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, Guangdong, China
Prepared By :	**OCT TECHNOLOGY TESTING CO., LTD.**
	1414, Building 3, No.41, Jinlong Road, Nansha District, Guangzhou City, Guangdong Province

Date of Test	**:**	**Mar 11-17,2025**
Date of Issue	**:**	**Mar 17,2025**

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 13849-1

Safety of machinery-Safety-related parts of control systems

Part 1: General principles for design

Testing laboratory …….....	:	Oct Technology Testing Co., Ltd.
Address ……..	:	1414, Building 3, No.41, Jinlong Road, Nansha District, Guangzhou City, Guangdong Province
Report body..... …….....	:	Oct Technology Testing Co., Ltd.
Address ..... ……...	:	1414, Building 3, No.41, Jinlong Road, Nansha District, Guangzhou City, Guangdong Province
Applicant ……..	:	BORUNTE ROBOT CO., LTD.
Address ……	:	NO. 83, Shafu Road, Shabu Village, Dalang Town, Dongguan City, Guangdong, China
Standard …….....	:	EN ISO 12100:2010 EN 60204-1:2018 EN ISO 13849-1:2015
Test Result ……..	:	Compliance with EN ISO 12100:2010 EN 60204-1:2018 EN ISO 13849-1:2015
Procedure deviation …….....	:	N.A.
Non-standard test method …….	:	N.A.
Type of test object …….	:	ROBOT FOR INJECTION MOLDING MACHINERY
Model/type reference …….....	:	BRTR09WDS5P0,BRTB06WDS1F0,BRTB06WDS1P0,BRTB08WDS1F0,BRTB08WDS1P0,BRTB10WDS1F0,BRTB10WDS1P0,BRTM09IDS5FC,BRTM09IDS5PC,BRTN17WSS5FC,BRTN17WSS5PC,BRTN24WSS5FC,BRTN24WSS5PC,BRTN30WSS5FC,BRTN30WSS5FF,BRTN30WSS5PC,BRTN30WSS5PF,BRTNG09WSS3F,BRTNG09WSS3P,BRTNG11WSS3F,BRTNG11WSS3P,BRTNN11WSS3F,BRTNN11WSS3P,BRTNN15WSS4F,BRTNN15WSS4P,BRTNN15WSS5F,BRTNN15WSS5P,BRTP06ISS0PC,BRTP07ISS1PC,BRTP08WSS0PC,BRTR07WDS5FC,BRTR07WDS5PC,BRTR08TDS5FC,BRTR08TDS5PC,BRTR09WDS5F0,BRTR11WDS5FC,BRTR11WDS5PC,BRTR13WDS5FC,BRTR13WDS5PC,BRTR17WDS5FC,BRTR17WDS5PC,BRTV09WDS5F0,BRTV09WDS5P0,BRTV13WDS5F0,BRTV13WDS5P0,BRTV17WSS5PC
Manufacturer …….....	:	BORUNTE ROBOT CO., LTD.
Address ……..	:	NO. 83, Shafu Road, Shabu Village, Dalang Town, Dongguan City, Guangdong, China

General remarks

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

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

"(see 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.**
1414, Building 3, No.41, Jinlong Road, Nansha District, Guangzhou City, Guangdong Province

Reported by : Signatu… Mar 17,2025 Date

Approved by : Signature Mar 17,2025 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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	a) the different machine operating modes and different intervention procedures for the users, including interventions required by malfunctions of the machine;		P
	b) the use of the machinery (for example, industrial, non-industrial and domestic) by persons identified by sex, age, dominant hand usage, or limiting physical abilities (visual or hearing impairment, size, strength, etc.);		P
	c) the anticipated levels of training, experience or ability of users including		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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	c) human interaction such as the operator–machine interface, and		P
	d) the machine–power supply interface.		P
5.3.4	Time limits		P
	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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	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
	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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5.5.2.3.3	Possibility of avoiding or limiting harm		P
	The possibility of avoiding or limiting harm influences the probability of occurrence of harm. Factors to be taken into account when estimating the possibility of avoiding or limiting harm are, among others, the following:		P
	a) different persons who can be exposed to the hazard(s), for example,		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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
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
	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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Application of the three-step method described in 6.1 is essential in achieving adequate risk reduction.		P
	Following the application of the three-step method, adequate risk reduction is achieved when		P
	-all operating conditions and all intervention procedures have been considered,		P
	-the hazards have been eliminated or risks reduced to the lowest practicable level,		P
	-any new hazards introduced by the protective measures have been properly addressed,		P
	-users are sufficiently informed and warned about the residual risks (see 6.1, step 3),		P
	protective measures are compatible with one another,		P
	sufficient consideration has been given to the consequences that can arise from the use in a nonprofessional/non-industrial context of a machine designed for professional/industrial use, and		P
	the protective measures do not adversely affect the operator's working conditions or the usability of the machine.		P
5.6.3	Comparison of risks		P
	As part of the process of risk evaluation, the risks associated with the machinery or parts of machinery can be compared with those of similar machinery or parts of machinery, provided the following criteria apply:		P
	-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

EN ISO 12100			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
6.1	General		P
	Step 1: Inherently safe design measures		P
	Step 2: Safeguarding and/or complementary protective measures		P
	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 13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**

EN ISO 13849-1 Safety of machinery—Safety- related parts of control systems Part 1: General principles for design			
4	Design considerations		P
4.1	safety objectives in design		P
4.2	strategy for risk reduction		P
4.2.1	General		P
4.2.2	Contribution to the risk reduction by the control system		P
	In this part of ISO 13849 the performance levels are defined in terms of probability of dangerous failure per hour. Five performance levels are set out, from the lowest PL a to the highest PL e with defined ranges of probability of a dangerous failure per hour(see table 2)	PL d	P
	In order to achieve a PL , beside quantifiable aspects , it is also necessary to satisfy requirements r elated to qualitative aspects of PL		P

Table 2 — Performance levels (PL)

PL	Average probability of dangerous failure per hour (PFH_D) 1/h
a	$\geq 10^{-5}$ to $< 10^{-4}$
b	$\geq 3 \times 10^{-6}$ to $< 10^{-5}$
c	$\geq 10^{-6}$ to $< 3 \times 10^{-6}$
d	$\geq 10^{-7}$ to $< 10^{-6}$
e	$\geq 10^{-8}$ to $< 10^{-7}$

--

EN ISO 13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
4.3	Determination of required performance level (PL r)		P
4.4	Design of SRP/CS		P
4.5	Evaluation of the achieved performance level PL and relationship with SIL		P
4.5.1	Performance level PL	PL d	P
	In standards in accordance with IEC 61508 , the ability of safety-related control systems to perform a safety function is given through a SI L. the relationship between the two concepts (PLs and SILs).	SIL3	P
	Table 3 — Relationship between performance level (PL) and safety integrity level (SIL) **PL** / **SIL** (IEC 61508–1, for information) high/continuous mode of operation a: No correspondence b: 1 c: 1 d: 2 e: 3		--
4.5.2	Mean time to dangerous failure of each channel ($MTTF_D$)	Denotation each channel medium	P
	The value of the $MTTF_D$ of each channel is given in three levels (see and shall be taken into account for each channel (e.g. single channel, each channel of a redundant system) individually.		P
	Table 4 — Mean time to dangerous failure of each channel ($MTTF_D$) $MTTF_D$ **Denotation of each channel** / **Range of each channel** Low: 3 years ≤ $MTTF_D$ < 10 years Medium: 10 years ≤ $MTTF_D$ < 30 years High: 30 years ≤ $MTTF_D$ ≤ 100 years NOTE 1 The choice of the $MTTF_D$ ranges of each channel is based on failure rates found in the field as state-of-the-art, forming a kind of logarithmic scale fitting to the logarithmic PL scale. An $MTTF_D$ value of each channel less than three years is not expected to be found for real SRP/CS since this would mean that after one year about 30 % of all systems on the market will fail and will need to be replaced. An $MTTF_D$ value of each channel greater than 100 years is not acceptable because SRP/CS for high risks should not depend on the reliability of components alone. To reinforce the SRP/CS against systematic and random failure, additional means such as redundancy and testing should be required. To be practicable, the number of ranges was restricted to three. The limitation of $MTTF_D$ of each channel values to a maximum of 100 years refers to the single channel of the SRP/CS which carries out the safety function. Higher $MTTF_D$ values can be used for single components (see Table D.1). NOTE 2 The indicated borders of this table are assumed within an accuracy of 5 %.		--

EN ISO 13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
4.5.3	Diagnostic coverage (DC)		P
	The value of the DC is given in four levels (see table 5)	DC 75%	P

Table 5 — Diagnostic coverage (DC)

DC	
Denotation	**Range**
None	DC < 60 %
Low	60 % ≤ DC < 90 %
Medium	90 % ≤ DC < 99 %
High	99 % ≤ DC

NOTE 1 For SRP/CS consisting of several parts an average value DC_{avg} for DC is used in Figure 5, Clause 6 and E.2.

NOTE 2 The choice of the DC ranges is based on the key values 60 %, 90 % and 99 % also established in other standards (e.g. IEC 61508) dealing with diagnostic coverage of tests. Investigations show that (1 - DC) rather than DC itself is a characteristic measure for the effectiveness of the test. (1 - DC) for the key values 60 %, 90 % and 99 % forms a kind of logarithmic scale fitting to the logarithmic PL-scale. A DC-value less than 60 % has only slight effect on the reliability of the tested system and is therefore called "none". A DC-value greater than 99 % for complex systems is very hard to achieve. To be practicable, the number of ranges was restricted to four. The indicated borders of this table are assumed within an accuracy of 5 %.

--

EN ISO 13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
4.5.4	Simplified procedure for estimating the quantifiable aspects of PL		P
4.5.5	Description of the output part of the SRP JCS by category		P
	If for mechanical, hydraulic or pneumatic components (or components comprising a mixture of technologies) no application- specific reliability data are available , the machine manufacturer may evaluate the quantifiable aspects of the PL without any $MTTF_D$-calculation.		P
4.6	Software safety requirements		P
4.6.1	General		P
	All lifecycle activities of safety-related embedded or application software shall primarily consider the avoidance of faults introduced during the software lifecycle (see The main objective of the following requirements is to have readable , understandable , testable and maintainable software.		P
4.6.2	Safety-related embedded (SRESW)		P
4.6.3	Safety-related application (SRASW)		P
4.6.4	Software-based parameterization		P
4.7	Verification that achieved PL meets PL_r		P
	For each individual safety function the PL of the related SRP/CS shall match the required performance level (PL_r) determined according (see If this is not the case , an iteration in the process described necessary.		P
4.8	Ergonomic aspects of design		P
5	safety functions		P
	This clause provides a list and derails of safety functions which can be provided by the SRP/CS. The designer (or type-C standard maker) shall include those necessary to achieve the measures of safety		P
5.1	specification of safety functions		P
5.2	Details of safety functions		P
5.2.1	Safety-related stop function		P
5.2.2	Manual reset function		P

EN ISO 13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5.2.3	Star/restart function		P
5.2.4	Local control function		P
5.2.5	Muting function		P
5.2.6	Response time		P
5.2.7	Safety-related parameters		P
5.2.8	Fluctuations , loss and restoration of power sources		P
6	Categories and their relation to MTTFD of each channel , DC avg and CCF		P
6.1	General		P
6.2 5	Specifications of categories		P
6.2.1	General		P
6.2 .2	Designated architectures		P
6.2.3	Category B		N
6.2.4	Category 1		N
6.2 .5	Category 2		N
6.2.6	Category 3	Category 3	P
6.2.7	Category 4		N
6.3	Combination of SRP /CS to achieve overall P L		P
	A safety function can be realized by combination of several SRP/CS: input system, signal processing unit, output system, These SRP/CS may be assigned to one and/or different categories. For each SRP/CS used ,a category according to 6.2 shall be selected. For the overall combination of these SR/CS, an. overall PL may be identified using the methods described in this clause. In this case, the validation of the combination of SRP/CS is required (see Figure 3).		P
7	Fault consideration , fault exclusion		P
7.1	General		P
7.2	Fault consideration		P

EN ISO 13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
7. 3	Fault exclusion		P
8	Validation		P
	The design of the SRP/CS shall be validated (see The validation shall demonstrate that the combination of SRP/CS providing each safety function meets all relevant requirements of this part of ISO 13849.		P
9	Maintenance		P
	Preventive or corrective maintenance can be necessary to maintain the specified performance of the safety-related parts. Deviations with time from the specified performance can lead to a deterioration in safety or even to a hazardous situation. The information for use of the SRP/CS shall include instructions for the maintenance (in cluding periodic inspection) of the S RP/CS		P
	The provisions for the maintainability of the safety-related part(s) of a control system shall follow the principles given in ISO 12100:2010 , 6.2.7. All information for maintenance shall comply with ISO 12100:2010		P
10	Technical documentation		P
	When designing a SRP/CS , its designer shall document at least the following information relevant to the safety-related part:		P
	safety function(s) provided by the SRP/CS;		P
	the characteristics of each safety function;		P
	the exact points at which the safety-related part(s) start and end;		P
	environmental conditions;		P
	the performance level (PL);		P
	the category or categories selected;		P
	the parameters relevant to the reliability (MTTFD , DC , CCF and mission time);		P
	measures against systematic failure;		P
	the technology or technologies used;		P
	all safety-relevant faults considered;		P
	justification for fault exclusions (see ISO 13849-2);		P

EN ISO 13849-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	the design rationale (e.g. faults considered , faults excluded);		P
	software documentation;		P
	measures against reasonably foreseeable misuse		P
11	Information for use		P
	The principles of ISO 12100 :2010 , 6.4.5.2 , and the applicable sections of other relevant documents IEC 60204-1:2005 , Clause 17) , shall be applied. In particular, that information which is important for the safe use of the SRP JCS shall be given to the user. This shall include , but is not limited to the following:		P
	the limits of the safety-related parts to the category(ies) selected and any fault exclusions;		P
	the limits of the SRP/CS and any fault exclusions (see for which , when essential for maintaining the selected category or categories and safety performance , appropriate information (e.g. for modification , maintenance and repair) shall be given to ensure the continued justification of the fault exclusion(s);		P
	the effects of deviations from the specified performance on the safety function(s);		P
	clear descriptions of the interfaces to the SRP/CS and protective devices;		P
	response time;		P
	operating limits (including environmental conditions);		P
	indications and alarms;		P
	muting and suspension of safety functions;		P
	control modes;		P
	maintenance		P
	maintenance check lists;		P
	ease of accessibility and replacing of internal parts;		P
	means for easy and safe trouble shoot in g		P
	information explaining the applications for use relevant to the category to which reference is made;		P
	checking test intervals where relevant.		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
4.	General requirements		P
4.1	General considerations		P
4.2	Selection of equipment		P
4.3	Electrical supply		P
4.3.1	General		P
4.3.2	AC supplies		P
4.3.3	DC supplies		N
4.3.4	On-board power supply		N
4.4	Physical environment and operating conditions		P
4.4.1	General		P
4.4.2	Electromagnetic compatibility (EMC)		P
4.4.3	Ambient air temperature		P
	The minimum requirement for all electrical equipment is correct operation between air temperatures of +5 °C and +40 °C.	0°C ~ +40 °C	P
4.4.4	Humidity		P
	The electrical equipment shall be capable of operating correctly when the relative humidity does not exceed 50 % at a maximum temperature of +40 °C. Higher relative humidities are permitted at lower temperatures (for example 90 % at 20 °C).		P
4.4.5	Altitude		P
	Electrical equipment shall be capable of operating correctly at altitudes up to 1 000 m above mean sea level.		P
4.4.6	Contaminants		P
4.4.7	Ionizing and non-ionizing radiation		N
4.4.8	Vibration, shock, and bump		P
4.5	Transportation and storage	Not exceed 50°C	P
4.6	Provisions for handing		P
4.7	Installation and operation	See supplier's instructions	P
5.	Incoming supply conductor terminations and devices for disconnecting and switching off		P
5.1	Incoming supply conductor terminations	Such terminations used	P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
5.2	Terminal for connection to the external protective earthing system		P
5.3	Supply disconnecting (isolating) device		P
5.3.1	General		-
5.3.2	Type		P
5.3.3	Requirements		P
5.3.4	Operating handle		P
	The operating means (for example, a handle) of the supply disconnecting device shall be easily accessible and located between 0,6 m and 1,9 m above the servicing level. An upper limit of 1,7 m is recommended.	Easily accessible	P
5.3.5	Excepted circuits		P
5.4	Devices for switching off for prevention of unexpected start-up		P
5.5	Devices for disconnecting electrical equipment		P
5.6	Protection against unauthorized, inadvertent and/or mistaken connection		P
6.	Protection against electric shock		P
6.1	General	Direct contact and indirect contact	P
6.2	Protection against direct contact		P
6.2.1	General		P
6.2.2	Protection by enclosures		P
	Opening an enclosure shall be possible only under one of the following conditions:		P
	a) The use of a key or tool is necessary for access by skilled or instructed persons		P
	b) The disconnection of live parts inside the enclosure before the enclosure may be opened		P

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 direct contact to at least IP2X or IPXXB		P
6.2.3	Protection by insulation of live parts	Insulation can withstanding the mechanical, chemical, electrical, and thermal stresses.	P
6.2.4	Protection against residual voltages		P
6.2.5	Protection by barriers		P
6.2.6	Protection by placing out of reach or protection by obstacles	Not protected by such devices.	N
6.3	Protection against indirect contact		P
6.3.1	General		-
6.3.2	Measures to prevent the occurrence of a hazardous touch voltage	Electrical separation	P
6.3.2.1	General		-
6.3.2.2	Protection by use of class II equipment or by equivalent insulation		P
6.3.2.3	Protection by electrical separation		P
6.3.3	Protection by automatic disconnection of supply		P
6.4	Protection by the use of PELV		N
6.4.1	General requirement		N
6.4.2	Sources for PELV		N
7.	Protection of equipment		P
7.1	General	See below	P
7.2	Overcurrent protection		P
7.2.1	General		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
7.2.2	Supply conductors	The supplier of the electrical equipment shall state on the installation diagram the data necessary for selecting the overcurrent protective device.	P
7.2.3	Power circuits		P
7.2.4	Control circuits		P
7.2.5	Socket outlets and their associated conductors		P
7.2.6	Lighting circuits		P
7.2.7	Transformers		P
7.2.8	Location of overcurrent protective devices		P
7.2.9	Overcurrent protective devices		P
7.2.10	Rating and setting of overcurrent protective devices		P
7.3	Overload protection of motors		P
7.4	Abnormal temperature protection	Temperature rise is within range of limited value	P
7.5	Protection against supply interruption or voltage reduction and subsequent restoration		P
7.6	Motor overspeed protection		P
7.7	Earth fault/residual current protection		P
7.8	Phase sequence protection		P
7.9	Protection against overvoltages due to lightning and to switching surges		P
8.	Equipotential bonding		N
8.1	General	See below	N
8.2	Protective bonding circuit		N
8.2.1	General		N
8.2.2	Protective conductors		N
8.2.3	Continuity of the protective bonding circuit		N

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
8.2.4	Exclusion of switching devices from the protective bonding circuit		N
8.2.5	Parts that need not be connected to the protective bonding circuit		N
8.2.6	Interruption of the protective bonding circuit		N
8.2.7	Protective conductor connecting points		N
8.3	Bonding for operational purposes		N
8.3.1	General		N
8.3.2	Bonding to the protective circuit		N
8.3.3	Bonding to a common reference potential		N
9.	Control circuits and control functions		P
9.1	Control circuits		P
9.1.1	Control circuit supply		P
9.1.2	Control circuit voltages		P
9.1.3	Protection		P
9.1.4	Connection of control devices		P
9.2	Control functions		P
9.2.1	Start functions		P
9.2.2	Stop functions		P
9.2.3	Operating modes		P
9.2.4	Suspension of safeguarding		P
9.2.5	Operation		P
9.2.5.1	General		P
9.2.5.2	Start		N
9.2.5.3	Stop		N
9.2.5.4	Emergency operations (emergency stop, emergency switching off)		N
9.2.5.4.1	General		N
9.2.5.4.2	Emergency stop		N
9.2.5.4.3	Emergency switching off		N

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
9.2.5.5	Monitoring of command actions		N
9.2.5.6	Hold-to-run controls		P
9.2.5.7	Two-hand control		N
9.2.5.8	Enabling device		P
9.2.6	Combined start and stop controls	Alternately initiate and stop motion are only used for functions which cannot result in a hazardous condition	P
9.2.7	Cableless control		N
9.2.7.1	General		N
9.2.7.2	Control limitation		N
9.2.7.3	Stop		N
9.2.7.4	Serial data communication		N
9.2.7.5	Use of more than one operator control station		N
9.2.7.6	Battery-powered operator control stations	Not By battery-power	N
9.3	Protective interlocks		N
9.3.1	Reclosing or resetting of an interlocking safeguard		N
9.3.2	Overtravel limits		N
9.3.3	Operation of auxiliary functions		N
9.3.4	Interlocks between different operations and for contrary motion		N
9.3.5	Reverse current braking		N
9.4	Control functions in the event of failure		P
9.4.1	General requirements		P
9.4.2	Measures to minimize risk in the event of failure		P
9.4.2.1	Use of proven circuit techniques and components		P
9.4.2.2	Provisions for redundancy		P
9.4.2.3	Use of diversity		P
9.4.2.4	Functional tests		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
9.4.3	Protection against maloperation due to earth faults, voltage interruptions and loss of circuit continuity		P
9.4.3.1	Earth faults		P
9.4.3.2	Voltage interruptions		P
9.4.3.3	Loss of circuit continuity		P
10.	Operator interface and machine-mounted control devices		P
10.1	General		-
10.1.1	General device requirements		P
10.1.2	Location and mounting	Readily accessible for service and maintenance	P
10.1.3	Protection		P
10.1.4	Position sensors		P
10.1.5	Portable and pendant control stations		P
10.2	Push-button		P
10.2.1	Colours	Correct colours	P
10.2.2	Markings		P
10.3	Indicator lights and displays		P
10.3.1	Modes of use		P
10.3.2	Colours		P
10.3.3	Flashing lights		P
10.4	Illuminated push-buttons		P
10.5	Rotary control devices		P
10.6	Start devices	Operation switch	P
10.7	Devices for emergency stop		N
10.7.1	Location	Located at each operator control station	P
10.7.2	Types		P
10.7.3	Colour of actuators		P
10.7.4	Local operation of the supply disconnecting device to effect emergency stop	Accessible to the operator	P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
10.8	Emergency switching off devices		N
10.8.1	Location		N
10.8.2	Types		N
10.8.3	Restoration of normal function after emergency switching off		N
10.8.4	Actuators		N
10.8.5	Local operation of the supply disconnecting device to effect emergency switching off		N
10.9	Displays		N
11.	Electronic equipment		P
11.1	General		P
11.2	Basic requirements		P
11.2.1	Inputs and outputs		P
11.2.2	Equipotential bonding		P
11.3	Programmable equipment		P
11.3.1	Programmable controllers		P
11.3.2	Memory retention and protection		P
11.3.3	Software verification		P
11.3.4	Use in safety-related functions		P
12.	Controlgear: location, mounting, and enclosures		P
12.1	General requirements	Refer to instruction	P
12.2	Location and mounting		P
12.2.1	Accessibility and maintenance		P
12.2.2	Physical separation or grouping		P
12.2.3	Heating effects		P
12.3	Degrees of protection		P
12.4	Enclosures, doors and openings		P
12.5	Access to controlgear		P
12.6	Flexible cables		P
12.7	Conductor wires, conductor bars		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
13.	Wiring practices		P
13.1	Connections and routing		P
13.1.1	General requirements		P
	All connections shall be secured against accidental loosening	No loosening	P
	Soldered connections shall only be permitted where terminals are provided that are suitable for soldering		P
	Terminal blocks shall be mounted and wired so that the internal and external wiring does not cross cover the terminals		P
13.1.2	Conductor and cable runs		P
	Conductors and cables shall be run from terminal to terminal without splices or joints		P
	The terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors		P
13.1.3	Conductors of different circuits		P
	Conductors of different circuits may be laid side by side, may occupy the same duct, or may be in the same multiconductor cable provided that the arrangement does not impair the proper functioning of the respective circuit		P
13.1.4	Connection between pick-up and pick-up converter of an inductive power supply system		P
13.2	Identification of conductors		P
13.2.1	Each conductor shall be identification at each termination in the accordance with the technical documentation		P
13.2.2	Identification of the protective conductor		N
13.2.3	Identification of the neutral conductor		P
13.2.4	Identification by colour		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
13.3	Wiring inside enclosures		P
	Conductors inside enclosures shall be supported where necessary to keep them in place		P
	Conductors and cables that do not run in ducts shall be adequately supported		P
	Power cables and cables of measuring circuit may be directly connected to the terminals of the devices for which the connections were intended		P
13.4	Wiring outside enclosures		N
13.4.1	General requirements		N
13.4.2	External ducts		N
	Flexible conduit or flexible multiconductor cable shall be used where it is necessary to employ flexible connections to pendant push-button stations		N
13.4.3	Connection to moving elements of the machine		N
	Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically designed for the purpose		N
13.4.4	Interconnection of devices on machine		N
13.4.5	Plug/socket combinations		N
	Where plug/socket combinations are provided, they shall fulfil one or more of the following requirements as applicable		N
13.4.6	Dismantling for shipment		N
13.4.7	Additional conductors		N
	Consideration should be given to providing additional conductors for maintenance or repair		N
13.5	Ducts, connection boxes and other boxes		P
13.5.1	General requirements		P
	Ducts shall provide a degree of protection suitable for application		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Ducts and cable trays shall be rigidly support and positioned at a sufficient distance from moving parts and in such a manner so as to minimize the possibility of damage or wear		P
	Ducts shall be provided only for mechanical protection		P
13.5.2	Percentage fill of ducts		P
13.5.3	Rigid metal conduit and fittings	No Such conduit and fittings applied	N
	Conduits shall be securely held in place and supported at each end		N
13.5.4	Flexible metal conduit and fittings	No such conduit and fittings	N
	Fittings shall be compatible with the conduit and appropriate for the application		N
13.5.5	Flexible non-metallic conduit and fittings		P
	The conduit shall be suitable for use in the expected physical environment	Such non-metallic conduit and fittings used	P
	Fittings shall be compatible with the conduit and appropriate for the application		P
13.5.6	Cable trunking systems		N
	Cable trunking systems external to enclosures shall be rigidly supported and clear of all moving or contaminating portions of the machine		N
	Where the cable trunking system is furnished in sections, the joints between sections shall fit tightly but need not be gasketed		N
	The only openings permitted shall be those required for wiring or for drainage		N
13.5.7	Machine compartments and cable trunking systems		P
13.5.8	Connection boxes and other boxes		P
13.5.9	Motor connection boxes		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
14.	Electric motors and associated equipment		P
14.1	General requirements		P
14.2	Motor enclosures		P
14.3	Motor dimensions		P
14.4	Motor mounting and compartments		P
	Each motor and its associated couplings, belts and pulleys, or chains, shall be so mounted that they are adequately protected and are easily accessible for inspection, maintenance, adjustment and alignment, lubrication, and replacement		P
14.5	Criteria for motor selection		P
14.6	Protective devices for mechanical brakes		P
15.	Accessories and lighting		N
15.1	Accessories		N
15.2	Local lighting of the machine and equipment		N
15.2.1	General		N
15.2.2	Supply		N
15.2.3	Protection		N
15.2.4	Fittings		N
16.	Marking, warning signs and reference designations		P
16.1	General		P
	Warning signs, nameplates, markings, and identification plates shall be of sufficient durability	See artwork of marking label and manufacturer's manual	P
16.2	Warning signs	 for electric shock hazard;	P
16.3	Functional identification	See instruction	P
16.4	Marking of equipment	See marking label	P
16.5	Reference designations		P
17.	Technical documentation		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
17.1	General		P
17.2	Information to be provided	(See instruction)	P
	a) a clear, comprehensive description of the equipment, installation and mounting, and the connection to the electrical supply(ies);		P
	b) electrical supply(ies) requirements		P
	c) information on the physical environment		P
	d) overview (block) diagram(s)		P
	e) circuit diagram		P
	f) information (where appropriate) on:		-
	1) programming		P
	2) sequence of operation(s)		P
	3) frequency of inspection		P
	4) frequency and method of functional testing		P
	5) guidance on the adjustment, maintenance, and repair, particularly of the protective devices and circuits		P
	6) parts list and recommended spare parts list		P
	g) a description of the safeguards, interlocking functions, and interlocking of guards for potentially hazardous motions, particularly for machines operating in a co-ordinated manner		P
	h) a description of the safeguarding and of the means provided		P
17.3	Requirements applicable to all documentation	Comply with correlative standard	P
17.4	Installation diagram	(See instruction)	P
17.5	Block (system) diagrams and function diagrams	(See instruction)	P
17.6	Circuit diagrams		P
17.7	Operating manual	(See instruction)	P
17.8	Maintenance manual	(See instruction)	P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
17.9	Parts list	(See instruction)	P
18.	Verification		P
18.1	General		P
	Verification, that electrical equipment is in compliance with the technical documentation		P
	The relevant tests for the particular machine type will be given in the dedicated product standard	Relative tests have been carried out according to this clause.	P
	In case of absence of such product standards, the appropriate tests include the ones listed under cl. 19.2 – 19.6		P
18.2	Continuity of the protective bonding circuit		P
	After completion of installation and electrical connection, continuity of the PE- circuit verified by a loop impedance test		P
	For small or pre-manufactured machines or parts of it, with protective bonding loops not exceeding approx. 30 meters, and where the machine cannot be connected to the power supply for loop impedance tests, following method is appropriate:		--
	Verify continuity of the PE-circuit by injecting a current of =10 A with 50Hz or 60Hz supply, derived from a PELV source	Test current 10A 50Hz Between PE terminal and exposed conductive parts 0.04 Ω	P
	Test made between PE- terminal and relevant points of PE-circuit (see cl. 5.2)		P
	Measured voltage between PE-terminal and points of test not exceed values given in table 9		P
18.3	Insulation resistance tests		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Insulation resistance measured with 500VDC between power circuit conductors and PE-circuit is to be =1.0 MΩ	test voltage 500VDC insulation resistance R >2 MΩ between: Live parts to enclosure	P
	Insulation value must be = 1.0 MΩ		--
	Test made on individual sections of complete electrical installation		P
	For certain parts of the electrical equipment, a lower minimum insulation value is permitted, but not less than 50 kΩ		P
18.4	Voltage tests		P
	Electrical equipment withstand a test voltage applied for a period of at least 1 second between live conductors of all circuits and the PE-circuit	1000V for 1 s, no disruptive discharge occurred.	P
	Exempt from above requirements are circuits intended to operate at, or below PELV voltages		P

	The test voltage is defined as having:		
	a value of twice the rated supply voltage of the equipment or 1000 VAC, which ever applies	1000 VAC	P
	Supplied from a transformer with a min. output rating of 500VA		N
	a frequency of 50Hz or 60Hz,	Frequency 50Hz	P
	Supply from a transformer with a minimum rating of 500 VA.		N
	Components not rated to withstand these test voltage are disconnected during testing		N
18.5	Protection against residual voltages		P
	Tests for protection against residual voltages are performed to ensure compliance with cl. 6.2.4		P
18.6	Functional tests		P

EN 60204-1			
Clause	**Requirement – Test**	**Result - Remark**	**Verdict**
	Functions tests of the electrical equipment performed, particularly those related to safety and safeguarding	The functions of Electrical equipment equipped with this machine have been tested.	P
18.7	Retesting		P
	Where a portion of the machine and its associated equipment is changed or modified, that portion is reverified and retested as appropriate (see cl. 19.1)		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	34.4	Pass
2	PE	Transformer	2.0	31.5	Pass
3	PE	Motor	3.5	43.3	Pass

18.3	**Insulation resistance tests**				
. NO	Measure point		Requirement	Results (MΩ)	Verdict
	From	To (power circuit conduct)			
1	PE	R	>1 MΩ	112	Pass
2	PE	S	>1 MΩ	41	Pass
3	PE	T	>1 MΩ	65	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	R	No disruptive discharge occurs	Pass
2	PE	S	No disruptive discharge occurs	Pass
3	PE	T	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	R-S main power supply	14	Pass
2	S-T main power supply	11	Pass
3	R-T main power supply	25	Pass

Appendix 1

Photo of EUT

