical supply(ies) requirements (for example maximum supply source impedance, leakage current) for each incoming supply • space required for servicing • installation requirements regarding cooling • environmental limitations (for example lighting, vibration, EMC environment, atmospheric contaminants) • functional limitations (for example peak starting currents and permitted voltage drops) • precautions to be taken for the installation regarding electromagnetic compatibility		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	an instruction for the connection of conductive-parts in the vicinity of the machine to the protective bonding circuit: • metallic pipes • fences • ladders • handrails		N/A
	information on the functioning and operation as applicable: • an overview of the structure of the electrical equipment • procedures for programming or configuring • procedures for restarting after an unexpected stop • a sequence of operation		P
	f) information on maintenance, as appropriate: • frequency and method of functional testing • instructions for safe maintenance and where necessary suspend a safety function and/or protective measure (see 9.3.6) • guidance on the adjustment, repair, and frequency and method of preventive maintenance • details of the interconnections subject to replacement • required special devices or tools; • spare parts; • possible residual risks, indication of particular training and specification of personal protective equipment • instructions to restrict availability of keys or too(s to skilled or instructed persons • settings (DIP-switches, programmable parameter values, etc); • information for validation of safety related control functions after repair or modification, and for periodic testing where necessary;		P
	g) information on handling, transportation and storage		P
	h) information for proper disassembly and handling of components		P
18	**VERFICATION**		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
18.1	The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no such standard, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g): a) verification that the electrical equipment complies with its technical documentation b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2) in case of fault protection by automatic disconnection of supply, conditions shall be verified according to 18.2; d) insulation resistance test (see 18.3) e) voltage test (see 18.4) f) protection against residual voltage (see 18.5) g) verification that the relevant requirements of 8.2.6 are met h) functional tests (see 18.6)		—
	The results of the verification shall be documented		P
18.2	Verification of conditions for protection by automatic disconnection of supply		P
18.2.1	Test 1 verifies the continuity of the protective bonding circuit. Test 2 verifies the conditions for protection by automatic disconnection of the supply in TN systems For TN-systems, those test methods are described in 18.2.2 and 18.2.3; their application for different conditions of supply are specified in 18.2.4 For TT systems, see Clause A.2 For IT systems, see IEC 60364-6		P
	Where RCDs are used in the electrical equipment, their function shall be verified in accordance with the manufacturer's instructions. The test procedure and test interval shall be specified in the maintenance instructions		N/A
18.2.2	Test 1: Verification of the continuity of the protective bonding circuit		—
	The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between 0.2 A and approximately 10 A derived from an electrically separated supply source having a maximum no-load voltage of 24 V	See appended table	P
	The resistance measured shall be in the expected range		P
18.2.3	Test 2: Fault loop impedance verification and suitability of the associated overcurrent protective device		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The connections of each power supply including the connection of the associated protective conductor to the PE terminal of the machine, shall be verified by inspection		P
	The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A shall be verified by both		P
	a) verification of the fault loop impedance by - calculation, **or** - measurement in accordance with A.4, and	Measurement	P
	b) confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A, and		P
	Where a power drive system (PDS) is used, confirmation that the setting and characteristics of the protective device(s) are in accordance with the converter manufacturer's and protective device manufacturer's instructions		N/A
18.2.4	Application of the test methods for TN-systems		P
	When Test 2 of 18.2.3 is carried out by measurement, it shall always be preceded by Test 1 of 18.2.2		P
	The tests that are necessary for machines of different status are specified in Table 9		P
18.3	**Insulation resistance tests (optional)**		P
	When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ		P
	If the electrical equipment of the machine contains surge protection devices which are likely to operate during the test, it is permitted to either: – disconnect these devices, or reduce the test voltage to a value lower than the voltage protection level of the surge protection devices		N/A
18.4	**Voltage tests (optional)**		P
	The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.	50Hz	P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater	1000V	P
	The test voltage shall be applied between the power circuit conductors and the protective bonding circuit for at least 1 s		P
	Components and devices that are not rated to withstand the test voltage and surge protection devices shall be disconnected		N/A
18.5	**Protection against residual voltages**		N/A
	Where appropriate, tests shall be performed to ensure compliance with 6.2.4		N/A
18.6	**Functional tests**		P
	The functions of electrical equipment shall be tested		P
18.7	**Retesting**		P
	Where a portion of the machine or its associated equipment is changed or modified, the need for re-verification and testing of the electrical equipment shall be considered		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

18.2	**Continuity of the protective bonding circuit**				
. NO	Measure point		Cross-sectional area (mm^2)	Results (mΩ)	Verdict
	From	To (Relevant points of protective bonding circuit)			
1	PE	Panel	2	32. 2	Pass
2	PE	Transformer	2.0	31.1	Pass
3	PE	Motor	3.5	30.4	Pass

18.3	**Insulation resistance tests**				
. NO	Measure point		Requirement	Results (MΩ)	Verdict
	From	To (power circuit conduct)			
1	PE	L/N	>1 MΩ	671	Pass

Note1: Circuits though contactors have been manually engaged.
Note2: All circuit breakers switched on.

18.4	**Voltage tests**			
. NO	Measure point		Results (MΩ)	Verdict
	From	To (power circuit conduct)		
1	PE	L/N	No disruptive discharge occurs	Pass

Note1: Circuits though contactors have been manually engaged.
Note2: All circuit breakers switched on.

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

18.4	**Conductor Voltage tests**

Requirement:

The insulation of cables and conductors used, shall be suitable for a test voltage:
- not less than 2 000 V a.c. for a duration of 5 min for operation at voltages higher than 50 V a.c. or 120 V d.c, or
- Not less than 500 V a.c. for a duration of 5 min for PELV circuits (see IEC 60364-4-41. class II equipment).|

. NO	Measure point		Results	Verdict
	From	To (power circuit and earth circuit)		
1	earth circuit	14 mm^2 PVC isolated wire	No breakdrown	Pass
2		1.25 mm^2 PVC isolated wire	No breakdrown	Pass
3		5.5 mm^2 PVC isolated wire	No breakdrown	Pass
4		3.5 mm^2 PVC isolated wire	No breakdrown	Pass

18.5	**Protection against residual voltages**

Requirement:

Live parts having a residual voltage greater than 60 V after the supply has been disconnected shall be discharged to 60 V or less within a time period of 5 s after disconnection of the supply voltage provided that this rate of discharge does not interfere with the proper functioning of the equipment. Exempted from this requirement are components having a stored charge of 60 µc or less.

. NO	Measure point	Results （V）	Verdict
1	L/N main power supply	10	Pass

Appendix 1

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