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SAFETY TEST REPORT

MEASUREMENT AND TEST REPORT

For

Shenzhen Karsun Access Technology Co.,Ltd	
F1- F3 , Building A2, Silicon Valley Power Digital Industrial Park, Guanlan Street, Longhua, Shenzhen, Guang Dong, China.518000	
Models:	JS-SJZ001
Additional model:	JS-SJZ002， JS-SJZ003， JS-SJZ005， JS-SJZ006， JS-SJZ007， JS-SJZ008，JS-SJZ009，JS-SJZ010，JS-SJZ011，JS-SJZ012
Equipment Type:	Rising Bollards
Test Standard:	EN IEC 62368-1:2018
Report Number:	GBT5020673659
Test Date:	2025-09-15 to 2025-09-23
Prepared By:	**Guangdong Baotong Quality Inspection Co.,Ltd.** Room 802,Building 22,CIMC Intelligent Manufacturing Center,No.15.Shunye West Road,Xingtan,Shunde District.Foshan,Guangdong.China
Date of issue	2025-09-23

Tested by: Reviewer: Approved:

EMC TEST REPORT	
Applicant	
name..... :	Shenzhen Karsun Access Technology Co.,Ltd
Address..... :	F1- F3 , Building A2, Silicon Valley Power Digital Industrial Park, Guanlan Street, Longhua, Shenzhen, Guang Dong, China.518000
Test specification:	
Standard..... :	EN IEC 62368-1:2018
Test procedure..... :	Type Test
Non-standard test method……..:	N/A
Test item	
Description..... :	Rising Bollards
Model and/or type reference..... :	See page 1
Additional model..... :	See page 1
Trade mark ..... :	/
Rated voltage ..... :	/
Manufacturer ..... :	Shenzhen Karsun Access Technology Co.,Ltd
Address ……..:	F1- F3 , Building A2, Silicon Valley Power Digital Industrial Park, Guanlan Street, Longhua, Shenzhen, Guang Dong, China.518000
Test item particulars	
Classification of installation and use:	N/A
Supply Connection..... :	N/A
Possible test case verdicts	
- test case does not apply to the test object :	N(.A)
- test object does meet the requirement :	P(Pass)
- test object does not meet the requirement :	F(Fail)

Summary of testing:

The product has been tested according to standard

EN IEC 62368-1:2018

- Maximum ambient temperature: +25℃
- Tested for moderate conditions

Copy of marking plate

Rising Bollards
Model:JS-SJZ002，JS-SJZ003，JS-SJZ005，JS-SJZ006，JS-SJZ007，JS-SJZ008，JS-SJZ009，JS-SJZ010，JS-SJZ011，JS-SJZ012
Rating(s): 220-240V~, 50/60Hz, 30W, Class I

ADLUCEO
Made In China

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
1	**Scope**		-
	This part of IEC 60076 applies to three-phase and single-phase power transformers(including auto-transformers)with the exception of certain categories of small and special transformers such as:		P
	- single-phase transformers with rated power less than 1 kVA and three-phase transformers less than 5kVA;		P
	- transformers,which have no windings with rated voltage higher than 1000 V;		P
	- instrument transformers;		P
	- traction transformers mounted on rolling stock;		P
	- starting transformers;		P
	- testing transformers;		P
	- welding transformers;		P
	- explosion-proof and mining transformers;		P
	- transformers for deep water (submerged)applications.		P
	When IEC standards do not exist for such categories of transformers(in particular transformer having no winding exceeding 1000 V for industrial applications),this part of IEC 60076 may still be applicable either as a whole or in part.		P
	This standard does not address the requirements that would make a transformer suitable for mounting in a position accessible to the general public.		N
	For those categories of power transformers and reactors which have their own IEC standards, this part is applicable only to the extent in which it is specifically called up by cross-reference in the other standard.Such standards exist for:		P
	- reactors in general(IEC 60076-6);		P
	- dry-type transformers(IEC60076-11);		P
	- self-protected transformers (IEC60076-13);		N
	- gas-filled power transformers(IEC 60076-15);		N
	- transformers for wind turbine applications (IEC 60076-16);		P
	-traction transformers and traction reactors (IEC 60310);		
	-converter transformers for industrial applications (IEC 61378-1);		
	-converter transformers for HVDC applications(IEC 61378-2)		

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	At several places in this part it is specified or recommended that an 'agreement' should be reached concerning alternative or additional technical solutions or procedures. Such agreement is made between the manufacturer and the purchaser. The matters should preferably be raised at an early stage and the agreements included in the contract specification.		
2	**Normative references**		
	The following referenced documents are indispensable for the application of this document.For dated references, only the edition cited applies. For undated references, the latest editionof the referenced document (including any amendments) applies.		
	IEC 60076-2, Power transformers - Part 2: Temperature rise for liquid-immersed transformers.		
	IEC 60076-3:2000, Power transformers - Part 3: Insulation levels, dielectric tests and external clearances in air.		
	EC 60076-5:2006,Power transformers- Part 5: Ability to withstand short circuit.		
	IEC 60076-10:2001,Power transformers- Part 10: Determination of sound levels.		
	IEC 60076-11:2004,Power transformers-Part 11: Dry-type transformers.		
	IEC 60137:2008, Insulated bushings for alternating voltages above 1000 V.		
	IEC 60214-1:2003,Tap-changers- Part 1: Performance requirements and test methods.		
	IEC 60296:2003, Fluids for electrotechnical applications - Unused mineral insulating oils for transformers and switchqear.		
	IEC 60721-3-4:1995,Classification of environmental conditions - Part 3: Classification of groups of environmental parameters and their severities- Section 4: Stationary use at non-weatherprotected locations.		
	IS0 9001:2008,Quality management systems-Requirements.		
3	**Terms and definitions**		
	For the purposes of this document, the following terms and definitions apply.		
3.1	General considerations		P
	Hazard and risk assessment		P
3.2	Electrical components/devices suitable for their intended use		P
	and conform to the relevant IEC orEN standards		P
3.3	Power supply and related conditions:		—
3.3.1	Electrical equipment to be designed for correct operation with conditions of mains power supply		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
3.3.2	Supply Voltage		P
	Frequency		P
	Harmonics		P
	Voltage unbalance		P
	Voltage interruption		P
	Voltage dips :		P
3.3.3	DC Supplies Voltage :		N
	Voltage interruption		N
	Ripple (peak-peak) :		N
3.3.4	Special power systems		N
	Onboard power supply acc. to cl.4.3.2 and 4.3.3 may be exceed		N
3.4	Physical environment and operating conditions		P
3.4.1	Electrical equipment to be suitable for use in physical environment and operating conditions		P
3.4.2	Electromagnetic compatibility (EMC)		P
	Equipment not to generate electromagnetic disturbances above harmful levels: (applicable EMC-standard: EN50081-2)		P
	Equipment has adequate level of immunity to EMC: (applicable EMC- standards: EN 61000)		P
3.4.3	Electrical equipment to be capable for correct operation at intended ambient air temperature	-40~5℃	P
3.4.4	Electrical equipment to be capable for correct operation at specified relative humidity:	5% to 80%	P
3.4.5	Electrical equipment capable of operating correctly at altitudes up to1000 m above m.s.l.	2000m	P
3.4.6	Electrical equipment shall be adequately protected against ingress of solid properties and liquids see clause 11.3		N
3.4.7	Ionizing and non-ionizing radiation Electrical equipment subject to radiation, additional measures to be taken to avoid equipment malfunction		N
3.4.8	Undesirable effects of vibration, shock and bump avoided		P
3.5	Electrical equipment designed to withstand the effects of transportation and storage within a temperature range of -25 to +55 °C	-40~5℃	P
3.6	Heavy or bulky electrical equipment of the machine provided with suitable means for handling		P
3.7	Electrical equipment installed and operated in accordance with the supplier's instruction	Skilled person for installing and See instruction	P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
4	**INCOMINGSUPPLYCONDUCTORTERMINATIONSANDDEVICES FOR DISCONNECTING AND SWITCHING OFF**		—
4.1	Incoming supply conductor terminal		P
	electrical equipment of a machine connected to a single power supply	Single power supply	P
	power supply conductors terminated to main disconnecting device of electrical equipment		P
	neutral conductor ”N” clearly indicated in technical documentation.	N indicated	P
	no connection between neutral conductor and bonding circuit nor combined PEN-terminals.	protective	
	All terminals of incoming supply clearly marked (symbols acc. to EN60445) and clause16.1		P
4.2	Terminal for connection to external protective earthing system		—
	Terminal for connection of external protective conductor provided and marked with ”PE”	Grounding symbol used for PE	P
	Cross section of incoming PE conductor acc. to cl. 5.2, table 1	S<16, PE cross is S	P
	Terminals allow connection of external protective earth conductors PE		P
	other protective earth identified either by graphic symbol,letters ”PE”, or bicolour combination green / yellow	PE identified by graphic symbol Green/Yellow bicolour used	P
4.3	Supply disconnecting device		—
4.3.1	Power supply disconnecting device provided for electrical equipment		P
4.3.2	The power supply disconnecting device shall be one of the following type:		—
	a) Switch-disconnector, acc. to EN60947-3 for appliance category AC-23 B or DC-23 B		N
	b) Disconnector with or without fuses, with aux. contact (acc. to EN60947-3)		N
	c) Power Circuit Breaker suitable for isolation(acc. to EN 60947-2)	Circuit Breaker comply with EN 60947-2	P
	d) any other switching device in accordance with an IEC product standard for that device and which meets the isolation requirements of IEC 60947-1 as well as a utilization category defined in the product standard as appropriate for on-load switching of motors or other inductive loads;		N
	e) a plug/socket combination for a flexible cable supply.		N
4.3.3	When supply disconnecting device is a switch-disconnector or a circuit- breaker		—
	Isolate electrical equipment from supply(acc. to EN 60947-2)	circuit- breaker	P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	One OFF (isolated) and one ON position only		P
	Clearly marked with ”0” and ”I”		P
	CB’s with additional reset position between ”0” and ”I”		N
	visible isolating distance or		P
	Position indication which cannot indicate the OFF-position until all contacts are actually open		N
	External operating device provided(except power operated CB’s)		N
	Colour black or grey preferred.		N
	If used as an emergency stop, red/yellow combination selected		N
	Locking means provided to lock in OFF-position		N
	In locked position an unintended closing for local or remote operation mode possible		N
	Disconnection of all live conductors (Exception: TN-supply systems, neutral conductor)		N
	Sufficient breaking capacity		N
	- a) to f) of clause 13.4.5Plug/socket combinations		N
4.3.4	Handle of disconnecting device to be easily accessible		N
	Handle located between 0.6m and1.9m above service level		N
4.3.5	Following circuits not disconnect by supply disconnecting device:		—
	Lighting circuits during maintenance or repair	All power isolated	N
	Plug/socket outlets exclusively used for maintenance or repair		N
	Undervoltage protection circuits used for automatic tripping only at power supply failures		N
	Circuits of equipment to remain normally energized for satisfactory operation		N
	Control circuits for interlocking purposes		N
	Circuits which are not disconnected by supply disconnecting device:		—
	Permanent warning labels placed in proximity of supply disconnectors		N
	Appropriate remark in maintenance manual		N
	Warning label in proximity of circuit concerned		N
	or wiring separated from other wiring		N
	Wiring of safety interlocking circuits installed with different colour of insulation.		N
4.4	Devices for switching off for prevention of unexpected start-up:		—
	Means shall be provided to prevent inadvertent and / or mistaken closure of the disconnecting device		N
	Such devices appropriate and convenient for intended use		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Suitable placed		N
	Readily identifiable		N
	The following devices that fulfil the isolation function may be provided for this purpose:		—
	– devices described in 5.3.2,		N
	– disconnectors, withdrawable fuse links and withdrawable links only if located in an enclosed electrical operating area (see 3.19).		N
	Devices that do not fulfil the isolation function (for example a contactor switched off by a control circuit) may only be provided where intended to be used for situations that include:		N
	– inspections;		N
	– adjustments;		N
	– work on the electrical equipment where: - there is no hazard arising from electric shock (see Clause 6) and burn; - the switching off means remains effective throughout the work; - the work is of a minor nature (for example replacement of plug-in devices without disturbing existing wiring).		N
	NOTE 1 This part of IEC 60204 does not address all provisions for prevention of unexpected start up. See ISO 14118 (EN 1037).		—
4.5	Devices provided for disconnecting electrical equipment		N
	Supply-disconnecting device used		N
	In addition to the supply disconnecting device, the following devices that fulfil the isolation function may be provided:		N
	– devices described in 5.3.2;		N
	-disconnectors, withdrawable fuse links and withdrawable links only if located in an enclosed electrical operating area and relevant information is provided with the electrical equipment (see Clause 17)		N
4.6	Provided with adequate means to prevent unauthorized, inadvertent and /or mistaken closing		N
	Devices acc. to cl. 5.4 and 5.5 provided with locking means		N
	Locking means provided with device		N
	Where a non-lockable disconnecting device (for example withdrawable fuse-links, withdrawable links) other means of protection against reconnection (for example warning labels in accordance with 16.1) may be provided.		N
	However, when a plug/socket combination according to 5.3.2 e) is so positioned that it can be kept under the immediate supervision of the person carrying out the work, means for		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	securing in the disconnected state need not be provided.		
5	**PROTECTION AGAINST ELECTRIC SHOCK**		—
5.2	Protection against direct contact:		—
5.2.1	- by means of protection by enclosure		P
	- by means of insulation of live parts		P
	- by means of protection against residual voltages		P
5.2.2	Protection by enclosure:		—
	Live parts located inside enclosures conform to relevant requirements of clauses 4, 12 and15 Protection against direct contact at least IP2X or IPXXB	Located for skilled person without children IP21 protected by enclosure and earthed	N
	Where top surfaces of enclosures are readily accessible, degree of protection against direct contact is IP4X or IPXXD.		N
	Opening of enclosure possible only under one of the following conditions:		—
	Live parts located inside enclosures conform to relevant requirements of clauses 4, 12 and15 Protection against direct contact at least IP2X or IPXXB	Located for skilled person without children IP21 protected by enclosure and earthed	N
	Where top surfaces of enclosures are readily accessible, degree of protection against direct contact is IP4X or IPXXD.		N
	Opening of enclosure possible only under one of the following conditions:		—
	a) use of a key or a tool. Special requirements for enclosed electrical operating areas may apply		N
	live parts inside of doors with protection degree of IP1X or IPXXA		N
	live parts likely to be touched during resetting or adjustment with protection degree IP2X or IPXXB		N
	b) disconnection of live parts inside enclosure prior to opening of enclosure	No such condition	N
	at door interlocking safety circuit, door will open only when main isolator is in open position		N
	For skilled persons a special device provided, to defeat interlocking circuit under following conditions:		—
	Special device or tool provided to permit skilled persons to defeat the interlock provided that:		—
	- opening of disconnector possible at all times while interlock is defeated		N
	- upon closing the door, interlock is automatically restored		N
	If more than one door allows access to live parts, care must be taken, at implementation of this subclause		N
	All parts remaining live after switching off mains supply to be	All parts not live after isolated	N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	protected against direct contact with at least IP2X or IPXXB	switching off	
	Such parts marked with warning symbol acc. to cl.17.2		N
	Excepted from this requirement for marking are:		—
	- Parts that can be live only due to connection to interlocking circuits, distinguished by colour as potentially live acc. to cl. 14.2.4		N
	- Terminals of supply disconnecting device when latter mounted alone in a separate enclosure		N
	c) opening of doors without use of key or tool and without disconnection of live parts possible only when all live parts are protected against direct contact by IP2X or IPXXB		N
	where protection is provided by barriers, tools required for their removal or		N
	all live parts automatically disconnected when barrier is removed		N
5.2.3	Protection by insulation of live parts:		—
	Live parts completely covered with insulation	Internal wire, components are covered with insulation	P
	insulation can be removed only by destruction		P
	insulation capable to withstand mechanical, chemical, electrical and thermal stress occurring under normal service conditions		P
	Paint, varnish lacquer etc. not used as insulation	Such material not used as insulation	P
5.2.4	Protection of residual voltage:		—
	Live parts with residual voltage =60V after disconnection, to be discharged to = 60V within 5s after disconnection,Except are components with charges of = 60 µC	residual voltage <60V	P
	where pins of plugs or similar devices after withdrawal are exposed, discharge time = 1s		N
	such conductors protected against direct contact by at least IP2X or IPXXB		N
	if above requirements cannot be achieved, additional disconnecting devices or appropriate warning devices shall be applied. (see cl.13.8.4)		N
5.2.5	For protection by barriers, 412.2 of IEC 60364-4-41 shall apply.	No barriers	N
5.2.6	For protection by placing out of reach, 412.4 of IEC 60364-4-41 shall apply. For protection by obstacles, 412.3 of IEC 60364-4-41 shall apply.		N
	For conductor wire systems or conductor bar systems with a degree of protection less than IP2X, see 12.7.1.		N
5.3	Protection against indirect contact:		—

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
5.3.2	Measures to prevent the occurrence of a hazardous touch voltage		—
5.3.2.2	use of class II electrical devices or apparatus (double insulation, reinforced insulation or by equivalent insulation acc. to EN60536)		N
	use of switch gear and control gear assemblies with total insulation acc. to EN 60439-1		P
	application of supplementary or reinforced insulation acc. to EN60364-4-41, 413.2		P
5.3.2.3	Electrical separation of an individual circuit to prevent hazardous touch voltage acc. to EN 60364-4-41, cl. 413.5		P
5.3.3	Protection by automatic disconnection of supply:		—
	This measure necessitates co-ordination between:		—
	– the type of supply and earthing system;	Earthing system	N
	– the impedance values of the different elements of the protective bonding system;		N
	– the characteristics of the protective devices that detect insulation fault(s).		N
	Automatic disconnection of the supply of any circuit affected by an insulation fault is intended to prevent a hazardous situation resulting from a touch voltage.		N
	This protective measure comprise both:		—
	-Connection of all exposed conductive parts to protective earth bonding circuit		N
	And		—
	a) overcurrent protective devices for the automatic disconnection of the supply on detection of an insulation fault in TN systems, or	overcurrent protective devices	N
	b) residual current protective devices to initiate the automatic disconnection of the supply on detection of an insulation fault from a live part to exposed conductive parts or to earth in TT systems, or		N
	c) insulation monitoring or residual current protective devices to initiate automatic disconnection of IT systems.		N
	This insulation monitoring device shall initiate an audible and/or visual signal which shall continue as long as the fault persists.		N
5.4	Protection by application of PELV circuit which have to fulfil following requirements:		—
5.4.1	a) nominal voltage not to exceed 25 AC (r.m.s.) or 60 DC (ripple- free) or	/	N
	6VAC or 15VDC for all other cases		N
	b) one side of PELV- circuit or one point of source of supply to be connected to PE- circuit		N
	c) live parts of PELV- circuits to be electrically separated from other live circuits.		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Electrical separation shall be not less than that required between the primary and secondary circuits of a safety isolating transformer (see IEC 61558-1 and IEC 61558- 2-6);	Switching power supply, safety isolating transformer used	N
	d) conductors of each PELV circuit to be physically separated from those of any other circuit.		N
	When this requirement is impracticable, the insulation provisions of 13.1.3 shall apply;		N
	e) plugs and socket outlets for PELV- circuits shall conform to following requirements:		N
	plugs shall not be able to enter socket outlets of other voltage systems		N
	socket outlets shall not admit plugs of other voltage systems		N
5.4.2	Sources for PELV- circuits to be one of the following:		—
	– a safety isolating transformer in accordance with IEC 61558-1 and IEC 61558-2-6;		N
	– a source of current providing a degree of safety equivalent to that of the safety isolating transformer (for example a motor generator with winding providing equivalent isolation);		N
	– an electrochemical source (for example a battery) or another source independent of a higher voltage circuit (for example a diesel-driven generator);		N
	-electronic power supply conforming to appropriate standards		N
6	**PROTECTION EQUIPMENT**		—
6.2	Overcurrent protection:		—
6.2.1	Overcurrent protection device provided	Circuit breaker	N
6.2.2	Supply conductors		—
	Overcurrent protective device at incoming feeder to the electrical equipment (see to cl. 7.2.10 and cl. 18.5)		N
	Electrical equipment supplier state data for overcurrent protective device		N
6.2.3	Power circuits:		
	Devices for detection and interruption of overcurrent, selected in accordance with7.2.10, shall be applied to each live conductor.		P
	The following conductors, as applicable, shall not be disconnected without disconnecting all associated live conductors:		P
	– the neutral conductor of a.c. power circuits;		N
	– the earthed conductor of d.c. power circuits;		N
	– d.c. power conductors bonded to exposed conductive parts of mobile machines.		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Cross section area of neutral conductor to be at least equal to phase conductor, no overcurrent protective/ disconnecting device required	Neutral conductor area same as phase conductor	P
	For neutral earth conductors with cross sections smaller than phase conductors, measures acc. to item b, cl 473.3.2.1 of IEC 60364-4-473 will apply		N
	For IT-systems use of neutral earth conductor (N) is not recommended. Nevertheless if an N-conductor is used, measures acc. to cl. 473.3.2.2 of IEC 60364-4-473 shall apply.	TN system	N
6.2.4	Control circuits:		—
	Conductors of control circuits directly connected to supply voltage and circuits feeding control voltage transformers protected against overcurrent acc. to cl.7.2.3		N
	Conductors of control circuits supplied by a control circuit transformer or d.c. supply shall be protected against overcurrent (see also 9.4.3.1):	Conductors protected overcurrent device	P
	– in control circuits connected to the protective bonding circuit, by inserting an overcurrent protective device into the switched conductor;		N
	– in control circuits not connected to the protective bonding circuit;		N
	- where the same cross sectional area conductors are used in all control circuits, by inserting an overcurrent protective device into the switched conductor, and;		N
	- where different cross sectional areas conductors are used in different sub-circuits, by inserting an overcurrent protective device into both switched and common conductors of each sub-circuit.		N
6.2.5	Socket outlets and their associated conductors:		—
	Overcurrent protection devices for socket outlets provided for non- earthed live conductors of each circuit feeding such socket outlets	No such circuit	N
6.2.6	Lighting circuits:		—
	All unearthed conductors of local lighting circuits protected by overcurrent protective devices	No lighting	N
6.2.7	Transformers:		—
	Transformers shall be protected against overcurrent in accordance with the manufacturer's instructions. Such protection shall (see also 7.2.10):	Transformer in the switching power supply, have enough protection	N
	– avoid nuisance tripping due to transformer magnetizing inrush currents;		N
	– avoid a winding temperature rise in excess of the permitted value for the insulation class of transformer when it is subjected to the effects of a short circuit at its secondary terminals.		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	The type and setting of the overcurrent protective device should be in accordance with the recommendations of the transformer supplier.	Overcurrent protected by inner fuse	N
6.2.8	Location of protective devices:		P
	Overcurrent protective device located at point where conductor is connected to the supply		P
	Current carrying capacity of conductors at least equal to that required for electrical load		P
	Each connecting conductor to overcurrent protective devices not longer than 3 meters		P
	Conductor protected by enclosure or duct		P
6.2.9	Overcurrent protective devices:		—
	Rated short-circuit breaking capacity at least equal to prospective fault current at point of installation	Circuit breaker rating have suitable capacity	P
	Current other than those coming from supply side taken into account		N
	Reduced breaking capacity is permitted, where another protective device is installed at supply side with the necessary breaking capacity		N
	Back-up protection carefully checked, no destruction of conductor or overcurrent protective device may result		N
	Co-ordination with other protective devices in circuit required		N
	Overcurrent protective devices in power circuits include fuses and circuit breakers. Electronic current limiting devices may also be used in protected circuits		N
6.2.10	Rating and setting of overcurrent protective devices:		—
	Rated current of fuses or overcurrent setting of other protective devices selected as low as possible, but adequate for anticipated overcurrents.	Current ratings of protective device are considered	N
	Settings of overcurrent protective devices appropriately listed in technical documentation		N
6.3	Protection of motors against overheating		P
6.3.1	Overload protection for all motors provided for ratings of > 0.5 kW in continuous operation.	No motor	N
	Protective device may be omitted for motors which cannot be overloaded		N
	Protection of motors against overheating can be achieved by:		N
	– overload protection (7.3.2),		N
	– over-temperature protection(7.3.3),		N
	– current-limiting protection(7.3.4).		N
	Automatic restarting of any motor after the operation of protection against overheating shall be prevented where this can cause a hazardous situation or damage to the machine		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	or to the work in progress.		
6.3.2	Where overload protection is provided, detection of overload(s) shall be provided in each live conductor except for the neutral conductor.		N
	However, where the motor overload detection is not used for cable overload protection (see also Clause D.2), the number of overload detection devices may be reduced at the request of the user (see also Annex B).		N
	For motors having single-phase or d.c. power supplies, detection in only one unearthed live conductor is permitted		N
	Where overload protection is achieved by switching off, the switching device shall switch off all live conductors. The switching of the neutral conductor is not necessary for overload protection.		N
	Appropriate protective devices designed to accommodate special duty motors or over-temperature protection (see 7.3.3) can be necessary. (for example, motors for rapid traverse, locking, rapid reversal, sensitive drilling)		N
	For motors that cannot be overloaded (for example torque motors, motion drives that either are protected by mechanical overload protection devices or are adequately dimensioned),overload protection is not required.		N
6.3.3	The provision of motors with over- temperature protection (see IEC60034-11) is recommended in situations where the cooling can be impaired		N
	Depending upon the type of motor, protection under stalled rotor or loss of phase conditions is not always ensured by over- temperature protection, and additional protection should then be provided.		N
	Over-temperature protection is also recommended for motors that cannot be overloaded (for example torque motors, motion drives that are either protected by mechanical overload protection devices or are adequately dimensioned), where the possibility of over-temperature exists (for example due to reduced cooling).		N
6.3.4	Where protection against the effects of overheating in three phase motors is achieved by current limitation, the number of current limitation devices may be reduced from 3 to 2 (see 7.3.2).		N
	For motors having single phase a.c or d.c. power supplies, current limitation in only one unearthed live conductor is permitted.		N
6.4	Abnormal temperature protection:		N
	Resistance heating or similar devices which cause excessive heat, equipped with suitable overtemperature detection	No high temperature during operation	N
6.5	Protection against supply interruption or voltage reduction and subsequent restoration		N
	Undervoltage protection provided for applications where loss of supply or undervoltage causes a hazardous condition	No hazardous if undervoltage.	—

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	If interruption or reduction of supply voltage is allowed for a short period of time, delayed undervoltage protection provided.		P
	Undervoltage protection not impair any stopping control of the machine		—
	Upon restoration of supply voltage, automatic or unexpected restarting of machine prevented	Software system inspection all data correct can be start.	N
	Undervoltage protection to initiate appropriate control responses to ensure co-ordination the groups of machines working together		N
6.6	Motor overspeed protection:		—
	Overspeed protection provided where overspeeding causes a hazardous condition	No motor	N
	Overspeed protection initiates appropriate control response and prevents automatic restarting		N
6.6	Motor overspeed protection:		—
	Overspeed protection provided where overspeeding causes a hazardous condition	No motor	N
	Overspeed protection initiates appropriate control response and prevents automatic restarting		N
6.7	Earth fault / residual current protection:		—
	To reduce damage to equipment due to earth fault currents below detection level, earth fault/residual protect used		N
	Detection level for earth fault protection set as low as possible		N
6.8	Phase sequence protection:		—
	Protection from incorrect phase sequence of supply voltage provided	Single phase	N
6.9	Protection against overvoltages due to lightning strike or switching action:		—
	Protective devices for the suppression of overvoltages caused by lightning strikes or switching surges provided	No SPD	N
	Devices for suppression of overvoltages due to lightning, connected at incoming terminals of the supply disconnecting device		N
	Devices for suppression of overvoltages due to switching surges connected across terminals of all equipment requiring such protection		N
7	**EQUIPOTENTIAL BONDING**		N
7.2.1	General:		—
	All parts of protective bonding circuit capable to withstand max. thermal and mechanical stress, caused by earth-fault currents		N
	Where the conductance of structural parts of the		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	electrical equipment or of the machine is less than that of the smallest protective conductor connected to the exposed conductive parts, a supplementary bonding conductor shall be provided.		
	This supplementary bonding conductor shall have a cross- sectional area not less than half that of the corresponding protective conductor.	At least 1.0mm^2 copper wire	N
	Any structural part of electrical equipment or of a machine used as part of protective bonding circuit		N
	If an IT distribution system is used, the machine structure shall be part of the protective bonding circuit and insulation monitoring shall be provided. See 6.3.3 c).		N
	Conductive structural parts of equipment in accordance with6.3.2.2 need not be connected to the protective bonding circuit.		N
	Extraneous conductive parts which form the structure of the machine need not be connected to the protective bonding circuit where all the equipment provided is in accordance with 6.3.2.2.		N
	Exposed conductive parts of equipment in accordance with6.3.2.3 shall not be connected to the protective bonding circuit.		N
7.2.2	Protective conductors:		--
	Identification and marking of protective conductors acc. to cl.13.2.2		P
	Copper conductors used as protective conductors	copper	P
	Other conductor materials allowed, if cross section of such conductors is not less than 16mm^2		N
	Cross-sectional area of protective conductors determined acc. to IEC60364-5-54, cl. 543 or EN 60439- 1, cl. 7.4.3.1.7, table 4		N
	Relationship between cross- section area of phase conductor and PE acc. to table 1		N
7.2.3	Continuity of protective bonding circuit:		—
	All exposed conductive parts of electrical equipment and machine(s) connected to protective bonding circuit.		N
	In case of removal of parts of PE system, remaining parts not to be interrupted		N
	Current-carrying capacity of connections and bonding points not impaired by mechanical, chemical or electrochemical influences		N
	Particular consideration should be given if enclosure consists of aluminium and its alloys	Not alloys	N
	Metal ducts and cable sheaths not used as protective conductors and not connected to protective bonding circuit		N
	If electrical equipment is mounted on lids, doors or cover plates, continuity of protective bonding circuit ensured		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Continuity of protective conductor ensured at cables which are exposed to damage		N
7.2.4	Exclusions of switching devices from protective bonding circuit:		—
	The protective bonding circuit shall not incorporate a switching device or an overcurrent protective device (for example switch, fuse).		N
	No means of interruption of the protective bonding conductor shall be provided.		N
	Exception: links for test or measurement purposes that cannot be opened without the use of a tool and that are located in an enclosed electrical operating area.		N
	Where the continuity of the protective bonding circuit can be interrupted by means of removable current collectors or plug/socket combinations, the protective bonding circuit shall be interrupted by a first make last break contact.		N
	This also applies to removable or withdrawable plug-in units (see also 13.4.5).		N
7.2.5	Equipment parts that need not to be connected to protective bonding circuit:		—
	Parts which cannot be touched on large surfaces or grasped by hand due to its small size (less than approx. 50 x 50 mm), small parts such as screws, rivets, nameplates or		P
	are located in such way, that either contact with live parts or an insulation failure is unlikely		N
7.2.6	Protective conductor connecting points:		—
	PE conductor connecting points have no other functions and not used for connection of appliances or other parts		N
	Each PE connecting point identified by using the protective earth symbol		N
	Alternatively, terminals for connection of protective conductors identified bicolour combination GREEN-YELLOW or letter PE	Green-yellow	N
7.2.7	Mobile machines		—
	On mobile machines with on- board power supplies, protective circuits, exposed conductive parts connected to a protective bonding terminal		N
	when mobile machines will be connected to an external incoming power supply, protective bonding terminal (PE) fixed to connecting point for the protective conductor.		N
7.2.8	Additional protective bonding requirements for electrical equipment having earth leakage currents higher than 10 mA a.c. or d.c.	leakage currents <10mA	N
	Where electrical equipment has an earth leakage current (for example adjustable speed electrical power drive systems and information technology equipment) that is greater than 10 mA a.c. or d.c. in any incoming supply, one or more of the		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	following conditions for the associated protective bonding circuit shall be satisfied:		
	a) the protective conductor shall have a cross-sectional area of at least 10 mm2 Cu or 16 mm2 Al, through its total run;		N
	b) where the protective conductor has a cross-sectional area of less than 10 mm2 Cu or 16 mm2 Al, a second protective conductor of at least the same cross-sectional area shall be provided up to a point where the protective conductor has a cross-sectional area not less than 10 mm2 Cu or16 mm2 Al.		N
	c) automatic disconnection of the supply in case of loss of continuity of the protective conductor.		N
	In addition, a warning label shall be provided adjacent to the PE terminal, and where necessary on the nameplate of the electrical equipment.		N
	The information provided under 17.2 b)1) shall include information about the leakage current and the minimum cross-sectional area of the external protective conductor.		N
7.3	Functional bonding		—
	Protection against maloperation as a result of insulation failures can be achieved by connecting to a common conductor in accordance with 9.4.3.1.		N
	For recommendations regarding functional bonding to avoid maloperation due to electromagnetic disturbances, see4.4.2.		N
7.4	Measures to limit the effects of high leakage current		—
	The effects of high leakage current can be restricted to the equipment having high leakage current by connection of that equipment to a dedicated supply transformer having separate windings.		N
	The protective bonding circuit shall be connected to exposed conductive parts of the equipment and, in addition, to the secondary winding of the transformer.		N
	The protective conductor(s) between the equipment and the secondary winding of the transformer shall comply with one or more of the arrangements described in 8.2.8.		N
8	**CONTROL CIRCUITS AND CONTROL FUNCTIONS**		—
8.1.1	Control circuits supplied by transformers have separately isolated windings	Switching power supply Comply with IEC 61558-2-16	N
	If several transformers used, secondary voltages in phase		N
	DC- control circuits connected to PE circuit supplied from a separate winding of the control circuit transformer or supplied from another control circuit transformer		N
	Transformers not mandatory for machines with a single motor starter and maximum of two control devices		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
8.1.2	Nominal voltage not exceed 277VAC when supplied from a transformer		N
8.1.3	Control circuits shall be provided with overcurrent protection in accordance with 7.2.4 and 7.2.10.		N
8.2	Control functions:		—
8.2.1	NOTE Subclause 9.2 does not specify requirements for the devices used to implement control functions. Examples of requirements for devices are given in Clause 10.		N
8.2.2	Categories of Stop functions:		—
	Category 0: Stopping by immediate removal of power to machine actuators	Power off, category 0 stop	P
	Category 1: A controlled stop with power available to machine actuators. Then removal of power when stop condition has been achieved.		N
	Category 2: A controlled stop with power left available to machine actuators		N
8.2.3	Operation		P
8.2.3.1	Where a machine has more than one control station, measures shall be provided to ensure that initiation of commands from different control stations do not lead to a hazardous situation.	All door have interlock Software safety inspection	N
8.2.3.2	Start		P
	Start functions shall operate by energizing the relevant circuit.		P
	Start of an operation shall be possible only when all of the relevant safety functions and/or protective measures are in place and are operational.		P
	Where safety functions and/or protective measures cannot be applied for certain operations, manual control of such operations are by hold-to-run controls, together with enabling devices, as appropriate.		P
	In the case of machines requiring the use of more than one control station to initiate a start, each of these control stations shall have a separate manually actuated start control device. The conditions to initiate a start are: - all required conditions for machine operation shall be met and - all start control devices shall be in the released (off) position, then -all start control devices have to be actuated concurrently (see 3.1.7).		N
8.2.3.3	Stop		N
	Stop category 0 and/or stop category 1 and/or stop category	Stop category 0	N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	2 stop functions are provided as indicated by the risk assessment and the functional requirements of the machine (see 4.1).		
	Stop functions shall override related start functions		N
	Where more than one control station is provided, stop commands from any control station is effective when required by the risk assessment of the machine.		N
8.2.3.4	Emergency operations (emergency stop, emergency switching off)		N
8.2.3.4.1	Emergency stop or emergency switching off commands shall be sustained until it is reset.		N
	This reset shall be possible only by a manual action at that locatic where the command has been initiated.		N
	The reset of the command shall not restart the machinery but only permit restarting.		N
	It shall not be possible to restart the machinery until all emergency stop commands are reset.		N
	It shall not be possible to reenergize the machinery until all emergency switching off commands are reset.		N
8.2.3.4.2	The emergency stop does function either as a stop category 0 or as a stop category 1.	Emergency stop switch provided category 0 function	N
	- it shall override all other functions and operations in all modes- shall stop the hazardous motion as quickly as practicable without creating other hazards- a reset shall not initiate a restart		N
8.2.3.4.3	Emergency switching off should be provided where: - Protection against direct contact is achieved only by placing out of reach or by obstacles (see 6.2.6) or-there is the possibility of other hazards or damage caused by electricity	Circuit breaker used as Emergency switching off	N
	Emergency switching off is accomplished by electromechanical switching devices, effecting a stop category 0 of machine actuator connected to this incoming supply		N
8.2.3.5	Operating modes		N
	Where machinery uses several control or operating modes requiring different protective measures and having a different impact on safety, it shall be fitted with a mode selector which can be locked in each position		N
	Another selection method can be used (for example an access code)		N
	Mode selection by itself does not initiate machine operation. A separate actuation of the start control has to be stated by the operator.		N
	Indication of the selected operating mode shall be provided (e.g. the position of a mode selector, the provision of an indicating light, a visual display indication)		N
8.2.3.6	Movement or action that can result in a hazardous situation shall be monitored by providing, for example, overtravel limiters, motor overspeed detection,		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	mechanical overload detection or anti-collision devices		
8.2.3.7	Hold-to-run controls shall require continuous actuation of the control device(s) to achieve operation		N
8.2.3.8	Two-hand controls shall be one of the following types and have the following features		N
	Type I: this type requires: - the provision of two control devices and their concurrent actuation by both hands; - continuous concurrent actuation during the hazardous situation; - machine operation shall cease upon the release		N
	Type II: a Type I control requiring the release of both control devices before machine operation can be reinitiated		N
	Type III: a Type II control requiring concurrent actuation of the control devices as follows: - it shall be necessary to actuate the control devices within a certain time limit of each other, not exceeding 0.5 s - where this time limit is exceeded, both control devices shall be released before machine operation can be initiated		N
8.2.3.9	Enabling control shall be so arranged as to minimize the possibility of defeating, for example by requiring the de-activation of the enabling control device before machine operation may be reinitiated		N
8.2.3.10	Combined start and stop controls: Push-buttons etc. that alternately initiate and stop motion shall only be provided for functions, which cannot result in a hazardous situation.		N
8.2.4	Cableless control system		N
8.2.4.1	The CCS shall have functionality and a response time suitable for the application based on the risk assessment.	No CCS	N
8.2.4.2	The ability of a CCS to control a machine shall be automatically monitored, either continuously or at suitable intervals.		N
	If the communication signal has degraded (e.g., reduced signal level, low battery power) a warning shall be given		N
	When the ability to control a machine has been lost, an automatic stop of the machine shall be initiated.		N
	Its restoration shall not restart the machine.		N
8.2.4.3	Measures shall be taken to prevent the machine from responding to signals other than those from the intended operator control station(s).		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Cableless operator control station(s) shall only control the intended machine(s) and shall affect only the intended machine functions.		N
8.2.4.4	When more than one cableless operator control station is used, then:		—
	- only one control station shall be enabled at a time except as necessary for the operation		N
	- transfer of control shall require a deliberate manual action at the station having control		N
	- transfer shall only be possible if both stations are in the same mode		N
	- a transfer shall not change the mode of operation or function		N
	- on the station that has control, a visual indication shall indicate this		N
8.2.4.5	Portable cableless operator control stations shall be provided with means to prevent unauthorized use		N
	Each machine should have an indication when it is under cableless control		N
	When possible to be connected to several machines, means shall be provided on the portable device to select		N
	Selecting a machine shall not initiate control commands.		N
8.2.4.6	A deliberate disabling shall meet the requirements of 9.2.4.2.		N
	Where disabling without interrupting machine operation is necessary, appropriate means shall be provided to transfer control		N
8.2.4.7	Emergency stop devices on portable cableless operator control stations shall not be the sole means of initiating an emergency stop		N
	Confusion between active and inactive devices shall be avoided		N
8.2.4.8	Restarting of a cableless control shall not result in a reset of an emergency stop condition		N
	The instructions shall state that a reset shall only be performed when it can be seen that the reason has been cleared		N
8.3	Protective interlocks:		—
8.3.1	Reclosing or resetting of an interlocking safeguard not to initiate a machine motion or operation which can produce a hazardous condition	Interlocking safeguard not to initiate a machine	N
8.3.2	Where an operating limit (for example speed, pressure, position) can be exceeded leading to a hazardous situation, means shall be provided to detect when a predetermined limit(s) is exceeded and initiate an appropriate control action.		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
8.3.3	Where non-operation of devices for auxiliary functions causes a hazardous condition, damage to the machine or to the process, appropriate interlocking be provided		N
8.3.4	Interlocks of contactors, relays, etc. between different operations and for opposite motions, interlocks against such incorrect operation provided		N
	Reversing contactors interlocked in such way, that in normal service no short circuit occurs during switching operation		N
	Where, for safety or for continuous operation, certain functions on the machine are required to be interrelated, proper co-ordination ensured by suitable interlocks		N
	For a group of machines working together in a coordinated manner and having more than one controller, provisions made for co- ordination of this controller		N
	If a failure of a mechanical brake actuator can result that the brake, is applied when the associated machine actuator is energised and a hazardous condition results, interlocks be provided to switch off the machine actuator		N
8.3.5	Reverse current breaking on a motor, effective measures taken to avoid motor starting in opposite direction at end of breaking where that reversal causes a hazardous condition, damage to the machine or to the process		N
	Control circuits arranged so, that rotation of a motor shaft, not to result in a hazardous condition		N
8.3.6	Where it is necessary to suspend safety functions and/or protective measures, the control or operating mode selector shall simultaneously		N
	disable all other operating (control) modes		N
	permit operation only by the use of a hold-to-run device or by a similar control device positioned so as to permit sight of the hazardous elements		N
	prevent any operation of hazardous functions by voluntary or involuntary action on the machine's sensors		N
	If these four conditions cannot be fulfilled, the mode selector shall activate other protective measures to ensure a safe intervention zone. In addition, the operator shall be able to control operation of the parts he is working on from the adjustment point.		N
8.4	Control functions in the event of failure:		—
	Measures to reduce those risks include but are not limited to:		—
	protective devices on the machine, (e.g. interlocking guards, trip devices)		P
	protective interlocking of electrical circuit		N
	use of proven circuit techniques and components (see cl. 9.4.2.)		P
	provision of partial or complete redundancy (see cl. 9.4.2.2) or diversity (see cl. 9.4.2.3)		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	provision for functional tests (see cl. 9.4.2.4)		P
	single failures only are to be considered		P
	for higher levels of risks, it may be necessary to ensure, that more than one failure cannot result in a hazardous condition		P
8.4.2	Measures to reduce the risk in case of failure:		—
8.4.2.1	bonding of control circuits to protective circuit for operational purposes (see cl. 9.4.3.1)		P
	connection of control devices in accordance with cl. 9.1.4		P
	stopping by de-energising (see cl.9.2.2)		P
	switching of all live conductors to device being controlled (see cl.9.4.3.1)		P
	use of switching devices having positive (or direct) opening operation (see IEC 60947-5-1)		P
	circuit design to reduce possibility of failures causing undesirable operations		P
8.4.2.2	on-line redundancy for normal operation		N
	off-line redundancy for protective functions, effective only when operating function fails		N
	where off-line redundancy is use, suitable measures taken, to ensure that those control circuits are available when required		N
8.4.2.3	Use of control circuits having different principles of operation or using different types of devices may reduce faults and failures. Examples include:		—
	Combination of normally open and normally closed contacts operated by interlocking guards		N
	Use of different types of circuit components in control circuit		N
	Combination of electromechanical and electronic circuits in redundant configurations		N
	Combination of electrical and non- electrical systems (e.g. mechanical, hydraulic, pneumatic) may perform redundant functions and provide diversity		N
8.4.2.4	Automatic functional test carried out by the control system		N
	Manual function tests by inspection		N
	Tests at start-up and at predetermined intervals or as a		N
	Combination as appropriate (see cl.18.2 and 18.6)		N
8.4.3	Protection against malfunction of control circuits		—
8.4.3.1	Measures shall be provided to reduce the probability that insulation faults on any control circuit can cause malfunction	Method (b)	P
	Methods to meet these requirements include but are not limited to the following:		—
	a) Control circuits, fed by control transformers:		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	The common conductor shall be connected to the protective bonding circuit at the point of supply.		N
	All control elements are to be inserted on the other side of the components		N
	Method b) – Non-earthed control circuits fed by transformers shall either	Switching power supply non-earthed transformer	N
	1) have 2-pole control switches that operate on both conductors; or		N
	2) be provided with a device that interrupts the circuit automatically in the event of an earth fault; or		N
	3) where 2) above would increase the risk, it can be sufficient to provide an insulation monitoring device hat will initiate an acoustic and optical signal		N
8.4.3.1.4	Method c) – Control circuits fed by transformer with an earthed centre-tap winding shall have overcurrent protective devices that break both the conductors		N
	The control switches shall be 2-pole types that operate on both conductors		N
8.4.3.1.5	Method d) – Control circuits not fed by a transformer are only allowed for machines with a maximum of one motor starter and/or maximum of two control devices, in accordance with 9.1.1		N
	Possible cases are:		N
	1) directly connected to an earthed supply system (TN- or TT-system)		N
	If powered between two lines, multi-pole control switches are required		N
	2) directly connected to a supply system that is not earthed or is earthed through a high impedance (IT-system)		N
	A device shall be provided that interrupts the circuit automatically in the event of an earth fault		N
8.4.3.2	Where the loss of memory due to a power failure can result in a hazardous situation, appropriate measures shall be taken	PLC control, memory not loss if power off	N
8.4.3.3	Where the loss of continuity of control circuits depending upon sliding contacts can result in a hazard, appropriate measures shall be taken		N
9	**OPERATOR INTERFACE AND MACHINE-MOUNTED CONTROL DEVICES**		—
9.1.1	Devices to be selected, mounted and identified or coded acc. to IEC61310 and IEC 60447		N
9.1.2	Machine-mounted control devices readily accessible for service and maintenance and		N
	Mounted to minimise possibility of damage from activities such as material handling		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Actuators of hand-operated control devices selected and installed as follows:		—
	Mounted not less than 0.6 m above servicing level, and within easy reach for operator (normal working position)	Control panel highness >0.6m	N
	Placed so that operator is not exposed to a hazardous situation when operating them		N
	Possibility of inadvertent operation is minimised		N
	The actuators of foot-operated control devices shall be selected and installed so that:		—
	– they are within easy reach of the normal working position of the operator;		N
	– the operator is not placed in a hazardous situation when operating them.		N
9.1.3	Degree of protection sufficient for expected use against:		—
	Effects of aggressive liquids, vapours or gases in environment of machine	No such evnironment	N
	Ingress of contaminants		N
	Operator interface control devices have a minimum degree of protection against direct contact of IPXXD	IP21	P
9.1.4	Position sensors arranged so, that they will not be damaged in the event of over travel		P
	Position sensors use in circuits with safety-related functions either have positive opening operation or provide similar reliability		P
9.1.5	Portable or pendant operator control stations and control devices selected or arranged in such wayas to minimise possibility of inadvertent machine operations caused by shocks and vibrations	control station fixe on ground	N
9.2	Push-buttons		P
9.2.1	Push button actuators colour-coded acc. To table 2	Red/yellow for emergency switch Start and stop color is gray	P
9.2.2	Recommendation that push buttons are preferably marked directly on actuator with symbols acc. To table3	words instead of symbol	N
9.3	Indicator lights and displays		N
9.3.1	Indicator lights and displays shall be selected and installed in such a manner as to be visible from the normal position of the operator (see also IEC 61310-1).	Suitable color and flash used	N
	Circuits used for visual or audible devices used to warn persons of an impending hazardous event shall be fitted with facilities to check the operability of these devices		N
9.3.2	Unless otherwise agreed between the supplier and the user (see Annex B), indicator lights shall be colour-coded with respect to the condition (status) of the machine in accordance with Table 4.		N
	Indicating towers on machines should have the	No indicating tower	N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	applicable colours in the following order from the top to down; RED, YELLOW, BLUE, GREEN and WHITE.		
9.3.3	Flashing lights for further information may be used for following purposes:		—
	to attract attention or	Panel button flashing for attrct attention	N
	to request immediate action or		N
	to indicate a discrepancy between command and actual state or		N
	to indicate a change in process(flashing during transition)		N
	higher frequency of flashing lights (pulse/pause ratios) recommended for higher priority of information		N
	Where flashing lights or displays are used to provide higher priority information, audible warning devices should also be provided.		N
9.4	Illuminated push-buttons		N
	Illuminated push-button actuators shall be colour-coded in accordance with Tables 2 and 4.		N
	WHITE colour shall be use, if it is difficult in assigning an appropriate colour		N
	RED colour shall be use, for emergency stop actuators, not depending upon illumination conditions (ON /OFF status) only	emergency stop is red	P
9.5	Rotary control devices		N
	Rotary control devices having a rotational member such as potentiometers and selector switches, mounted in such way as to prevent rotation of stationary member		N
9.6	Start devices		P
	Start devices use to initiate start functions or movement of machine or elements designed and mounted such as to minimise inadvertent operation	Considered	P
	Mushroom - type actuators use for two-hand control devices		N
9.7	Devices for emergency stop:		—
9.7.1	Devices for emergency stop readily accessible		N
	Emergency stop devices shall be provided at each location where the initiation of an emergency stop can be required		N
	In circumstances where confusion can occur between active and inactive emergency stop devices caused by disabling the operator control station, means (for example, information for use) are provided to minimise confusion.		N
9.7.2	Types of devices for emergency stop include following elements:		—
	push-button operated switch or	Push-button emergency stop	P
	pull-cord operated switch or		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	pedal-operated switch without mechanical guard		N
	The devices shall be in accordance with IEC 60947-5-5.		P
9.7.3	Where a stop category 0 is suitable, the supply disconnecting device may serve the function of emergency stop where: – it is readily accessible to the operator; and – it is of the type described in 5.3.2 a), b), c), or d)		P
	Where intended for emergency use, the supply disconnecting device shall meet the colour requirements of 10.2.1		N
9.8	Devices for emergency switching off:		—
9.8.1	Location of emergency switching- off devices normally placed separate from operator control station		N
	Operator control station equipped with separate emergency stop device, since function effects a category 0 emergency stop		N
9.8.2	Types of emergency switching-off devices include:Push-button operated switch or		N
	Pull-cord operated switch		N
	Devices of self-latching type and ensure positive (or direct) opening operation		N
	Push-button operated switch in break-glass enclosure		N
9.8.3	Where the supply disconnecting device is to be locally operated for emergency switching off, it shall be readily accessible and shall meet the colour requirements of 10.2.1		N
9.9	Enabling control device		—
	When an enabling control device is provided as a part of a system, it shall signal the enabling control to allow operation when actuated in one position only. In any other position, operation shall be stopped or prevented.		N
	Enabling control devices shall be selected and arranged so as to minimize the possibility of defeating.		N
	Enabling control devices shall be selected that have the following features:		—
	-Designed in consideration with ergonomic principles		N
	-Requirements for a two-position type:		—
	Position 1: OFF-function of switch(actuator is not operated)		N
	Position 2: enabling function(actuator is operated)		N
	-Requirements for a three-position type:		—
	Position 1: OFF-function of switch, (actuator is not operated)		N
	Position 2: enabling function of switch, (actuator is operated and in its mid position)		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Position 3: OFF-function of switch, (actuator is operated past its mid position)		N
	When returning from position 3 to 2, function not enabled		N
10	**CONTROLGEAR: LOCATION, MOUNTING, AND ENCLOSURES**		—
10.1	All control gear located and mounted so, as to cover the following points:facilitate accessibility and maintain ability		P
	facilitate protection against external influences or operating conditions under which operation is intended		P
	facilitate easy access for operation and maintenance of the machine and its associated equipment		P
10.2	Location and mounting:		—
10.2.1	all control-gear components placed and oriented so, that identification is possible without moving them or the associated wiring		N
	Components checked for correct operation or possible replacement without dismantling other equipment or parts of the machine		N
	Terminals not associated with control gear also to conform to this requirement		N
	Operation and maintenance of all control gear possible from front of cabinet	N	P
	Special tools for removal of electronic devices provided with the equipment	No need special tool	N
	Access for regular maintenance or adjustment to equipment, relevant devices located between0.4m to 2.0 m above servicing level		N
	Terminals located at least 0.2 m above servicing level and placed such, that conductors and cables can be easily connected		N
	No devices mounted on doors, except those for operating, indicating, measuring and cooling purposes on normally removable access-covers of enclosure	No devices mounted on doors	N
	Plug-in type control devices belonging functionally together, their association made clear by type (shape), marking or reference designation single or in combination (see cl. 13.4.5)		N
	Plug-in type control devices, that are handled during normal operation, shall be designed with non-interchangeable characteristics, where lack of such facility can result in malfunctioning		N
	Plug/socket combinations, handled during normal operation, shall be located and mounted so as to provide unobstructed access		N
	If test points are provided, they should be:		—
	mounted so as to provide unobstructed access	No test point	N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	clearly marked to correspond with the documentation (see cl. 17.3)		N
	adequately insulated		N
	sufficiently means spaced for connection of test equipment or		N
10.2.2	Non-electrical parts and devices, not directly associated with the electrical equipment, not located within enclosures containing control gear		N
	Devices such as solenoid valves separated from other electrical equipment	valves separated from other electrical equipment	N
	Control devices mounted at same location and connected to the main supply voltage, or to both main supply and control voltage, are grouped separately from those connected to control voltage only		N
	Terminals separated into groups for:power circuits or		N
	associated control circuits or		N
	other control circuits, fed from external sources		N
	Terminal groups mounted adjacently, providing that each group is readily identified		N
	When arranging the location of devices, clearances and creepage distances specified for them shall be maintained, taking into account external influences or physical conditions of its environment(IEC60664-1)		N
10.2.3	Heat generating components located so, that temperature of each component in its vicinity remains within the permitted limits	No heat generating components	N
10.3	Degrees of protection:		—
	Protection of control gear against ingress of solid foreign objects and liquids shall be adequate. External influences under which the equipment is intended to operate is to be taken into account and is to be	Metal enclosure provided	N
	Its protection sufficient against dust, coolants and swarf		N
	Enclosures of control gear provide a degree of protection of at least IP22		N
	Exceptions:		—
	a) Where an electrical operating area is use as a protective enclosure for an appropriate degree of protection against ingress of solid bodies and liquids	Electrical operating area is in clean house, no water and dust	N
	b) Where removable collectors on collector bar systems are use, and IP22 is not achieved but measures of cl. 6.2.5 are applied		N
10.4	Enclosures doors and openings:		—
10.4	Enclosures to withstand mechanical, electrical and thermal stress as well as effects of humidity during normal service		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Fasteners for doors or covers of captive type		P
	Windows for viewing internally mounted indicating devices, made of material suitable to withstand mechanical stress and chemical attack		P
	Doors of enclosure not wider than0,9 meter	Door width <0.9m	P
	Doors with vertical hinges, preferably lift-off type		N
	Doors with opening angle of at least 95 °		N
	Gaskets of doors, lids, covers and enclosures withstand the chemical effects of aggressive liquids, vapours or gases use on the machine		N
	Means use to maintain degree of protection of an enclosure of doors, lids and covers that require opening or removed for operational or maintenance shall:		—
	be securely attached to either door, cover or enclosure		N
	not deteriorate due to removal or replacement of door or cover and so impair degree of protection		N
	all openings in enclosure closed by supplier(s), ensuring degree of protection specified for equipment		N
	openings for cable entries at enclosure to be easily re-opened on site		N
	suitable opening in base of enclosure within the machine provided, as to enable drainage of moisture due to condensation		N
	no opening between enclosure containing electrical equipment and compartment containing coolant, lubricating or hydraulic fluids	Liquid in water tank with lever sensor	N
	holes in enclosure for mounting purposes not impair required degree of protection		N
	If equipment could attain a surface temperature sufficient to cause a risk of fire during normal or abnormal operation:		—
	located within an enclosure, that can withstand, without risk of fire or harmful effect, the heat emitted by the equipment or	No high temperature risk	N
	mounted and located at sufficient distance from adjacent equipment, so as to allow safe dissipation of heat or		N
	otherwise screened by material that can withstand, without risk of fire or harmful effect, the heat emitted by the equipment		N
10.5	Access to control gear:		—
	Minimum dimensions of doors and corridors for access to electrical operating areas:at least 0.7 meter wide and 2.0 meter high	No such door	N
	Doors open outwards		N
	Doors equipped with means to allow opening from inside without the use of a key or tool		N
	Enclosures which readily allow a person to fully enter shall		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	be provided with means to allow escape, for example panic bolts on the inside of doors.		
	Enclosures intended for such access, for example for resetting, adjusting, maintenance, shall have a clear width of at least 0,7 m and a clear height of at least 2,1 m.		N
	In cases where: –equipment is likely to be live during access; and – conducting parts are exposed,		N
	the clear width shall be at least 1,0 m. In cases where such parts are present on both sides of the access way, the clear width shall be at least 1,5 m.		N
11	**CONDUCTORS AND CABLES**		—
11.1	Conductors and cables selected so as to be suitable for operating conditions and external influences that are existing		P
	Requirements not applicable for integral wiring of assemblies, subassemblies and devices that are manufactured and tested acc. to their relevant standard		P
11.2	Conductors		
	Generally conductors shall be of copper		P
	Where aluminium conductors are used, the cross-sectional area shall be at least 16 mm2.	No aluminium wire	N
	To ensure adequate mechanical strength, the cross-sectional area of conductors should not be less than as shown in Table 5	At least 0,75mm^2	P
	Class 1 and class 2 conductors are primarily intended for use between rigid, non-moving parts.		P
	All conductors that are subject to frequent movement (for example one movement per hour of machine operation) shall have flexible stranding of class 5 or class 6.	No such movement	N
11.3	Insulation		P
	Where insulation of conductors or cables can constitute hazards due to propagation of fire or emission of toxic/ corrosive fumes, guidance from cable supplier to be sought		N
	Special attention to integrity of a circuit having a safety-related function		N
	Special attention to integrity of a circuit having a safety- related function		
	Dielectric strength of insulation adequate for required test voltage with a 5min. of 2000VAC for cables operating with voltages >50VAC or>120 VDC	2000VAC for a test duration of 5 minutes	P
	For separate PELV circuits, dielectric strength adequate for test voltage of 500VAC for a duration of5 minutes	PELV wire, test duration of 5 minutes	P
	The insulation shall be such that it cannot be damaged in operation or during laying, especially for cables pulled into ducts.		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
11.4	Current-carrying capacity in normal service in accordance with table 6.	1.0mm^2 for control circuit No size requirement for signal wire	P
	Or in accordance with suppliers recommendation.		N
11.5	The voltage drop from the point of supply to the load in any power circuit cable shall not exceed 5 % of the nominal voltage under normal operating conditions.	voltage drop of cable less then 5%	P
	In control circuits, the voltage drop shall not reduce the voltage at any device below the manufacturer's specification for that device, taking into account inrush currents.		N
11.6	Flexible cables		P
11.6.1	Flexible cables have cl. 5 or cl. 6 conductors(see table C.4)		P
	cables exposed to severe duties shall be of adequate construction to protect against:		—
	abrasion due to mechanical handling and dragging across rough surfaces	Not use at severe duty	N
	kinking to operation without cable guides		N
	stress resulting from guide rollers and forced guiding, being wound and re-wound on cable drums		N
11.6.2	Cable handling system of machine designed such, as to keep tensile stress of conductors as low as practicable during machine operation		N
	tensile stress for copper conductors not to exceed 15N/mm2 of copper cross section area		N
	where tensile stress of conductors is exceeding 15 N/mm2 , cables of special design are use		N
	maximum stress for flexible cables agreed with the cable manufacturer		N
11.6.3	Cables wound on drums selected such, as the maximum allowable conductor temperature is not exceeded		N
	cables for circular cross-section area, installed on drums, max. current-currying capacity in free air as declared acc. to table 7		N
11.7	Collector wires, collector bars and slip-ring assemblies:		—
	protection by partial insulation of live parts		N
	protection by enclosure or barriers provide a degree of protection of at least IP2X	Enclosure protection IP21	P
	horizontal top surfaces of barriers or enclosures which are readily accessible provide a degree of protection of at least IP4X		N
	if required degree of protection is not achieved, protection by placing live parts out of reach in combination with emergency switching-off acc. to cl. 9.2.5.4.3 applied		N
	collector wires and bares placed such and / or protected as to prevent contact, especially for unprotected wires and bars,	collector wires in the metal cabinet	N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	with conductive items such as, cords of pull- cord switches, strain-relief devices and drive chains and		
	prevent damage from a swinging load		N
11.7.2	Where collector wires, collector bars and slip-ring assemblies are installed as part of the PE-circuit, they do not carry current in normal operation	PE collector wire N collector wire	N
11.7.3	Protective conductors of current collectors have a shape or are designed such, so that they are not interchangeable with other current collectors of the sliding contact type		N
11.7.4	Removable current collectors with disconnector function are designed such, that PE-circuit is interrupted only after live conductors have been disconnected and the continuity of the PE-circuit is re- established before any live conductor is reconnected		N
11.7.5	Clearances between respective conductors and between adjacent systems of collector wires, bars, slip-ring assemblies and their current collectors designed for operation in pollution degree 3 conditions and an overvoltage category III in accordance with IEC60664-1	Clearances comply with IEC60664-1 on wires collector	P
11.7.6	Creepage distances suitable for operation in pollution degree 3	Pollution degree 2	N
	In abnormally dusty, moist or corrosive environments, following creepage distances apply:		—
	for unprotected collector wires, bars and slip-ring assemblies equipped with insulators, the minimum creepage distance is 60 mm		N
	for enclosed collector wires, insulated multipole collector bars and insulated individual collector bars, the minimum creepage distance is 30 mm		N
	gradual reduction of insulation values due to unfavourable ambient conditions regarded		N
11.7.7	Suitable design measures taken, in order to prevent energisation of adjacent sections by current collectors themselves		N
11.7.8	Collector wires, collector bar systems and slip-ring assemblies use for power circuits kept separately from those use for control circuit applications		N
	above systems capable of withstanding without damage to mechanical forces and thermal effects of short circuit currents		N
	removable covers to above systems, laid underground or under floor, designed that they cannot be opened by one person without the use of a tool		N
	collector bars which are installed in a common metal enclosure, the individual section of it bonded together and earthed at several points depending upon their length		N
	Metal covers of collector bars laid underground or under floor, bonded together end earthed		N
	Underground and under floor collector bar ducts have		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	drainage facilities		
12	WIRING PRACTICES		—
12.1.1	All connections, especially those of the protective bonding circuit, secured against accidental loosening		P
	Means of connection suitable for cross-sectional areas and nature of conductors being terminated		P
	Connection of two or more conductors to one terminal only where terminal is designed for that purpose		N
	Only one PE-conductor connected to one terminal connecting point		P
	Soldered connections only, where terminals are provided which are suitable for soldering connections		N
	Terminals on terminal blocks plainly identified to correspond with markings on wiring diagrams		P
	Installation of flexible conduits and cables such, that liquids are drained away from fittings and joints		P
	Means to retain stranded conductors together when terminating conductors at terminals/ devices provided		P
	Solder not use for that purpose		N
	Shielded conductors terminated so, as to prevent fraying of strands and to permit easy disconnection		N
	Identification tags legible, permanent and appropriate for physical environment		P
	Terminal blocks mounted and wired so, that internal and external wiring does not cross over terminals		P
12.1.2	Conductors and cables shall be run from terminal to terminal without splices or joints		P
	Connections using plug/socket combinations with suitable protection against accidental disconnection are not considered to be splices or joints for the purpose of this subclause		P
	Exceptions are possible as described		N
	Terminations of cables shall be adequately supported to prevent mechanical stresses at the terminations of the conductors		P
	Protective conductor shall be placed close to the associated live conductors in order to decrease the impedance of the loop		P
	Conductors and cables shall be run from terminal to terminal without splices or joints		P
12.1.3	Conductors of different circuits		P
	Conductors of different circuits laid side by side and occupy the same duct or be in same multiconductor cable, provided that such arrangement does not impair proper functioning of respective circuits		P
	Where circuits operate at different voltage levels,		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	conductors separated by suitable barriers or insulated for maximum voltage to which any conductor within the same duct is subjected		
12.1.4	Conductors of AC circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit, including the protective conductor of each circuit, are contained in the same enclosure		N
	Single-core cables armoured with steel wire or steel tape should not be used for AC circuits		N
12.1.5	The cable between the pick-up and the pick-up converter as specified by the manufacturer of the inductive power supply shall be:		N
	– as short as practicable;		N
	– adequately protected against mechanical damage.		N
12.2	Identification of conductors:		—
12.2.1	Conductors identifiable at each termination point acc. to technical documentation(see Clause 17).		P
	It is recommended (for example to facilitate maintenance) that conductors be identified by number, alphanumeric, colour (either solid or with one or more stripes), or a combination of colour and numbers or alphanumeric.		P
	When numbers are used, they shall be Arabic; letters shall be Roman (either upper or lower case).		P
12.2.2	Protective conductor readily distinguishable by shape, location, marking or colour		P
	Bicolour combination GREEN-AND- YELLOW use throughout the length of the conductor	GREEN-AND- YELLOW use throughout the length	P
	For insulated conductors, the bicolour combination GREEN- AND-YELLOW shall be such that on any 15 mm length, one of the colours covers at least 30 % and not more than 70 % of the surface of the conductor, the other colour covering the remainder of the surface.		N
	This colour identification is strictly reserved for the protective conductor, so that it can be easily identified by its shape		N
	Ends or accessible positions of a protective conductor clearly identified by graphical symbol or by bicolour combination GREEN-AND- YELLOW		N
12.2.3	Where a circuit includes a neutral conductor identified by colour, the colour is LGHT BLUE	N wire use light blue	N
	LIGHT BLUE must not be use for identification of any other conductor where confusion is possible		N
	Where bare conductors are use as neutral conductors and identification by colour is use, they either be coloured by LIGHT BLUE stripes, 15 to 100 mm wide in each compartment or unit, or at each accessible position		N
	Bare conductor colour coloured LIGHT BLUE over its full		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	length		
12.2.4	Where colour-coding is used, BLACK, BROWN, RED, ORANGE, YELLOW, GREEN, BLUE (including LIGHT BLUE), VIOLET, GREY, WHITE, PINK, TURQUOISE may be used	Each wire indicated by letter	N
	GREEN and YELLOW should not be used where there is a possibility of confusion with the bicolour combination GREEN-AND-YELLOW		N
12.3	Wiring inside enclosures		N
	Conductors inside enclosures shall be supported where necessary	All conduct inside trunking system	N
	Non-metallic supports shall be made with a flame-retardant insulating material (see IEC 60332 series)		N
	Connections to devices mounted on doors or to other movable parts shall be made using flexible conductors in accordance with 12.2 and 12.6.		N
	Conductors and cables that do not run in ducts shall be adequately supported		N
12.4	Wiring outside enclosures:		—
12.4.1	Conductors of a circuit shall not be distributed over different multi-core cables, conduits, etc.		N
12.4.2	External ducts		N
	Conductors and their connections external to the electrical equipment shall be placed in suitable ducts (see cl.13.5) Exceptions: --Cables with special suitable protection. -Position switches or proximity switches supplied with a dedicated cable which is sufficiently short	Cables with PVC protection	N
12.4.3	Connections to moving parts shall take into account the foreseeable frequency of movement and shall be made using conductors in accordance with 12.2 and 12.6		N
	The bending radius of the cable shall be at least 10 times the diameter of the cable		N
	Flexible cables of machines shall be so installed or protected as to minimize the possibility of external damage (run over, forces, rubbing, heat, etc.)		N
	Cables close to moving parts, shall maintain a space of at least 25 mm between the moving parts and the cables or barriers are provided		N
	Cable handling systems: Lateral cable angles not exceeding 5°at being wound on and off cable drums or approaching and leaving cable guidance devices. The bending radius shall be in accordance with Table 8		N
	Flexible conduit shall not be used for connections subject to rapid or frequent movements except when specifically designed for that purpose		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
12.4.4	Where several machine-mounted devices are connected in series or in parallel, it is recommended that the connections between those devices be made through terminals forming intermediate test points		N
12.4.5	Plug/socket combinations	No plug/socket	N
	Components or devices inside an enclosure, terminated by fixed plug/socket combinations (no flexible cable), or components connected to a bus system by a plug/socket combination, are excluded		N
	Where the plug/socket contains a contact for the protective bonding circuit, it shall have a first make last break contact (see also 8.2.4).		N
	Plug/socket combinations intended to be connected or disconnected during load conditions shall have sufficient load-breaking capacity		N
	Where the plug/socket combination is rated at 30 A, or greater, it shall be interlocked		N
	Plug/socket combinations that are rated at more than 16 A shall have a retaining means to prevent unintended or accidental disconnection.		N
	Where an unintended or accidental disconnection of plug/socket combinations can cause a hazardous situation, they shall have a retaining means.		N
	The installation of plug/ socket combinations shall fulfil the following requirements as applicable:		N
	a) The component which remains live after disconnection shall have a degree of protection of at least IP2X or IPXXB		N
	b) Metallic housings of plug/ socket combinations shall be connected to the protective bonding circuit		N
	c) Plug/ socket combinations intended to carry power loads but not to be disconnected during load conditions shall have a retaining means to prevent unintended or accidental disconnection and shall be clearly marked accordingly		N
	d) Where more than one plug/socket combination is provided in the same electrical equipment, the associated combinations shall be clearly identifiable. Mechanical coding is recommended		N
	e) Plug/ socket combinations used in control circuits shall fulfil the applicable requirements of IEC 61984. Exception: combinations in accordance with IEC 60309- 1, only those contacts shall be used for control circuits which are intended for those purposes. This exception does not apply to control circuits using high frequency signals superimposed on the power circuits.		N
12.4.6	Dismantling for shipment		P
	If wiring needs to be disconnected for shipment, terminals or plug/socket combinations are provided at the disconnecting points		P
12.4.7	Additional wiring for maintenance or repair purposes provided		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
12.5	Ducts, connection boxes and other boxes:		—
12.5.1	Ducts shall provide a degree of protection suitable for the application (see IEC 60529).	No such duct	N
	All sharp edges, flash, burrs, rough surfaces or threads which the insulation of conductors may come into contact, removed from ducts and conduits		N
	In order to avoid confusion between conduits for electrical installation and those for oil, water or air, either physically separated or suitably identified		N
	Ducts or cable trays rigidly supported and positioned at sufficient distance from moving parts		N
	Ducts or cable trays mounted at least 2 meters above the working surface in areas where human passage is required		N
	Ducts provided only for mechanical protection (see cl. 8.2.3)		N
	Cable trays which are partially covered, not to serve as cable trays or installation trunking		N
	Conductors and cables suitable for installation in cable trays		N
12.5.2	Cable trays dimensioned or located such, as to enable easy access for installation of additional conductors and cables		N
	Consideration given on percentage of filling of such ducts.		N
12.5.3	Rigid metal conduits or trays consist of galvanised steel or corrosion-resistant material, suitable for the environmental conditions.		N
	Application of cable trays of different metal avoided, due to electrolytic corrosion		N
	Installation conduits secured, held in place and supported at each end		N
	Joints and fittings compatible with conduits and appropriate for its application		N
	Conduit-bends fabricated such, as to avoid damage or reduction of internal cross-section		N
12.5.4	Flexible metallic conduits and fittings consist of flexible metal tubing or wire mesh armour.		N
	They are suitable for its application and environmental conditions		N
13.5.5	Flexible non-metallic conduits are resistant to buckling and with similar characteristics as the sheath of multicore cables	Flexible non-metallic conduits are resistant to buckling	P
	They shall be suitable for its application and environmental conditions		N
	Joints and fittings compatible with conduits and appropriate for its application		N
12.5.6	Cable trunking systems outside of enclosures are rigidly supported and kept clear of moving and contaminating parts	All cable trunking systems	N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	of the machine	inside of enclosures	
	Covers of cable trunking designed such, as to overlap at both sides of cable trunking(see cl. 14.5.6)		N
12.5.7	Installation of cables layed in cable trays with covers permitted within the machine-foundations, providing that they are completely closed and separated from coolant and lubrication systems(see cl. 14.5.6)		N
12.5.8	Cable connection boxes and junction boxes use for wiring purposes are readily accessible for maintenance (see cl. 12.3)		N
	provide protection against ingress of solids or liquids, taking into account external influences during operation of the machine (see cl. 12.3)		N
	Junction boxes not have openings for cable entries and are designed so, as to avoid ingress of entrained dust, lubricants and coolant		N
12.5.9	Motor terminal boxes use for motor cable connection and for devices attached to the motor		N
13	**ELECTRIC MOTORS AND ASSOCIATED EQUIPMENT**		—
13.1	Electric motors are conform to EN60034-1	Only fan, no motor	N
	Electric motors and associated equipment protected against following risks:		—
	overcurrent (see cl. 7.2)		N
	thermal overload (see cl. 7.3)		N
	overspeed (see cl. 7.6)		N
	Compliance ensured with the requirements stated (see clauses5.3, 5.4, 5.5, 7.5, 7.6 and 9.4)		N
	Motor control equipment located and mounted acc. to cl. 12		N
13.2	Selection of motor enclosure recommended acc. to EN 60034-5		N
	Degree of protection at least IP23		N
	Incorporated motors mounted such, as to provide adequate protection against mechanical damage		N
13.3	Dimensions of motors conform to those given in IEC regulations(see EN 60072-1 and EN 60072-2)		N
13.4	Each motor with associated coupling, belt, pulley or chain mounted such, as to provide adequate protection and easy access for inspection, maintenance, adjustment or alignment, lubrication and replacement		N
	Motors mounted such, as to allow easy access to all terminal boxes		N
	Motors mounted such, as to ensure proper cooling Temperature rise to be within limits of relevant insulation class		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	Temperature rise within limits of relevant insulation class		N
	If possible, motor compartments stay clean and dry and when required, ventilated directly to the outside of the machine		N
	Motor-vents at an acceptable level and designed such, as to avoid ingress of swarf, dust or water spray		N
	No opening between motor compartment and any other compartment, which does not fulfil the requirement for motor compartments		N
13.5	Electric motors selected acc. to service and environmental conditions		N
	Design criteria for evaluation include: type of motor and		N
	type of duty cycle (see IEC 60034-1) and		N
	fixed speed or variable speed operation and		N
	mechanical vibrations and		N
	type of converter for motor speed control and		N
	influence of the harmonic spectrum of voltage and/or current when supplied from static converter on the temperature rise and		N
	method of starting and possible influence of inrush current		N
	variation of counter torque load with time and speed		N
	influence of loads with large inertia and		N
	influence of constant torque or constant power operation and		N
	possible need of inductive reactors between motor and converter		N
13.6	Operation of overload or overcurrent protective devices for mechanical brake-actuators initiate simultaneous de-energisation(release) of associated machine actuators		N
14	**ACCESSORIES AND LIGHTING**		—
	No accessories and lighting		—
14.1	Where the machine or its associated equipment is provided with socket-outlets for auxiliary equipment, the following will apply:		—
	socket-outlets are conform to regulations	No socket-outlet	N
	if not possible, they are clearly marked with voltage and current ratings		N
	continuity of protective bonding circuit to be ensured		N
	all unearthed conductors connected to socket-outlets, protected against overcurrent		N
	when required, protection against overload in accordance with cl. 7.2 and cl. 7.3 separately from protection of other circuits		N
	if power supply to socket-outlets is not disconnected, than requirements of cl.5.3.5 apply		N

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
14.2.1	Connection to PE-circuit acc. to cl.8.2.2		N
	ON-OFF switch not incorporated in lamp holder or in flexible connecting cord		N
	Stroboscopic effects from lights avoided		N
	If fixed lighting is provided in an enclosure, electromagnetic compatibility (EMC) taken into account		N
	Application of EMC requirements acc. to principles stated in cl. 4.4.2		N
14.2.2	Nominal voltage of local lighting circuits not exceeding 50 V		N
	If higher voltages are applied, value not exceeding 250 V between conductors	Voltage Less than 250V	N
	Lighting circuits supplied from one of the following sources:		—
	from a dedicated isolating transformer connected to load side or		N
	overcurrent protection provided in secondary circuit or		N
	a dedicated isolating transformer connected to line side provided or		N
	source permitted for maintenance purpose or		N
	lighting circuits placed in control enclosures only or		N
	overcurrent protection provided in secondary circuit or		N
	from a machine-circuit with dedicated overcurrent protection or		N
	from an isolating transformer connected to line side of supply disconnecting device, when a dedicated primary disconnecting means and a secondary overcurrent protection are provided or		N
	for an externally supplied lighting circuit, which is only permitted in a control enclosures		N
	where fixed lighting is out of reach for operator during normal operations, provisions of this subclause do not apply		N
14.2.3	local lighting circuits protected		N
14.2.4	adjustable lighting fittings suitable for the physical environment provided		N
	lampholders in accordance with relevant IEC-publications and		N
	designed of an insulating material protecting the lamp cap, as to prevent unintentional contact		N
	reflectors supported by a bracket and not by the lampholder		N
	where fixed lighting is out of reach for operator during normal operations, provisions of this subclause do not apply		N
15	**MARKING, WARNING SIGNS AND REFERENCE DESIGNATIONS**		—

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
15.1	Warning signs, nameplates, markings- and identification plates of sufficient durability to withstand the physical environment involved		P
15.2	Warning signs		P
15.2.1	Enclosures that do not otherwise clearly show that they contain electrical shall be marked with the graphical symbol ISO 7010-W012 	Symbol marked on outer enclosure	P
	It may be omitted (see also 6.2.2 b)) for: – an enclosure equipped with a supply disconnecting device – an operator- machine interface or control station – a single device with its own enclosure (for example position sensor)		P
15.2.2	Hot surfaces hazard		N
	Where the risk assessment shows the need to warn against the possibility of hazardous surface temperatures, the graphical symbol ISO 7010-W017 shall be used 	No hot surface	N
15.3	Control devices and visual indicators, shall be clearly and durably marked with regard to their functions		P
15.4	The following information shall be legibly and durably marked - plainly visible after installation on enclosures that receive incoming power supplies: • name or trade mark of supplier • certification mark or other marking where applicable • type designation or model, where applicable • serial number where applicable • main document number (see IEC 62023) where applicable • rated voltage, number of phases and frequency (if AC), and full-load current for each incoming supply It is recommended that this information is provided adjacent to the main incoming supply(ies)	See marking plate(page 6)	P
15.5	All enclosures, assemblies, control devices, and components shall be plainly identified with the same reference designation as shown in the technical documentation		P
16	**TECHNICAL DOCUMENTATION**		P
16.1	The information necessary for identification, transport, installation, use, maintenance, decommissioning and disposal of the electrical equipment shall be supplied		P
	Annex I should be considered as guidance for the preparation of information and documents		P
16.2	Information provided with electrical equipment		—
	The following shall be supplied:		—
	a) where more than one document is provided, a main document for the electrical equipment		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	as a whole, listing the complementary documents		
	b) identification of the electrical equipment		P
	c) information on installation and mounting including: • a description of installation and mounting, and its connection to the electrical and other supplies • short-circuit current rating for each incoming power supply • rated voltage, number of phases and frequency (if AC.), type of distribution system (TT, TN, IT) and full- load current for each incoming supply • any additional electrical supply(ies) requirements (for example maximum supply source impedance, leakage current) for each incoming supply • space required for servicing • installation requirements regarding cooling • environmental limitations (for example lighting, vibration, EMC environment, atmospheric contaminants) • functional limitations (for example peak starting currents and permitted voltage drops) • precautions to be taken for the installation regarding electromagnetic compatibility		P
	d) an instruction for the connection of conductive-parts in the vicinity of the machine to the protective bonding circuit: • metallic pipes • fences • ladders • handrails	No such parts	N
	e) information on the functioning and operation as applicable: • an overview of the structure of the electrical equipment • procedures for programming or configuring • procedures for restarting after an unexpected stop • a sequence of operation		P
	f) information on maintenance, as appropriate: • frequency and method of functional testing • instructions for safe maintenance and where necessary suspend a safety function and/or protective measure (see 9.3.6) • guidance on the adjustment, repair, and frequency and method of preventive maintenance • details of the interconnections subject to replacement • required special devices or tools; • spare parts; • possible residual risks, indication of particular training and specification of personal protective equipment • instructions to restrict availability of keys or too(s to		P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	skilled or instructed persons • settings (DIP-switches, programmable parameter values, etc); • information for validation of safety related control functions after repair or modification, and for periodic testing where necessary;		
	g) information on handling, transportation and storage		P
	h) information for proper disassembly and handling of components		N
17	**TESTING AND VERIFICATION**		—
17.1	The extent of verification will be given in the dedicated product standard for a particular machine. Where there is no such standard, the verifications shall always include the items a), b), c) and h) and may include one or more of the items d) to g): a) verification that the electrical equipment complies with its technical documentation b) verification of continuity of the protective bonding circuit (Test 1 of 18.2.2) c) in case of fault protection by automatic disconnection of supply, conditions shall be verified according to 18.2; d) insulation resistance test (see 18.3) e) voltage test (see 18.4) f) protection against residual voltage (see 18.5) g) verification that the relevant requirements of 8.2.6 are met h) functional tests (see 18.6)		P
	The results of the verification shall be documented		P
17.2	Verification of conditions for protection by automatic disconnection of supply	P	18.2
17.2.1	Test 1 verifies the continuity of the protective bonding circuit. Test 2 verifies the conditions for protection by automatic disconnection of the supply in TN systems For TN-systems, those test methods are described in 18.2.2 and 18.2.3; their application for different conditions of supply are specified in 18.2.4 For TT systems, see Clause A.2 For IT systems, see IEC 60364-6		P
	Where RCDs are used in the electrical equipment, their function shall be verified in accordance with the manufacturer's instructions. The test procedure and test interval shall be specified in the maintenance instructions		P
17.2.2	Test 1: Verification of the continuity of the protective bonding circuit		P
	Test 1 verifies the continuity of the protective bonding circuit.		P
	The resistance between the PE terminal (see 5.2 and Figure 4) and relevant points that are part of the protective bonding circuit shall be measured with a current between 0.2 A and approximately 10 A derived	See appended table	P

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	from an electrically separated supply source having a maximum no-load voltage of 24 V		
	The resistance measured shall be in the expected range		P
17.2.3	Test 2: Fault loop impedance verification and suitability of the associated overcurrent protective device		P
	The connections of each power supply including the connection of the associated protective conductor to the PE terminal of the machine, shall be verified by inspection		P
	The conditions for the protection by automatic disconnection of supply in accordance with 6.3.3 and Annex A shall be verified by both		P
	a) verification of the fault loop impedance by - calculation, or - measurement in accordance with A.4, and		P
	b) confirmation that the setting and characteristics of the associated overcurrent protective device are in accordance with the requirements of Annex A, and		N
	Where a power drive system (PDS) is used, confirmation that the setting and characteristics of the protective device(s) are in accordance with the converter manufacturer's and protective device manufacturer's instructions		N
17.2.4	Application of the test methods for TN-systems		P
	When Test 2 of 18.2.3 is carried out by measurement, it shall always be preceded by Test 1 of 18.2.2		P
	The tests that are necessary for machines of different status are specified in Table 9		P
17.3	Insulation resistance tests (optional)		P
	When insulation resistance tests are performed, the insulation resistance measured at 500 V DC between the power circuit conductors and the protective bonding circuit shall be not less than 1 MΩ	>1 MΩ	P
	If the electrical equipment of the machine contains surge protection devices which are likely to operate during the test, it is permitted to either: – disconnect these devices, or – reduce the test voltage to a value lower than the voltage protection level of the surge protection devices		P
17.4	Voltage tests (optional)		P
	The test voltage shall be at a nominal frequency of 50 Hz or 60 Hz.		P
	The maximum test voltage shall have a value of twice the rated supply voltage of the equipment or 1 000 V, whichever is the greater		P
	The test voltage shall be applied between the power circuit		—

EN IEC 62368-1:2018, IEC 60076-2:2011, IEC 60076-3:2013, IEC 60076-5:2006, IEC 60076-7:2018, IEC 60076-10:2016, IEC 60076-11:2022, IEC 60076-14:2013, IEC 60076-16:2018, IEC 60076-20:2018			
Clause	Requirement + Test	Result - Remark	Verdict
	conductors and the protective bonding circuit for at least 1 s		
	Components and devices that are not rated to withstand the test voltage and surge protection devices shall be disconnected		P
17.5	Protection against residual voltages		P
	Where appropriate, tests shall be performed to ensure compliance with 6.2.4		P
17.6	Functional tests		
	The functions of electrical equipment shall be tested		P
17.7	Retesting		
	Where a portion of the machine or its associated equipment is changed or modified, the need for re-verification and testing of the electrical equipment shall be considered		N

1. Risk assessment

This risk assessment report is based on the methods in the EN ISO 12100:2010 and EN ISO 14121-2 standards, and the 4 factors S-A-G-W have been used for evaluating the level of risks.

S：Severity of possible harm

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

A：Frequency any duration of exposure

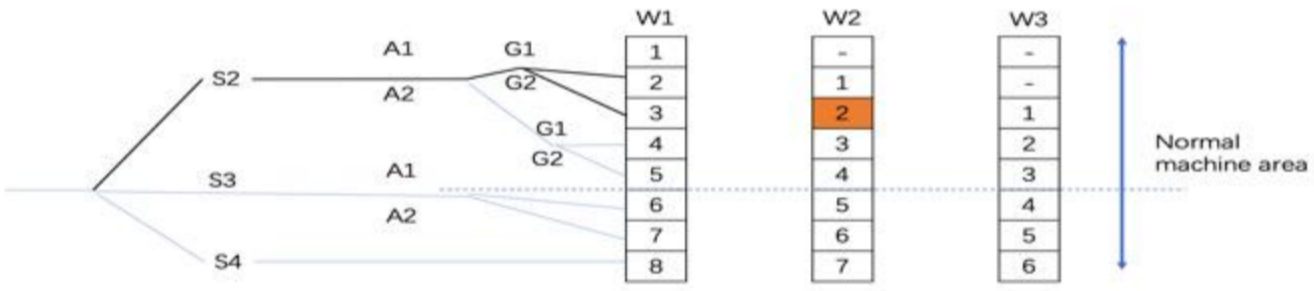
- A1：Seldom to very often
- A2：Frequent to continuous

G：Possibilities of avoidance

- G1：Possible
- G2：Impossible

W：Probability of occurrence of harm

- W1：Low
- W2：Medium
- W3：High



Solutions for the level of hazards

1：Protected by warning sign

2：Protected by guard and warning sign

3：Consider the other design, choose the best one, add both guard and warning sign

4：Consider another two design, choose the best one, add both guard and warning sign

5：Consider another three design, choose the best one, add both guard and warning sign

NO.	Hazards source	S	A	G	W	Level
Mechanical hazards						
1.0-1	Mechanical hazards due to machine parts or work pieces					
1.0-2	Mechanical hazards due to accumulation of energy inside the machinery					
1.1	Crushing					
1.2	Shearing					
1.3	Cutting or severing					
1.4	Entanglement					
1.5	Drawing-in or trapping					
1.6	Impact					
1.7	Stabbing or puncture					
1.8	Friction or abrasion					
1.9	High pressure fluid injection or ejection					
Electrical hazards						
2.1	Contact with live parts					
2.2	Contact with parts which have become live under faulty conditions	***1***	***1***	***1***	***1***	***1***
2.3	Approach to live part under high voltage					
2.4	Electrostatic phenomena					
2.5	Thermal radiation or other phenomena such as projection of molten particles and chemical effects form short-circuits, overloads etc.					
Thermal hazards						
3.1	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources					
3.2	Damage to health by hot or cold working environment					
Hazards generated by noise						
4.1	Hearing loss (deafness), other physiological disorders					
4.2	Interference with speech communication, acoustic signals, etc.					
Hazards generated by vibration						
5.1	Use of hand-help machines resulting in a variety of neurological and vascular disorder					
5.2	Whole body vibration, particular when combined with poor postures					
Hazards generated by radiation						
6.1	Low frequency, radio frequency radiation, microwaves					
6.2	Infrared, visible and ultraviolet light					
6.3	X and gamma rays					
6.4	Alpha, beta rays, electron or ion beams, neutrons					
6.5	Lasers					

Hazards generated by materials and substances processed or used by the machinery						
7.1	Hazards from contact with or inhalation of harmful fluids, gases, mists, fumes and dusts					
7.2	Fire and explosion hazard					
7.3	Biological and micro-biological (viral or bacterial) hazards					
Hazards generated by neglecting ergonomic principles in machine design						
8.1	Unhealthy postures or excessive effort					
8.2	Inadequate consideration of hand-arm or foot-leg anatomy					
8.3	Neglected use of personal protection equipment					
8.4	Inadequate local lighting					
8.5	Mental overload or underload, stress					
8.6	Human error, human behavior	***1***	***1***	***1***	***1***	***1***
8.7	Inadequate design, location or identification of manual controls					
8.8	Inadequate design, location or identification of manual controls					
Combination of hazards						
9	Combination of hazards					
Unexpected start-up, unexpected overrun/over-speed						
10.1	Failure/disorder of the control system					
10.2	Restoration of energy on supply after an interruption					
10.3	External influences on electrical equipment					
10.4	Other external influences (gravity, wind, etc.)					
10.5	Errors in the software					
10.6	Error made by the operator (due to mismatch of machinery with human characteristics and abilities, see 8.6)					
Impossibility of stopping the machine in the best possible conditions						
11	Impossibility of stopping the machine in the best possible conditions					
Variations in the rotational speed of tools						
12	Variations in the rotational speed of tools					
Failure of the power supply						
13	Failure of the power supply					
Failure of the control circuit						
14	Failure of the control circuit					
Errors of fitting						
15	Errors of fitting					
Break-up during operation						
16	Break-up during operation					
Falling or ejected objects or fluids						
17	Falling or ejected objects or fluids					

Loss of stability / overturning of machinery						
18	Loss of stability / overturning of machinery					
Slip, trip and fall of persons (related to machinery)						
19	Slip, trip and fall of persons(related to machinery)					
Additional hazards, hazardous situations and hazardous events due to mobility						
20	Relating to the traveling function					
20.1	Movement when starting the engine					
20.2	Movement without a driver at the driving position					
20.3	Movement without all parts in a safe position					
20.4	Excessive speed of pedestrian controlled machinery					
20.5	Excessive oscillations when moving					
20.6	Insufficient ability of machinery to be slowed down, stopped and immobilisated					
Linked to the work position (including driving station) on the machine						
21.1	Fall of persons during access to (or at/from) the work position					
21.2	Exhaust gases/lack of oxygen at the work position					
21.3	Fire（flammability of the cab, lack of extinguishing means）					
21.4	Mechanical hazards at the work position: contact with the wheels; rollover; fall of objects, penetration by objects; break-up of parts rotation at high speed; contact of persons with machine parts or tools（pedestrian controlled machines）					
21.5	Insufficient visibility form the work positions					
21.6	Inadequate lighting					
21.7	Inadequate seating					
21.8	Noise at the work position					
21.9	Vibration at the work position					
21.1	Insufficient means for evacuation/emergency exit					
Due to the control system						
22.1	Inadequate location of manual controls					
22.2	Inadequate design of manual controls and their mode of operation					
Form handling the machine (lack of stability)						
23	Form handling the machine（lack of stability）					

Due to the power source and to the transmission of power						
24.1	Hazards form the engine and the batteries					
24.2	Hazards form the transmission of power between machines					
24.3	Hazards form coupling and towing					
Form/to third persons						
25.1	Unauthorized start-up/use					
25.2	Drift of a part away from its stopping position					
25.3	Lack or inadequacy of visual or acoustic warning means					
Insufficient instructions for the driver/operator						
26	Insufficient instructions for the driver/operator					
Additional hazards, hazardous situations and hazardous events due to lifting						
27	Mechanical hazards and hazardous events					
27.1	Form load falls, collisions, machine tipping caused by:					
27.1.1	Lack of stability					
27.1.2	Uncontrolled loading-overloading-overturning moments exceeded					
27.1.3	Uncontrolled amplitude of movements					
27.1.4	Unexpected/unintended movement of loads					
27.1.5	Inadequate holding devices/accessories					
27.1.6	Collision of more then one machine					
27.2	Form access of persons to load support					
27.3	Form derailment					
27.4	Form insufficient mechanical strength of parts					
27.5	Form inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine					
27.6	Form inadequate selection of chains, ropes, lifting and accessories and their inadequate integration into the machine					
27.7	Form lowering of the load under the control of friction brake					
27.8	Form abnormal conditions of assembly/testing/use/maintenance					
27.9	Form the effect of load on persons (impact by load or counterweight)					
Electrical hazards						
28.1	Form lightning					
Hazards generated by neglecting ergonomic principles						
29.1	Insufficient visibility from the driving position					

Additional hazards, hazardous and situations and hazardous events due to underground work						
30	Mechanical hazards and hazardous events due to:					
30.1	Lack of stability of powered roof supports					
30.2	Failing accelerator or brake control of machinery running on rails					
30.3	Failing or lack of dead man's control of machinery running on rails					
31	Restricted movement of persons					
32	Fire and explosion					
33	Emission of dust, gases etc.					
Additional hazards, hazardous situations and hazardous events due to the lifting or moving of persons						
34	Mechanical hazards and hazardous events due to:					
34.1	Inadequate mechanical strength-inadequate working coefficients					
34.2	Failing of loading control					
34.3	Failing of controls in person carrier (function, priority)					
34.4	Over speed of person carrier					
35	Falling of person from person carrier					
36	Falling or overturning of person carrier					
37	Human error, human behavior					

NO.	**Hazards source**	**S**	**A**	**G**	**W**	**Level**
2.2	Contact with parts which have become live under faulty conditions	***1***	***1***	***1***	***1***	***1***
Where	*The moving part of the machine*					
When	*The machine is working*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Affixing suitable warning signs. *2. Only operation by training/authorized persons.* *3. Operation of the machine shall conform to the instructions of the instruction manual.*		***1***	***1***	***1***	***1***	***1***

NO.	**Hazards source**	**S**	**A**	**G**	**W**	**Level**
8.6	Human error, human behavior	***1***	***1***	***1***	***1***	***1***
Where	*The tools*					
When	*The machine is working*					
Improvement result						
Method		**S**	**A**	**G**	**W**	**Level**
1. Affixing suitable warning signs. *2. Only operation by training/authorized persons.* *3. Operation of the machine shall conform to the instructions of the instruction manual.*		***1***	***1***	***1***	***1***	***1***

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6 Risk reduction			
	The objective of risk reduction can be achieved by the elimination of hazards, or by separately or simultaneously reducing each of the two elements that determine the associated risk: —severity of harm from the hazard under consideration; —probability of occurrence of that harm. All protective measures intended for reaching this objective shall be applied in the following sequence, referred to as the three-step method (see also Figures 1 and 2). **Step 1: Inherently safe design measures** **Step 2: Safeguarding and/or complementary protective measures** **Step 3: Information for use**		P
6.2	**Inherently safe design measures**		
6.2.1	**General**		
	Inherently safe design measures are the first and most important step in the risk reduction process. 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. 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**		
6.2.2.1	**Geometrical factors**		
	Such factors include the following. a)The form of machinery is designed to maximize direct visibility of the working areas and hazard zones from the control position —reducing blind spots, for example —and choosing and locating means of indirect vision where necessary (mirrors, etc.) so as to take into account the characteristics of human vision, particularly when safe operation requires permanent direct control by the operator, for example: —the travelling and working area of mobile machines; —the zone of movement of lifted loads or of the carrier of machinery for lifting persons; —the area of contact of the tool of a hand-held or hand-guided machine with the material being worked. The design of the machine shall be such that, from the main control position, the operator is able to ensure that there are no exposed persons in the danger zones. b) The form and the relative location of the mechanical components parts: for instance, crushing and shearing hazards are avoided by increasing the minimum gap between the moving parts, such that the part of the body under consideration can enter the gap safely, or by		P

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	reducing the gap so that no part of the body can enter it (see ISO 13854 and ISO 13857). 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. d) The form of the machine is designed so as to achieve a suitable working position and provide accessible manual controls (actuators).		
6.2.2.2	**Physical aspects**		
	Such aspects include the following: a) limiting the actuating force to a sufficiently low value so that the actuated part does not generate a mechanical hazard; b) limiting the mass and/or velocity of the movable elements, and hence their kinetic energy; c) limiting the emissions by acting on the characteristics of the source using measures for reducing 1) noise emission at source (see ISO/TR 11688-1), 2) the emission of vibration at source, such as redistribution or addition of mass and changes of process parameters [for example, frequency and/or amplitude of movements (for hand-held and hand-guided machinery, see CR 1030-1)], 3) the emission of hazardous substances, including the use of less hazardous substances or dust-reducing processes (granules instead of powders, milling instead of grinding), and 4) radiation emissions, including, for example, avoiding the use of hazardous radiation sources, limiting the power of radiation to the lowest level sufficient for the proper functioning of the machine, designing the source so that the 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**		
	This general technical knowledge can be derived from technical specifications for design (standards, design codes, calculation rules, etc.), which should be used to cover a) mechanical stresses such as —stress limitation by implementation of correct calculation, construction and fastening methods as regards, for example, bolted assemblies and welded assemblies, —stress limitation by overload prevention (bursting disk,		P

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	pressure-limiting valves, breakage points,torque-limiting devices, etc.), —avoiding fatigue in elements under variable stresses (notably cyclic stresses), and —static and dynamic balancing of rotating elements, b) materials and their properties such as —resistance to corrosion, ageing, abrasion and wear, —hardness, ductility, brittleness, —homogeneity, —toxicity, and —flammability, and c) emission values for —noise, —vibration, —hazardous substances, and —radiation. 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 workingcoefficients.		
6.2.4	**Choice of appropriate Testing**		
	One or more hazards can be eliminated or risks reduced by the choice of the Testing to be used in certain applications such as the following: a)on machines intended for use in explosive atmospheres, using —appropriately selected pneumatic or hydraulic control system and machine actuators, —intrinsically safe electrical equipment (see IEC 60079-11); 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; c)the use of alternative equipment to avoid high noise levels, such as —electrical instead of pneumatic equipment, —in certain conditions, water-cutting instead of mechanical equipment.		N
6.2.5	**Applying principle of positive mechanical action**		
	Positive mechanical action is achieved when a moving mechanical component inevitably moves another component along with it, either by direct contact or via rigid elements. An example of this 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**		
	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 —the geometry of the base, —the weight distribution, including loading, —the dynamic forces due to movements of parts of the		P

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	machine, of the machine itself or of elements held by the machine which can result in an overturning moment, —vibration, —oscillations of the centre of gravity, —characteristics of the supporting surface in case of travelling or installation on different sites (ground conditions, slope, etc.), and —external forces, such as wind pressure and manual forces. Stability shall be considered in all phases of the life cycle of the machine, including handling, travelling, installation, use, dismantling, disabling and scrapping. Other protective measures for stability relevant to safeguarding are given in 6.3.2.6.		
6.2.7	**Provisions for maintainability**		
	When designing a machine, the following maintainability factors shall be taken into account to enable maintenance of the machine: —accessibility, taking into account the environment and the human body measurements, including the dimensions of the working clothes and tools used; —ease of handling, taking into account human capabilities; —limitation of the number of special tools and equipment.		P
6.2.8	**Observing ergonomic principles**		
	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. NOTE Also improved are the performance and reliability of operation and hence the reduction in the probability of errors at all stages of machine use. Account shall be taken of body sizes likely to be found in the intended user population, strengths and postures, movement amplitudes, frequency of cyclic actions (see ISO 10075 and ISO 10075-2). All elements of the operator–machine interface, such as controls, signalling or data display elements shall be designed to be easily understood so that clear and unambiguous interaction between the operator and the machine is possible. See EN 614-1, EN 13861 and IEC 61310-1. The designer's attention is particularly drawn to following ergonomic aspects of machine design. 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). 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		P

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	and hand, arm and leg anatomy. c) Limit as far as possible noise, vibration and thermal effects such as extreme temperatures. d) Avoid linking the operator's working rhythm to an automatic succession of cycles. 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. f) Select, locate and identify manual controls (actuators) so that —they are clearly visible and identifiable, and appropriately marked where necessary (see 6.4.4), —they can be safely operated without hesitation or loss of time and without ambiguity (for example, a standard layout of controls reduces the possibility of error when an operator changes from a machine to another one of similar type having the same pattern of operation), —their location (for push-buttons) and their movement (for levers and hand wheels) are consistent with their effect (see IEC 61310-3), and —their operation cannot cause additional risk. See also ISO 9355-3.		
6.2.9	**Electrical hazards**		
	For the design of the electrical equipment of machines, IEC 60204-1 gives general provisions about disconnection and switching of electrical circuits and for protection against electric shock. For requirements related to specific machines, see corresponding IEC standards (for example, IEC 61029, IEC 60745 or IEC 60335).		P
6.2.10	**Pneumatic and hydraulic hazard**		
	Pneumatic and hydraulic equipment of machinery shall be designed so that —the maximum rated pressure cannot be exceeded in the circuits (using, for example, pressure-limiting devices), —no hazard results from pressure fluctuations or increases, or from loss of pressure or vacuum, —no hazardous fluid jet or sudden hazardous movement of the hose (whiplash) results from leakage or component failures, —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, —all elements of the equipment, especially pipes and hoses, are protected against harmful external effects, —as far as possible, reservoirs and similar vessels (for		N

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	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 —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.		
6.2.11	**Applying inherently safe design measures to control systems**		
6.2.11.1	**General**		
	The design measures of the control system shall be chosen so that their safety-related performance provides a sufficient amount of risk reduction (see ISO 13849-1 or IEC 62061). The correct design of machine control systems can avoid unforeseen and potentially hazardous machine behavior. Typical causes of hazardous machine behavior are —an unsuitable design or modification (accidental or deliberate) of the control system logic, —a temporary or permanent defect or failure of one or several components of the control system, —a variation or a failure in the power supply of the control system, and —inappropriate selection, design and location of the control devices. Typical examples of hazardous machine behavior are —unexpected start-up (see ISO 14118), —uncontrolled speed change, —failure to stop moving parts, —dropping or ejection of part of the machine or of a workpiece clamped by the machine, and —machine action resulting from inhibition (defeating or failure) of protective devices. 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). Control systems shall be designed to enable the operator to interact with the machine safely and easily. This requires one or several of the following solutions: —systematic analysis of start and stop conditions; —provision for specific operating modes (for example, start-		P

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	up after normal stop, restart after cycle interruption or after emergency stop, removal of the workpieces contained in the machine, operation of a part of the machine in case of a failure of a machine element); —clear display of the faults; —measures to prevent accidental generation of unexpected start commands (for example, shrouded start device) likely to cause dangerous machine behaviour (see ISO 14118:2000, Figure 1); —maintained stop commands (for example, interlock) to prevent restarting that could result in dangerous machine behaviour (see ISO 14118:2000, Figure 1). An assembly of machines may be divided into several zones for emergency stopping, for stopping as a result of protective devices and/or for isolation and energy dissipation. The different zones shall be clearly defined and it shall be obvious which parts of the machine belong to which zone. Likewise, it shall be obvious which control devices (for example, emergency stop devices, supply disconnecting devices) and/or protective devices belong to which zone. The interfaces between zones shall be designed such that no function in one zone creates hazards in another zone which has been stopped for an intervention. Control systems shall be designed to limit the movements of parts of the machinery, the machine itself, or workpieces and/or loads held by the machinery, to the safe design parameters (for example, range, speed, acceleration, deceleration, load capacity). Allowance shall be made for dynamic effects (swinging of loads, etc.). For example: —the travelling speed of mobile pedestrian controlled machinery other than remote-controlled shall be compatible with walking speed; —the range, speed, acceleration and deceleration of movements of the person-carrier and carrying vehicle for lifting persons shall be limited to non-hazardous values, taking into account the total reaction time of the operator and the machine; —the range of movements of parts of machinery for lifting loads shall be kept within specified limits. 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).		
6.2.11.2	**Starting of an internal power source/switching on an external power supply**		
	The starting of an internal power source or switching-on of an external power supply shall not result in a hazardous situation. For example: —starting the internal combustion engine shall not lead to movement of a mobile machine;		P

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	—connection to mains electricity supply shall not result in the starting of working parts of a machine. See IEC 60204-1:2005, 7.5 (see also Annexes A and B).		
6.2.11.3	**Starting/stopping of a mechanism**		
	The primary action for starting or accelerating the movement of a mechanism should be performed by 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). 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). In certain applications, such as high-voltage switch gear, 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. 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**		
	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).		NN
6.2.11.5	**Interruption of power supply**		
	Machinery shall be designed to prevent hazardous situations resulting from interruption or excessive fluctuation of the power supply. At least the following requirements shall be met: —the stopping function of the machinery shall remain; —all devices whose permanent operation is required for safety shall operate in an effective way to maintain safety (for example, locking, clamping devices, cooling or heating devices, power-assisted steering of self-propelled mobile machinery); —parts of machinery or workpieces and/or loads held by machinery which are liable to move as a result of potential energy shall be retained for the time necessary to allow them to be safely lowered.		N
6.2.11.6	**Use of automatic monitoring**		
	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		N

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	generated. 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). The protective measure may be, for example, —the stopping of the hazardous process, —preventing the restart of this process after the first stop following the failure, or —the triggering of an alarm.		
6.2.11.7	**Safety functions implemented by programmable electronic control systems**		
6.2.11.7.1	**General**		
	A control system that includes programmable electronic equipment (for example, programmable controllers) can, where appropriate, be used to implement safety functions at machinery. Where a programmable electronic control system is used, it is necessary to consider its performance requirements in relation to the requirements for the safety functions. The design of the programmable electronic control system shall be such that the probability of random hardware failures and the likelihood of systematic failures that can adversely affect the performance of the safety-related control function(s) is sufficiently low. Where a programmable electronic control system performs a monitoring function, the system behavior on detection of a fault shall be considered (see also the IEC 61508 series for further guidance). NOTE Both ISO 13849-1 and IEC 62061, specific to machinery safety, provide guidance applicable to programmable electronic control systems. 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**		
	The hardware (including, for example, sensors, actuators and logic solvers) shall be selected, and/or designed and installed, to meet both the functional and performance requirements of the safety function(s) to be performed, in particular, by means of —architectural constraints (the configuration of the system,		P

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	its ability to tolerate faults, its behaviour on detection of a fault, etc.), —selection, and/or design, of equipment and devices with an appropriate probability of dangerous random hardware failure, and —the incorporation of measures and techniques within the hardware so as to avoid systematic failures and control systematic faults.		
6.2.11.7.3	**Software aspects**		
	The software, including internal operating software (or system software) and application software, shall be designed so as to satisfy the performance specification for the safety functions (see also IEC 61508-3). 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)]. When the application requires reprogramming by the user, the access to the software dealing with safety functions should be restricted (for example, by locks or passwords for the authorized persons).		N
6.2.11.8	**Principles relating to manual control**		
	These are as follows. a) Manual control devices shall be designed and located according to the relevant ergonomic principles given in 6.2.8, item f). 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. 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. d) Whenever possible, control devices and control positions shall be located so that the operator is able to observe the working area or hazard zone. 1) The driver of a ride-on mobile machine shall be able to actuate all control devices required to operate the machine from the driving position, except for functions which can be controlled more safely from other positions. 2) On machinery intended for lifting persons, controls for lifting and lowering and, if appropriate, for moving the carrier shall generally be located in the carrier. If safe operation requires controls to be situated outside the carrier, the operator in the carrier shall be provided with the means of preventing hazardous movements. e) If it is possible to start the same hazardous element by		N

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	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. 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). 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). 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).		
6.2.11.9	**Control mode for setting, teaching, process changeover, fault-finding, cleaning or maintenance**		
	Where, for setting, teaching, process changeover, fault-finding, cleaning or maintenance of machinery, a guard has to 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 a) disables all other control modes, b) permits operation of the hazardous elements only by continuous actuation of an enabling device, a two-hand control device or a hold-to-run control device, c) permits operation of the hazardous elements only in reduced risk conditions (for example, reduced speed, reduced power/force, step-by-step, for example, with a limited movement control device), and d) prevents any operation of hazardous functions by voluntary or involuntary action on the machine's sensors. NOTE For some special machinery other protective measures can be appropriate. This control mode shall be associated with one or more of the following measures: —restriction of access to the danger zone as far as possible; —emergency stop control within immediate reach of the operator; —portable control unit (teach pendant) and/or local controls (allowing sight of the controlled elements). See IEC 60204-1.		P
6.2.11.10	**Selection of control and operating modes**		

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

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	components.		
6.2.12.3	**Use of "oriented failure mode" components**		
	"Oriented failure mode" components or systems are those in which the predominant failure mode is known in advance and which can be used so that the effect of such a failure on the machine function can be predicted. NOTE In some cases, it will be necessary to take additional measures to limit the negative effects of such a failure. The use of such components should always be considered, particularly in cases where redundancy (see 6.2.12.4) is not employed.		N
6.2.12.4	**Duplication (or redundancy) of components or subsystems**		
	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. 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. Diversity of design and/or Testing can be used to avoid common cause failures (for example, from electromagnetic disturbance) or common mode failures.		N
6.2.13	**Limiting exposure to hazards through reliability of equipment**		
	Increased reliability of all component parts of machinery reduces the frequency of incidents requiring intervention, thereby reducing exposure to hazards. 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. Safety-related components (for example, certain sensors) of known reliability shall be used. 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**		
	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. Automation can be achieved by, for example, robots, handling devices, transfer mechanisms and air-blast equipment. Mechanization can be achieved by, for example, feeding slides, push-rods and hand-operated indexing tables.		N

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	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. 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.		
6.2.15	**Limiting exposure to hazards through location of setting and maintenance points outside danger zones**		
	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**		
6.3.1	**General**		
	Guards and protective devices shall be used to protect persons whenever an inherently safe design measure does not reasonably make it possible either to remove hazards or to sufficiently reduce risks. Complementary protective measures involving additional equipment (for example, emergency stop equipment) may have to be implemented. NOTE The different kinds of guards and protective devices are defined in 3.27 and 3.28. Certain safeguards may be used to avoid exposure to more than one hazard. EXAMPLE A fixed guard preventing access to a zone where a mechanical hazard is present used to reduce noise levels and collect toxic emissions.		P
6.3.2	**Selection and implementation of guards and protective devices**		
6.3.2.1	**General**		
	This subclause gives guidelines for the selection and the implementation of guards and protective devices the primary purpose of which is to protect persons against 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). The exact choice of a safeguard for a particular machine shall be made on the basis of the risk assessment for that machine. 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		P

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	machinery. 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). 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. Consideration shall be given to the enclosure of control positions or intervention zones to provide combined protection against several hazards including a) hazards from falling or ejected objects, using, for example, protection in the form of a falling object protection structure (FOPS), b) emission hazards (protection against noise, vibration, radiation, substances hazardous to health, etc.), c) hazards due to the environment (protection against heat, cold, foul weather, etc.), 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). The design of enclosed work stations, such as cabs and cabins, shall take into account ergonomic principles concerning visibility, lighting, atmospheric conditions, access, posture.		
6.3.2.2	**Where access to the hazard zone is not required during normal operation**		
	Where access to the hazard zone is not required during normal operation of the machinery, safeguards should be selected from the following: a) fixed guards (see also ISO 14120); b) interlocking guards with or without guard locking (see also 6.3.3.2.3, ISO 14119 and ISO 14120); c) self-closing guards (see ISO 14120:2002, 3.3.2); 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**		
	Where access to the hazard zone is required during normal operation of the machinery, safeguards should be selected from the following: a) interlocking guards with or without guard locking (see also ISO 14119, ISO 14120 and 6.3.3.2.3 of this document); b) sensitive protective equipment, such as electrosensitive protective equipment (see IEC 61496);		P

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	c) adjustable guards; d) self-closing guards (see ISO 14120:2002, 3.3.2); e) two-hand control devices (see ISO 13851); f) interlocking guards with a start function (control guard) (see 6.3.3.2.5).		
6.3.2.4	**Where access to the hazard zone is required for machine setting, teaching, process changeover, fault-finding, cleaning or maintenance**		
	production operator also ensure the protection of personnel carrying out setting, teaching, process changeover, fault-finding, cleaning or maintenance, without hindering them in the performance of their task. Such tasks shall be identified and considered in the risk assessment as parts of the use of the machine (see 5.2). NOTE Isolation and energy dissipation for machine shut-down (see 6.3.5.4, and also ISO 14118:2000, 4.1 and Clause 5) ensure the highest level of safety when carrying out tasks (especially maintenance and repair tasks) that do not require the machine to remain connected to its power supply.		N
6.3.2.5	**Selection and implementation of sensitive protective equipment**[1)]		
6.3.2.5.1	Due to the great diversity of the technologies on which their detection function is based, all types of sensitive protective equipment are far from being equally suitable for safety applications. The following provisions are intended to provide the designer with criteria for selecting, for each application, the most suitable device(s). Types of sensitive protective equipment include —light curtains, —scanning devices, for example, laser scanners, —pressure-sensitive mats, and —trip bars, trip wires. Sensitive protective equipment can be used —for tripping purposes, —for presence sensing, —for both tripping and presence sensing, or —to re-initiate machine operation — a practice subject to stringent conditions. NOTE Some types of sensitive protective equipment can be unsuitable either for presence sensing or for tripping purposes. The following characteristics of the machinery, among others, can preclude the sole use of sensitive protective equipment: —tendency for the machinery to eject materials or component parts; —necessity to guard against emissions (noise, radiation, dust, etc.); —erratic or excessive machine stopping time; —inability of a machine to stop part-way through a cycle.		P
6.3.2.5.2	**Implementation**		
	Consideration should be given to		P

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	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), b) the reaction of the device to fault conditions (see IEC 61496 for electrosensitive protective equipment), c) the possibility of circumvention, and 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). NOTE 1 IEC 61496 defines the detection capability of electrosensitive protective equipment. Sensitive protective equipment shall be integrated in the operative part and associated with the control system of the machine so that —a command is given as soon as a person or part of a person is detected, —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, —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, —the machine cannot operate during interruption of the detection function of the sensitive protective equipment, except during muting phases, and —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. NOTE 2 Muting is the temporary automatic suspension of a safety function(s) by safety-related parts of the control system (see ISO 13849-1). For detailed consideration of the fault behaviour of, for example, active optoelectronic protective devices, IEC 61496 should be taken into account.		
6.3.2.5.3	**Additional requirements for sensitive protective equipment when used for cycle initiation**		
	In this exceptional application, the starting of the machine cycle is initiated by the withdrawal of a person or of the detected part of a person from the sensing field of the sensitive protective equipment, without any additional start command, hence deviating from the general requirement given in the second point of the dashed list in 6.3.2.5.2, above. After switching on the power supply, or when the machine has been stopped by the tripping function of the sensitive protective equipment, the machine cycle shall be		N

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	initiated only by voluntary actuation of a start control. Cycle initiation by sensitive protective equipment shall be subject to the following conditions: a) only active optoelectronic protective devices (AOPDs) complying with IEC 61496 series shall be used; b) the requirements for an AOPD used as a tripping and presence-sensing device (see IEC 61496) are satisfied — in particular, location, minimum distance (see ISO 13855), detection capability, reliability and monitoring of control and braking systems; c) the cycle time of the machine is short and the facility to re-initiate the machine upon clearing of the sensing field is limited to a period commensurate with a single normal cycle; d) entering the sensing field of the AOPD(s) or opening interlocking guards is the only way to enter the hazard zone; e) if there is more than one AOPD safeguarding the machine, only one of the AOPDs is capable of cycle re-initiation; f) with regard to the higher risk resulting from automatic cycle initiation, the AOPD and the associated control system comply with a higher safety-related performance than under normal conditions. NOTE 1 The hazard zone as referred to in d) is any zone where the hazardous function (including ancillary equipment and transmission elements) is initiated by clearing of the sensing field. NOTE 2 See also IEC/TS 62046.		
6.3.2.6	**Protective measures for stability**		
	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 —anchorage bolts, —locking devices, —movement limiters or mechanical stops, —acceleration or deceleration limiters, —load limiters, and —alarms warning of the approach to stability or tipping limits.		P
6.3.2.7	**Other protective devices**		
	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 —when the operator has insufficient visibility of the hazard zone, —when the operator lacks knowledge of the actual value of a safety-related parameter (distance, speed,mass, angle, etc.), and —when hazards can result from operations other than those		P

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	controlled by the operator. The necessary devices include a) devices for limiting parameters of movement (distance, angle, velocity, acceleration), b) overloading and moment limiting devices, c) devices to prevent collisions or interference with other machines, d) devices for preventing hazards to pedestrian operators of mobile machinery or other pedestrians, e) torque limiting devices, and breakage points to prevent excessive stress of components and assemblies, f) devices for limiting pressure or temperature, g) devices for monitoring emissions, h) devices to prevent operation in the absence of the operator at the control position, i) devices to prevent lifting operations unless stabilizers are in place, j) devices to limit inclination of the machine on a slope, and k) devices to ensure that components are in a safe position before travelling. 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).		
6.3.3	**Requirements for design of guards and protective devices**		
6.3.3.1	**General requirements**		
	Guards and protective devices shall be designed to be suitable for the intended use, taking into account mechanical and other hazards involved. Guards and protective devices shall be compatible with the working environment of the machine and designed so that they cannot be easily defeated. They shall provide the minimum possible interference with activities during operation and other phases of machine life, in order to reduce any incentive to defeat them. NOTE For additional information, see ISO 14120, ISO 13849-1, ISO 13851, ISO 14119, ISO 13856, IEC 61496 and IEC 62061. Guards and protective devices shall a) be of robust construction, b) not give rise to any additional hazard, c) not be easy to bypass or render non-operational, d) be located at an adequate distance from the danger zone (see ISO 13855 and ISO 13857), e) cause minimum obstruction to the view of the production process, and f) enable essential work to be carried out for the installation and/or replacement of tools and for maintenance by allowing access only to the area where the work has to be		P

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	carried out — if possible, without the guard having to be removed or protective device having to be disabled. For openings in the guards, see ISO 13857.		
6.3.3.2	**Requirements for guards**		
6.3.3.2.1	**Functions of guards**		
	The functions that guards can achieve are —prevention of access to the space enclosed by the guard, and/or —containment/capture of materials, workpieces, chips, liquids which can be ejected or dropped by the machine, and reduction of emissions (noise, radiation, hazardous substances such as dust, fumes, gases) that can be generated by the machine. Additionally, they could need to have particular properties relating to electricity, temperature, fire, explosion, vibration, visibility (see ISO 14120) and operator position ergonomics (for example, usability, operator's movements, postures, repetitive movements).		P
6.3.3.2.2	**Requirements for fixed guards**		
	Fixed guards shall be securely held in place either —permanently (for example by welding), or —by means of fasteners (screws, nuts) making removal/opening impossible without using tools; they should not remain closed without their fasteners (see ISO 14120). NOTE A fixed guard can be hinged to assist in its opening.		P
6.3.3.2.3	**Requirements for movable guards**		
	Movable guards which provide protection against hazards generated by moving transmission parts shall a) as far as possible when open remain fixed to the machinery or other structure (generally by means of hinges or guides), and b) be interlocking (with guard locking when necessary) (see ISO 14119). See Figure 4. Movable guards against hazards generated by non-transmission moving parts shall be designed and associated with the machine control system so that —moving parts cannot start up while they are within the operator's reach and the operator cannot reach moving parts once they have started up, with this able to be achieved by interlocking guards, with guard locking when necessary, —they can be adjusted only by an intentional action, such as the use of a tool or a key, and —the absence or failure of one of their components either prevents starting of the moving parts or stops them, with this able to be achieved by automatic monitoring (see 6.2.11.6). See Figure 4 and ISO 14119.		P

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6.3.3.2.4	**Requirements for adjustable guards**		
	Adjustable guards may only be used where the hazard zone cannot for operational reasons be completely enclosed. Manually adjustable guards shall be —designed so that the adjustment remains fixed during a given operation, and —readily adjustable without the use of tools.		P
6.3.3.2.5	**Requirements for interlocking guards with a start function (control guards)**		
	An interlocking guard with a start function may only be used provided that a) all requirements for interlocking guards are satisfied (see ISO 14119), b) the cycle time of the machine is short, 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, 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), e) all other guards, whether fixed (removable type) or movable, are interlocking guards, 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 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.		N
6.3.3.2.6	**Hazards from guards**		
	Care shall be taken to prevent hazards which could be generated by —the guard construction (sharp edges or corners, material, noise emission, etc.), —the movements of the guards (shearing or crushing zones generated by power-operated guards and by heavy guards which are liable to fall).		P
6.3.3.3	**Technical characteristics of protective devices**		
	Protective devices shall be selected or designed and connected to the control system such that correct implementation of their safety function(s) is ensured. Protective devices shall be selected on the basis of their having met the appropriate product standard (for example, IEC 61496 for active optoelectronic protective devices) or shall be designed according to one or several of the principles formulated in ISO 13849-1 or IEC 62061.		P

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	Protective devices shall be installed and connected to the control system so that they cannot be easily defeated.		
6.3.3.4	**Provisions for alternative types of safeguards**		
	Provisions should be made to facilitate the fitting of alternative types of safeguards on machinery where it is known that it will be necessary to change the safeguards because of the range of work to be carried out.		P
6.3.4	**Safeguarding to reduce emissions**		
6.3.4.1	**General**		
	If the measures for the reduction of emissions at source specified in 6.2.2.2 are not adequate, the machine shall be provided with additional protective measures (see 6.3.4.2 to 6.3.4.5).		P
6.3.4.2	**Noise**		
	Additional protective measures against noise include —enclosures (see ISO 15667), —screens fitted to the machine, and —silencers (see ISO 14163).		P
6.3.4.3	**Vibration**		
	Additional protective measures against vibration include —vibration isolators, such as damping devices placed between the source and the exposed person, —resilient mounting, and —suspended seats. For measures for vibration isolation of stationary industrial machinery see EN 1299.		P
6.3.4.4	**Hazardous substances**		
	Additional protective measures against hazardous substances include —encapsulation of the machine (enclosure with negative pressure), —local exhaust ventilation with filtration, —wetting with liquids, and —special ventilation in the area of the machine (air curtains, cabins for operators). See ISO 14123-1.		N
6.3.4.5	**Radiation**		
	Additional protective measures against radiation include —use of filtering and absorption, and —use of attenuating screens or guards.		N
6.3.5	**Complementary protective measures**		
6.3.5.1	**General**		
	Protective measures which are neither inherently safe design measures, nor safeguarding (implementation of guards and/or protective devices), nor information for use, could have to be implemented as required by the intended use and the reasonably foreseeable misuse of the machine. Such measures include, but are not limited to, those dealt with in 6.3.5.2 to 6.3.5.6.		P
6.3.5.2	**Components and elements to achieve emergency stop function**		

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	If, following a risk assessment, a machine needs to be fitted with components and elements to achieve an emergency stop function for enabling actual or impending emergency situations to be averted, the following requirements apply: —the actuators shall be clearly identifiable, clearly visible and readily accessible; —the hazardous process shall be stopped as quickly as possible without creating additional hazards, but if this is not possible or the risk cannot be reduced, it should be questioned whether implementation of an emergency stop function is the best solution; —the emergency stop control shall trigger or permit the triggering of certain safeguard movements where necessary. NOTE For more detailed provisions, see ISO 13850. Once active operation of the emergency stop device has ceased following an emergency stop command, the effect of this command shall be sustained until it is reset. This reset shall be possible only at the location where the emergency stop command has been initiated. The reset of the device shall not restart the machinery, but shall only permit restarting. More details for the design and selection of electrical components and elements to achieve the emergency stop function are provided in IEC 60204.		P
6.3.5.3	**Measures for the escape and rescue of trapped persons**		
	Measures for the escape and rescue of trapped persons may consist, among others, of —escape routes and shelters in installations generating operator-trapping hazards, —arrangements for moving some elements by hand, after an emergency stop, —arrangements for reversing the movement of some elements, —anchorage points for descender devices, —means of communication to enable trapped operators to call for help.		P
6.3.5.4	**Measures for isolation and energy dissipation**		
	Machines shall be equipped with the technical means to achieve isolation from power supply(ies) and dissipation of stored energy by means of the following actions: a) isolating (disconnecting, separating) the machine (or defined parts of the machine) from all power supplies; b) locking (or otherwise securing) all the isolating units in the isolating position; c) dissipating or, if this is not possible or practicable, restraining (containing) any stored energy which can give rise to a hazard; d) verifying, by means of safe working procedures, that the		N/A

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	actions taken according to a), b) and c) above have produced the desired effect. See ISO 14118:2000, Clause 5, and IEC 60204-1:2005, 5.5 and 5.6.		
6.3.5.5	**Provisions for easy and safe handling of machines and their heavy component parts**		
	Machines and their component parts which cannot be moved or transported by hand shall be provided or be capable of being provided with suitable attachment devices for transport by means of lifting gear. These attachments may be, among others, —standardized lifting appliances with slings, hooks, eyebolts, or tapped holes for appliance fixing, —appliances for automatic grabbing with a lifting hook when attachment is not possible from the ground, —fork locating devices for machines to be transported by a lift truck, —lifting and stowing gear and appliances integrated into the machine. Parts of machinery which can be removed manually in operation shall be provided with means for their safe removal and replacement. See also 6.4.4 c), item 3).		N
6.3.5.6	**Measures for safe access to machinery**		
	Machinery shall be so designed as to enable operation and all routine tasks relating to setting and/or maintenance to be carried out as far as possible by a person remaining at ground level. Where this is not possible, machines shall have built-in platforms, stairs or other facilities to provide safe access for those tasks; however, care should be taken to ensure that such platforms or stairs do not give access to danger zones of machinery. The walking areas shall be made from materials which remain as slip resistant as practicable under working conditions and, depending on the height from the ground, shall be provided with suitable guard-rails (see ISO 14122-3). In large automated installations, particular attention shall be given to safe means of access, such as walkways, conveyor bridges or crossover points. Means of access to parts of machinery located at height shall be provided with collective means of protection against falls (for example, guard-rails for stairways, stepladders and		N

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	platforms and/or safety cages for ladders). As necessary, anchorage points for personal protective equipment against falls from height shall also be provided (for example, in carriers of machinery for lifting persons or with elevating control stations). Openings shall, whenever possible, open towards a safe position. They shall be designed to prevent hazards due to unintended opening. The necessary aids for access shall be provided (steps, handholds, etc.). Control devices shall be designed and located to prevent their being used as aids for access. When machinery for lifting goods and/or persons includes landings at fixed levels, these shall be equipped with interlocking guards for preventing falls when the platforms is not present at a level. Movement of the lifting platforms shall be prevented while the guards are open. For detailed provisions see ISO 14122.		
6.4	**Information for use**		
6.4.1	**General requirements**		
6.4.1.1	Drafting information for use is an integral part of the design of a machine (see Figure 2).Information for use consists of communication links, such as texts, words, signs, signals, symbols or diagrams,used separately or in combination to convey information to the user. Information for use is intended for professional and/or non-professional users. NOTE See also IEC 62079 for structuring and presentation of information for use.		P
6.4.1.2	Information shall be provided to the user about the intended use of the machine, taking into account, notably, all its operating modes. The information shall contain all directions required to ensure safe and correct use of the machine. With this in view, it shall inform and warn the user about residual risk. The information shall indicate, as appropriate, —the need for training, —the need for personal protective equipment, and —the possible need for additional guards or protective devices (see Figure 2, Footnote d). It shall not exclude uses of the machine that can reasonably be expected from its designation and description and shall also warn about the risk which would result from using the machine in other ways than the ones described in the information, especially considering its reasonably		P

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

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	1) the name and address of the manufacturer, 2) the designation of series or type, and 3) the serial number, if any, b) in order to indicate its compliance with mandatory requirements, comprising 1) marking, and 2) written indications, such as the authorized representative of the manufacturer, designation of the machinery, year of construction, and intended use in potentially explosive atmospheres), c) for its safe use, for example, 1) maximum speed of rotating parts, 2) maximum diameter of tools, 3) mass (in kilograms) of the machine itself and/or of removable parts, 4) maximum working load, 5) necessity of wearing personal protective equipment, 6) guard adjustment data, and 7) frequency of inspection. Information printed directly on the machine should be permanent and remain legible throughout the expected life of the machine. Signs or written warnings indicating only “Danger” shall not be used. 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. Signs and pictograms should only be used if they are understood in the culture in which the machinery is to be Used. Written warnings shall be drawn up in the language(s) of the country in which the machine will be used for the first time and, on request, in the language(s) understood by operators. NOTE In some countries the use of specific language(s) is covered by legal requirements. Markings shall comply with recognized standards (for example, ISO 2972 or ISO 7000, for pictograms,symbols and colours in particular). See IEC 60204-1 as regards marking of electrical equipment.		

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	See ISO 4413 and ISO 4414 for hydraulic and pneumatic equipment.		
6.4.5	**Accompanying documents (in particular — instruction handbook)**		
6.4.5.1	**Contents**		
	The instruction handbook or other written instructions (for example, on the packaging) shall contain, among others, the following: a) information relating to transport, handling and storage of the machine, such as 1) storage conditions for the machine, 2) dimensions, mass value(s), position of the centre(s) of gravity, and 3) indications for handling (for example, drawings indicating application points for lifting equipment); b) information relating to installation and commissioning of the machine, such as 1) fixing/anchoring and dampening of noise and vibration requirements, 2) assembly and mounting conditions, 3) space needed for use and maintenance, 4) permissible environmental conditions (for example, temperature, moisture, vibration, electromagnetic radiation), 5) instructions for connecting the machine to power supply (particularly on protection against electrical overloading), 6) advice on waste removal/disposal, and 7) if necessary, recommendations related to protective measures which have to be implemented by the user — for example, additional safeguards (see Figure 2, Footnote d), safety distances, safety signs and signals; c) information relating to the machine itself, such as 1) detailed description of the machine, its fittings, guards and/or protective devices, 2) the comprehensive range of applications for which the machine is intended, including prohibited usages, if any, taking into account variations of the original machine if appropriate, 3) diagrams (especially schematic representation of safety functions), 4) data on noise and vibration generated by the machine, and on radiation, gases, vapours and dust emitted by it, with reference to the measuring methods (including measurement uncertainties) used, 5) technical documentation of electrical equipment (see IEC 60204), and 6) documents attesting that the machine complies with mandatory requirements; d) information relating to the use of the machine, such as that related to or describing 1) intended use,		P

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

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	be emphasized by the use of colours, symbols and/or large print. b) The information for use shall be given in the language(s) of the country in which the machine will be used for the first time and in the original version. If more than one language is to be used, each should be readily distinguished from another, and efforts should be made to keep the translated text and relevant illustration together. NOTE In some countries the use of specific language(s) is covered by legal requirements. c) Whenever helpful to the understanding, text should be supported by illustrations. These illustrations should be supplemented with written details enabling, for example, manual controls (actuators) to be located and identified. They should not be separated from the accompanying text and should follow sequential operations. d) Consideration should be given to presenting information in tabular form where this will aid understanding.Tables should be adjacent to the relevant text. e) The use of colours should be considered, particularly in relation to components requiring quick identification. f) When information for use is lengthy, a table of contents and/or an index should be provided. g) Safety-relevant instructions which involve immediate action should be provided in a form readily available to the operator.		
6.4.5.3	**Drafting and editing information for use**		
	The following applies to the drafting and editing of information for use. a) Relationship to model: the information shall clearly relate to the specific model of machine and, if necessary, other appropriate identification (for example, by serial number). b) Communication principles: when information for use is being prepared, the communication process “see – think – use” should be followed in order to achieve the maximum effect and should follow sequential operations. The questions, “How?” and “Why?” should be anticipated and the answers provided. 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. d) When it is foreseen that a machine will be put to non-professional use, the instructions should be written in a form that is readily understood by the non-professional user. If personal protective equipment is required for the		P

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

Sample pictures

******END OF REPORT******